CASE STUDY ON THE APPLICATION OF UNFC TO ENERGY AND MINERAL RESOURCES IN UZBEKISTAN

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Contents

EXECUTIVE SUMMARY

In the Republic of Uzbekistan, geological exploration works for solid minerals (gold, uranium, coal and other non-metallic minerals) are carried out in accordance with the Methodological Instructions for geological exploration according to the stages, 1999 [1] and the Tentative classification of reserves and deposits and forecast resources of solid minerals, 1994 [2].

In general, a comparison of UNFC and the Uzbek classification shows, in general, the similarity of proposed approaches to the categorization of reserves (resources) based on the above three main characteristics. For each category of reserves (resources) allocated in UNFC, there is a corresponding analogue of the Uzbek classification.

In recent years, the country has been actively striving for attraction of foreign investments in all sectors. Application of the UNFC system certainly serves for efficient attraction of investments, conducting of international research in the field of energy and minerals, carrying out analysis in the field of resource management, industrial process planning and efficient allocation of capital.

In order to carry out this case study for the UNFC application to energy and mineral resources in Uzbekistan, two objects were selected – the Tebinbulak titanomagnetite ore deposit and the Tsentralny coal site – which could be characterized as follows (location of the selected objects is presented in Fig.1):

1. The Tebinbulak iron ore deposit is located in the north-western part of the Republic in the Sultanuvays Mountains. Administratively, it is located in the Karauzyak district of the Republic of Karakalpakstan, in 12 km north-east of the Karatau village. The nearest major settlements are the towns: Nukus (70 km to the north-west), Turtkul (90 km), Beruniy (60 km south-east). The Nukus-Uchkuduk highway runs in 3 km north of the deposit, the Nukus-Turtkul-Bukhara asphalted highway is 5 km to the west, and the Nukus-Karatak-Turtkul-Gazachak railway spur is in 5-7 km in the same direction. The Karauzyak nearest railway station with a large petroleum depot on its territory is located in 7 km to south-south-west from the center of the field. The source of electric power in the area is the Takhiatash State District Power Plant. In 5 km from the field there is the Takhiatash-Karatau-Turtkul high-voltage transmission line. The Bukhara-Center gas pipeline passes on the port side of the Amu Darya, and the Gazli-Nukus gas pipeline passes very close to the field. Along the Nukus-Turtkul highway, the Tyuya-Muyun-Nukus water conduit operates, providing water to nearby settlements. Currently, the final stage of appraisal works is underway at the deposit. Reserves (commercial products) in the projected contour of the quarry of the Tebinbulak deposit are calculated by B + C1 category - 1695.8 million tons with an average grade of 19.2% Fe2O3, at a cutoff grade 15%. In general, the Tebinbulak field qualifies as: E1.2 F1 G1, i.e. the project is commercial.
2. The Tsentralny coal site is located in the southern part of the Republic in the Baysuntau Mountains. Administratively, it belongs to the Baysun district of the Surkhandarya region of the Republic of Uzbekistan. The climate of the region is continental with extended hot, dry summer (up to + 40º) and short but cold winter (up to -20º) with heavy rainfall. The relief of the area is high-mountain, strongly dissected with absolute marks of 1750-3240 m. The site is located in 80 km north-west of the Shurchi nearest railway station and is connected to the Baysun city by an asphalt road 6 km in length. Power supply is possible to be produced from an electric substation of 6/0.4 kv (Gossets) from the Central Asian energy ring. Commercial coal-bearing

capacity is associated with the middle Jurassic deposits. Currently, at the field reserves by B+C1 categories are calculated at 6986.0 thousand tons and 5707.0 thousand tons at C2 category. The Tsentralny deposit is sufficiently studied and is considered to be promising for the construction of an exploration and production enterprise. The deposit can be assigned the E1.1. F1.2. G2 code of UNFC, and at the same time it can be classified as a “commercial project”.

Fig.1 – Map of the Republic of Uzbekistan and location of the objects selected for case study

NATIONAL CLASSIFICATION SYSTEM FOR ENERGY AND MINERAL RESOURCES AND BRIDGING OR MAPPING TO UNFC

Description and details of the national classification and management system

Currently, the Methodological guidelines on the exploration of the stages (solid minerals) adopted by the State Committee on Geology in 1999 are in force in the Republic of Uzbekistan.

Classification of mineral reserves (resources) of Uzbekistan is as follows (see Tab.1):

- Stage 1. Regional geological study of the territory of the Republic of Uzbekistan
- Stage 2. Geological survey of 1:50,000 (1:25,000) scale
- Stage 3. Prospecting
    A. Specialized advanced prospecting works
    B. Prospecting works
- Stage 4. Evaluation
    A. Preliminary assessment
    B. Detailed field assessment
- Stage 5. Exploration
- Stage 6. Supplementary exploration
- Stage 7. Operational exploration

Tab.1 – Stages of geological exploration for solid minerals in Uzbekistan

<table>
<tr><td colspan="4">Stage 1. Regional geological study of the territory of the Republic of Uzbekistan</td></tr>
<tr><td>A. Regional geological and geophysical surveys on a scale 1:1000000-1:500000</td><td>B. Regional geological survey, geophysical, geoecological, geodynamic, geochemical, aerospace geological, hydrogeological and engineering-geological works of a scale 1:200000 (1:100000)</td><td>C. Local conventional ultradeep work</td><td>D. Other small-scale studies and generalizations in terms of international cooperation in the study of the geological structure of the Earth, etc.</td></tr>
<tr><td colspan="4">Stage 2. Geological survey scale 1: 50000 (1: 25000) (Possible P_2 - (P_3))</td></tr>
<tr><td colspan="4">Stage 3. Search</td></tr>
<tr><td colspan="2">A. Specialized early search works operations (possible P_2 (P_3))</td><td colspan="2">B. Prospecting works (P_2 – P_1)</td></tr>
<tr><td colspan="4">Stage 4. Valuation</td></tr>
<tr><td colspan="2">A. A priori estimate (C_2, FS)</td><td colspan="2">D. Detailed assessment minefield (C_2-C_1, FS)</td></tr>
<tr><td colspan="4">Stage 5. Prospecting (C_2-C_1, FS)</td></tr>
<tr><td colspan="4">Stage 6. Additional exploration</td></tr>
<tr><td colspan="4">Stage 7. In-mine exploration</td></tr>
</table>

Relationship with other international systems

Comparison of national classification and CRIRSCO is presented in Tab.2.

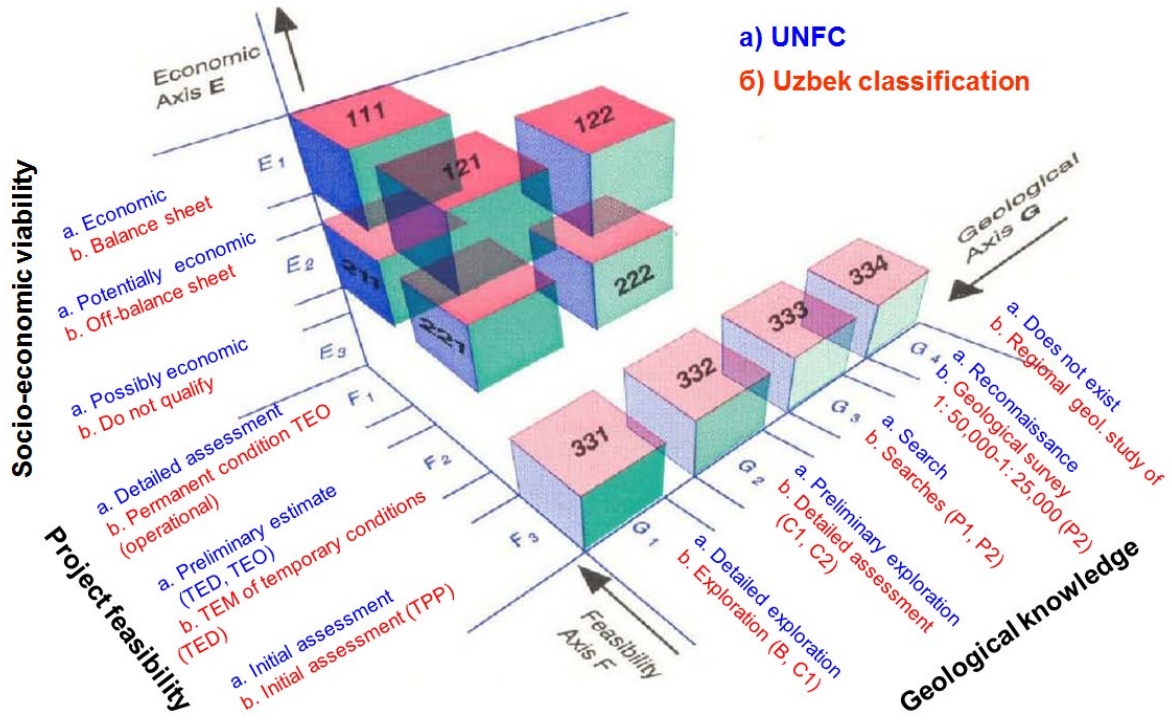
Tab.2 – Comparison of national classification and CRIRSCO

National Classification	$A+B+C_1$	C_1+C_2	P_1	P_2+P_3
Template categories CRIRSCO	measured resources (Rus.: “измеренные ресурсы”)	indicated resources (Rus.: “исчисленные ресурсы”)	Inferred (Rus.: “предполагаемые ресурсы”)	Exploration results (Rus.: “результаты геологических исследований”)

Relationship with UNFC

The comparison of UNFC and new Uzbek classification shows generally the similarity of the proposed approaches to the categorization of reserves (resources) based on the three main characteristics considered above. For each category of reserves (resources) allocated in UNFC, there is a corresponding analogue of the Uzbek classification (Fig.2).

Fig.2 – The principle of coding reserves (resources)



As regard the reserves (resources) separation into categories of economic efficiency proposed by UNFC – “economic” and “potentially economic” it coincides with the groups of reserves identified in the Uzbek classification as “balance” (economic) and “off-balance” (potentially economic). “Intrinsically Economic” is not qualified in the Uzbek classification (Tab.3).

Tab.3 – Social and economic viability

Cat.	UNFC Definition	Definition by Classification of the Republic of Uzbekistan
E1	Economic expediency of mining and marketing is confirmed	Balance sheet
E2	Assumed economic expediency	Off-balance-sheet
E3	Economic feasibility cannot be assumed	Do not qualify

Three stages of economic and technological study of the reserves (resources) of UNFC correspond to three stages of technical and economic assessment of reserves approved in Uzbekistan, and realized within the framework of working out the feasibility study, engineering and economic report, technical and economic substantiation, permanent or operational conditions, the requirements for which are generally consistent with the UNFC (Tab.4).

Tab.4 – Project feasibility

Cat.	UNFC Definition	Definition by Classification of the Republic of Uzbekistan
F1	Mining validity is confirmed	Feasibility study of permanent conditions (operational)
F2	Expediency of mining requires further evaluation	Technical and economic assessment of temporal conditions (Feasibility study of provisional standards)
F3	Mining validity cannot be assessed due to lack of technical data	Initial assessment (Feasibility Study)
F4	Development project or mining operations project is not available	Not qualified or considered as reserved - explored

The four stages of geological knowledge of reserves of the UNFC are basically similar to the stages of geological exploration, in the framework of which the reserves (resources) of various categories are justified (B, C_1, C_2, P_1, P_2) (Tab.5).

Tab.5 – Geological knowledge (State of geological exploration)

Cat.	UNFC Definition	Definition by Classification of the Republic of Uzbekistan
G1	Quantities can be estimated with a high degree of confidence	Exploration (B, C_1)
G2	Quantities can be estimated with an average degree of confidence	Detailed assessment (C_1, C_2)
G3	Quantities can be estimated with a low degree of confidence	Prospecting (P_1, P_2)
G4	Estimated quantities attributed to a potential deposit, which are mainly based on indirect data	Geological survey of 1:50000-1:25000 (P_2, P_3)
		Regional Geological Survey

It should be noted that when comparing the classifications under consideration, it should be borne in mind that the “detailed assessment” along the axis of geological knowledge in the classification adopted in Uzbekistan coincides with the stage of “preliminary exploration” at UNFC. Reserves explored and qualified in Uzbekistan, can be identified within the framework of the Republic of Kazakhstan with the assignment of appropriate codes.

The main conclusions are as follows. The UNFC principle of codification, based on the priority of the index of “economic effectiveness” is somewhat subjective. The reserves, quantity and quality of which allow them to be qualified as economic in one country, may be non-economic in another, and vice versa.

Compliance of the Uzbek classification with UNFC is rather high. The main difference of UNFC approach is to give economic factor a leading value. Other differences include:

- At staging of geological study, the term “Regional geological study” in UNFC does not exist.
- As noted above, preliminary exploration (reconnaissance) of UNFC corresponds to a detailed assessment of the Uzbek classification.
- «Detailed exploration» of the UNFC is similar to the term «exploration».
- The term “Additional exploration and Operational Exploration” of UNFC is not covered.
- The “reserves” and “resources” at UNFC are applied to codified reserves classes 111, 121, 122; the Uzbek classification also includes 211, 221, 222, 331 and 332.

Application of UNFC at geological exploration in Uzbekistan will require a reassessment of solid mineral reserves of all previously explored deposits based on market economy criteria.

BACKGROUND INFORMATION ON THE PROJECTS SELECTED FOR THE CASE STUDY

Tebinbulak titano-magnetite ores deposit

Previous work

The Tebinbulak area of titano-magnetite associated with the gabbro-pyroxenite massif of the same name was discovered in 1937. Ya.S. Wisniewski.

The Tebinbulak deposit of titano-magnetite ores has been known since 1937, and was subsequently studied during geological surveying at a scale of 1:100000 (1953-1956) and prospecting (1955-1956). As a result of special thematic works carried out in 1963-1966 by the Ministry of Geology of Uzbekistan, it was classified as Kachkanar (Ural, Russia) type and recognized as commercially interesting. In this regard, in 1968-1970, comprehensive geological and geophysical studies were conducted on the area of the deposit with drilling of several boreholes which confirmed the presence of titanium-magnetite mineralization.

A qualitatively new stage in the study of the Tebinbulak intrusion began with special work on the topic "Intrusions of ultrabasic and basic rocks of Uzbekistan and their ore content, performed in 1963–66 (VV Baranov et al., 1966). In these years, the manifestation, according to its petrological and metallogenic features, was attributed to the Kachkanar geological and industrial type. The estimated forecast resources of 1.5 billion tons have made it possible to classify it as large, industrially interesting objects and recommend it for setting up exploration work. Then these works were carried out in three stages:

- geophysical work and lithochemical testing;
- technological research of ores and
- compilation of a geological and economic justification for the feasibility of exploration.

According to the results of gravimetric studies, a significant depth of distribution of ultrabasic intrusive rocks was determined (more than 1.0 km) (its potential productivity was determined at 1.5 billion tons). Terrestrial magnetic imaging of a base of 1: 10000 revealed 18 large anomalies with an intensity of more than 1000 gamma, the nature of which is explained by impregnation of titano-magnetite. These anomalies were extended in the meridional direction with the following parameters: length from 350 to 2650 m, with a width of 40 to 425 m.

Later, in the period of 1968-1996 (interruptedly), more detailed geological and geophysical studies (gravimetric, magneto metric), prospecting and prospect evaluation survey were carried out at the deposit.

According to the results of geological exploration carried out at the deposit, it was found that the Tebinbulak titanium-magnetite ore deposit is spatially and genetically associated with the gabbro-pyroxenite intrusive massif of the same name. The intrusive massif is confined to the Urusay deep-seated fault zone and is located in the core of the synclinal fold among siliceous, terrigenous (sandstones, siltstones) and greenstone (schists) rocks with intercalations of limestone. It represents an asymmetric body stretching from south to north, 4.5x1.8 km in size, with the fall of the western contact of the intrusion to the east at an angle of 65-70 degrees and the eastern – presumably to the west at an angle of 80-85 degrees. Ultrabasic rocks – pyroxenites, tebinites, wehrlite, peridotites are dominated in the composition of the intrusion. The rocks of the main composition are represented by gabbro, gabbro-syenites.

According to the results of prospecting and appraisal work carried out at the Tebinbulak field in 1991-96. (V.V. Baranov, 1996), forecast resources were calculated for categories C2+P1+P2 to a depth of 300-600 m and amounted to 3943.8 million tons of ore.

In 1990, geological re-exploration of the western part of the Sultanuvays mountains was started at a scale of 1: 50,000 with deep geological mapping of the pre-Mesozoic basement. In the course, the prospects of certain areas of the mountain system for copper and gold mineralization were confirmed (Logvin et al. 1997). Similar work in the eastern part of the region was completed in 2003 by OJSC Regionalgeology (Artykov, Dementeyenko et al., 2003). In the work of O.N. Nikitina et al., (2007) summarized the materials obtained as a result of geological exploration of the territory of Sultanuvays and identified several areas that are promising for the detection of ore concentrations of gold, copper, tungsten and other metals. Geochemical studies of the second half of the twentieth century revealed two sub-latitudinally oriented zones within Sultanuvays. Haloes of chalcophilic siderophilic elements – Cu, Ni, Co, Cr, Pb, Zn, Pt – in connection with ultramafites, peridotite-gabbral stratified intrusions, and massive syenito-diorites are widespread in the northern part.

By its petrological and mineralogical features, the Tebinbulak massif is very similar to the Kachkanarsky, Gusevgorsky and other dunite-pyroxenite-gabbroic massifs of the Urals, with which the largest deposits of titanium-magnetite ores are associated. The ores of the Kachkanarsky and Gusevogorsky deposits belong to the low-titanium type of iron ores, they have been developed for more than 35 years, and the use of these ores as an iron feedstock is considered to be the task solved by industry. In the Ural mining and metallurgical region, titanium-magnetite ores are the main type of ores – 85% of production in 2000. Titanium-magnetite ores of the Tebinbulak deposit also belong to the low titanium type of iron ores.

Titanium-magnetite ores of the Tebinbulak deposit represent zones (sites) of disseminated, vein-disseminated mineralization, forming steeply dipping “bands” of meridional strike in ultrabasic rocks of the intrusive massif.

In the Eastern zone, the “Exploration within the Eastern zone and advancing specialized exploration works on the northern flank of the Tebinbulak titanomagnetite ore deposit in the Sultanuvais Mountains” were carried out for 2011-2014.

Based on the results of 2011-2015, the mineralogical-petrographic and geochemical information on the rocks composing the area of the deposit was systematized, the geological structure of the deposit, the morphology of 10 identified ore bodies and the depth of their distribution were clarified.

The Tebinbulak deposit was studied (estimated) based on preliminary, detailed assessment and exploration results for 2012-2017 (Tab.6).

Tab.6 – Covered amount of the main types of geological exploration

№	Name	Units of measurement	Volume
1	Trenching	cubic meter	15100.2
2	Open pit mining	cubic meter	-
3	Core drilling	line meter	28911.1
4	Sampling:		
4.1	- Trench sampling of section 10x5cm	pcs / m	4157/5023
4.2	- Line- chip sampling from ditches	pcs	693
4.3	- Well geochemical sampling	pcs	650
4.4	- Core sampling	pcs / m	9841/22709.4
4.5	- Technological sampling	t	1.446

As a result of a preliminary, detailed assessment and exploration of the Tebinbulak deposit of titanomagnetite ores in the Sultanuvays Mountains, the geological structure of the Tebinbulak deposit was revised and previously identified ore bodies and deposits No. 1 were correlated, and their morphology and content of useful components in vanadium-containing titanium-magnetite ores were clarified, that made it possible to more objectively calculate the reserves in them.

Current status of the project

Currently, geological sections were tied up along all exploration profiles, the geological and structural position, the elements of occurrence and the parameters of the ore deposit and ore bodies and their relationship with each other (compact connection) were adjusted.

Mineralogical and geochemical studies have been performed for studying the material composition of titanium-magnetite and other ores. The necessary amount of sampling works and geophysical research in trenches and holes made it possible to tie up the identified continuation of zones along strike and to make reserves estimation.

A titanium-magnetite concentrate containing 20-22% iron was obtained. According to the recommended scheme, a magnetic iron-containing concentrate was obtained with a yield of 20%, containing on average 59.61% of iron upon extraction of 64.15%, and also a concentrate with a yield of 3.94%, containing on average 56.5% of iron upon extraction 11 % The total extraction of iron in concentrate is 75%.

In 2014, NIIMR SE investigated a sample No. 6 weighing 1127 kg, composed of four private samples taken from ditches No. 2 and 6, an experimental quarry and old ditch No. 103, with the aim of developing an enrichment technology and obtaining the optimal recovery scheme for useful components from titanium-magnetite ore of the Tebinbulak deposit.

Uralmekhanobr Institute previously processed 2 ore samples from the Tebinbulak deposit.

Sample No. 1 was processed in 1971. According to the total iron content, this sample was not representative for the deposit as a whole. The iron content in this sample was 26.4%, while in the approved reserves this indicator is in the range of 15-16%. Therefore, these tests are not taken into account.

Sample No. 2, processed in 1983, was representative, therefore, the indicators obtained in the studies of this sample were taken as the basis for the calculations.

Based on the conducted technological studies, an enrichment scheme is recommended, including dry magnetic separation of ore in a particle size of 25-0.01 mm, two-stage enrichment of an intermediate product by dry magnetic separation in the first stage to 0.5-0.01 mm, in the second stage to 95%, minus 0.074 mm. From ore with a mass fraction of iron of 15.53%, an iron-vanadium concentrate was obtained in an amount of 10.9% with an iron content of 65.5%, vanadium pentoxide 0.63%, titanium oxide 3.02%, while extracting iron into a concentrate 46, 0% At the same time, 15.6% of tails of dry magnetic separation with a total iron content of 9.72%, magnetite 1.99% and 73.5% of wet magnetic separation (WMS) tails with a total iron content of 9.3%, magnetite 0.99% were isolated.

From the practice of the Kachkanarsky mining and concentration plant (GOK) it is known that 1.575 tons of concentrate are needed to produce 1 ton of pig iron – these data are the basis for the calculation. According to the results of studies on the ore beneficiation of the Tebinbulak deposit, it was found that the concentrate yield is 10.9% with an iron content of 65.5%.

As a result of technological research and laboratory analysis of the ore composition, the material composition of the ore was studied by chemical, spectral, granulometric and mass spectrometric methods.

The main valuable component of ore is iron, the content of which, according to the results of chemical control analysis, averaged 13% in terms of iron (Fe_2O_3 – 18.57%). The composition of the original ore contains useful impurities of titanium oxide in the amount of 1.74% and vanadium pentoxide – 0.06%; of harmful impurities, the total sulfur content is less than 0.4%, phosphorus pentoxide – 0.13%. The main ore minerals are finely disseminated, and therefore, fine grinding is required to separate iron minerals and gangue.

Conducted laboratory studies on the concentration of iron ores by gravity, with dry magnetic separation, with different particle sizes, modes and current strength revealed. At the same time, the indicators obtained during ore concentration of -0.315 + 0 mm fineness at a current strength of 12A should be considered a good result. Under these conditions, a concentrate containing 56.14% (Fe_2O_3 – 50.60%, FeO – 26.64%) of iron was obtained, while extracting it 41.84% from the ore.

Therefore, in order to increase the extraction of valuable components, the ore is proposed to be subjected to finer grinding and staged WMS. The obtained concentrate should be granulated before processing in order to combine fine particles. In this case, you can get a better concentrate and increase the extraction of the main component.

Semi-industrial technological sample No. 1/2015 - weighing 1250 kg was selected by gross method from private samples in ditches No. 2.10a, 12 in the Eastern ore zone within the planned quarry of the primary mining of the Tebinbulak deposit. A sample was selected for technological research at the GP “IMR” to study the material composition and develop a technology for the enrichment of titanium-magnetite ore (2015-2016).

Based on the results of the studies, a scheme was recommended for processing the studied ore sample, including grinding the ore to a particle size of -0.15 + 0, WMS and cleaning of the non-magnetic fraction at a current strength of 12A. When enriching the ore of the deposit according to the recommended scheme, it is possible to obtain a concentrate containing 63.35% of iron while extracting it 62.45%.

A direct calculation of geological reserves combined into a common quarry contour of the Tebinbulak deposit with titanomagnetite ore of the entire deposit at B+C1 category totaling 695.8 million tons at an average grade of 19.2% Fe_2O_3, at cut-off grade of 15% was made.

The Tebinbulak deposit possessing reserves and significant forecasted resources of titanomagnetite ores similar to the Kachkanarsky ones, which are now successfully developed in the Urals, may be of undoubted and practical interest in the near future.

The conducted mining and geological study cases, analysis of technological studies and economic calculations showed the possibility in principle of establishment of a full metallurgical cycle plant without inclusion of the blast furnace production (pig iron production) in the technological chain at certain studies of ore quality. Recommendations on the searching of improving the efficiency of obtaining vanadium containing products of the standard quality, which requires additional research on the expenses and costs of this type of product, as well as market study, were also given.

Outlook

In the process of further studying of the technological properties of the ore of the deposit, it is necessary to conduct additional technological tests of a representative sample (subcommercial volume), in view of the significant difference between the throughout

recovery and yield of an enriched ore (concentrate) obtained in the studies of Uralmekhanobr (Russia) and Outotec (Germany, 2014).

The uneven formation and collection of scrap across regions of the country, as well as the significant volatility of scrap procurement from the timely withdrawal and repair of fixed assets, price and other market factors create additional risks in the supply of scrap metallurgy. This requires covering the deficit through imports or the active development of production of mining and processing of own mineral raw materials.

A feature of the current state of ferrous metallurgy is that it does not have its own stable mineral resource base. This explains the import of iron ore. Given this, one of the priority areas for the development of the local raw material base should be an effective solution to the issue of providing raw materials for metallurgical production, with optimally balanced imports from neighboring countries (Russia, Kazakhstan, China) and further work on the search and development of local raw materials.

In the Republic for the medium term, the expansion of the raw material base of the industry is considered by deepening the processing of ferrous metals, increasing the degree of extraction of useful components from ore, as well as the processing of metal waste.

Study, development and implementation of transfer technologies for mineral processing equipment in a modular design for processing and beneficiation of iron ore deposits, tailings and industrial formations of mining and metallurgical and energy enterprises (metallurgical and energy slags) containing scarce metals, including rare earths, are considered. It is planned to create a mining and smelting plant on the basis of the Tebinbulak deposit, which will provide raw materials for the production of tool steels, as well as for the production of special products. Therefore, by the end of 2019, the project plans to complete all technical and technological studies, and also, to complete a bank feasibility study for the field to expose the field to a wide range of foreign investors.

Tsentralny bituminous coal site

Previous work

The first information about the geological structure of the area dates back to 1919. Special prospecting works for coal were carried out in 1933 and as a result of these works a qualitative characteristic of the composition of coal in the seams was first given.

In 1939, coal seams were studied in the core of the Ketmen-Chaptinskaya anticline. Coal seams were tracked for 1.5 km along strike and practical interesting 3 coal seams No. 1, 2 and 3 were identified. In 1940-1943, prospecting works were carried out at a scale of 1:25000. As a result of the conducted works the forecast of coal by seams No. 1, 2 and 3 was made.

After the Patriotic War (World War II), during the recovery and development of the coal industry, the requirements of the State Reserves Committee for the study of coal deposits increased significantly. In this regard, there was a need to reassess previously explored coal reserves, in accordance with new instructions in 1958, exploration work at the Baysunskoye field was restored.

Searches were conducted in the southern and western areas within the previously studied areas. In order to clarify the reserves and general prospects of the field, 5 wells were drilled, 301 linear meters of adits and 3,120 m^3 of ditches were completed. As a result of the work performed, a geological report was compiled with the calculation of reserves for prospecting and structural exploration of the object.

Despite the expansion of the Western area, due to well drilling, almost no absolute increase in proven reserves has been obtained. In addition to calculating reserves in the explored areas, a predictive assessment was made of the coal potential of the "Promising" area on the north-western wing of the Ketmenchaptinskaya anticline. The total number of forecasted coal reserves at the field was determined in the amount of 450 million tons and was justified only by the presence of industrial coal seams in the south-western explored part of the field.

In 1962-67, work was continued on the north-western and north-eastern flanks of the area by drilling deep wells No. 14, 15 and 16. Carboniferous formations of the Gurud Formation were studied for the first time at deep horizons of the area, and industrial coal content was confirmed at a distance of 10 km to the north-west in the fall from the outcropping of formation No. 1 on the day surface. Forecasted coal reserves in formations 1, 2 and 3 on the area are determined at 204.0 million tons.

In 1965-67, Fattakhov et al. Conducted a state geological survey at a scale of 1: 50,000 on the area of sheets J-42-63 and J-42-51-G, as a result of which the stratigraphy, tectonics and minerals of this area were studied in detail.

In 1980-83, detailed searches were conducted on the area by drilling deep wells (5119.0 m) and geological surveying at a scale of 1:10000 per 93.0 km^2. As a result of these works, new data were obtained that significantly change the results of calculating the forecast resources of past years. Search wells Nos. 21 and 22 on the Charvak anticline and 29 on the north-western wing of the Ketmen-Chaptinskaya anticline opened reservoir No. 1 with a thickness of 0.3 m, 0.25 m and 0.6 m, respectively, which led to a decrease in the average thickness of the reservoir when calculating reserves up to 1.3 m. The volumetric mass of coal in bed No. 1 was determined in VUKHIN (Sverdlovsk) and is equal to (with an average ash content of 11%) 1.45 t/m^3. The prospective area involved in the calculation of forecast resources for category P2 amounted to 77.5 sq. Km. With the indicated parameters, taking into account a decreasing confidence coefficient of 0.8, P2 reserves amounted to 121.6 million tons of coal.

It was not until the 1960s, that based on the established requirements of the State Reserves Committee, the exploration works resumed and searches and exploration were done in this area. In 1982-1986, prospecting and evaluation works have been carried out. At the same time, the characteristics of the site were studied in detail, and the quality of coal was reliably established by a complex of laboratory studies and its industrial value as a source of electric power carrier was proved.

Current status of the project

The reserves of seam No. 1 of the Tsentralny block were approved, corresponding to "T" grades by B+C1+C2 categories in the amount of 12,693 thousand tons, and the forecast resources by P1 category in the amount of 15,860 thousand tons were calculated. Currently, in accordance with the recommendations of previous work, underground mining, surface testing wells, research are ongoing.

Since 2018, a detailed assessment is being conducted at the Tsentralny site to study flanks and deep horizons. Office work was carried out, the processing of field geological materials passed through the wells in 2018.

Vertical wells No. 51, 60 and 61 for crossing ore bodies to a depth of 1225 m, in order to open coal seams No. 1 and 2, are being drilled. Geochemical samples obtained from core wells in the amount of 72 pcs. All core samples taken from coal wells were sent to the laboratory of Uzbekugol JSC for the conduct of coal chemistry analyzes in Angren.

Outlook

In the Republic, the share of new energy sources in world energy consumption will increase, however, traditional sources (oil, gas, coal) and nuclear energy will continue to hold their leading positions.

Creation by 2025 of a complex for the local use of coal processing products and the creation of pilot plants for the production of synthetic liquid fuels from coal, including a complex of demonstration plants for deep coal processing processes with subsequent industrial development of the technology for producing synthetic liquid fuels in the coal industry in 2025-2030. It should be noted that the key importance is not only the production of individual products, but the expansion of relationships and the integrated development of industries. Work to attract foreign investment will also continue.

SOCIO-ECONOMIC AND SOCIO-ENVIRONMENTAL ASPECTS OF SELECTED PROJECTS

Tebinbulak titano-magnetite ores deposit

Economic aspects

The economy of the region is determined by agriculture in the irrigation zone by the waters of the Amu Darya River; livestock; passing through it (close to the area of projected works) the railways Nukus-Turtkul-Miskin, Miskin-Uchkuduk; Nukus-Turtkul highway; high-voltage line from Takhiatash GRES; Gazli-Nukus gas pipeline.

The Republic of Uzbekistan has reached a high level of industrial development; it is becoming a major industrial center in the Central Asian region. Currently, the total demand for ferrous metallurgy products exceeds 2.0 million tons, and the existing production capacity for the production of rolled ferrous metals makes up 1.1 million tons. Covering the metal deficit is associated with significant foreign currency expenses (procurement and transportation) and depends on supplies from foreign countries.

The ever-increasing metal consumption and the need for iron and steel products induce to raise the question of creating our own iron ore raw material base in the Republic of Uzbekistan, as a very urgent problem requiring a reasonable, well-considered solution. The Tebinbulak deposit, possessing reserves and significant forecasted resources of titanomagnetite ores, may be of undoubted and practical interest in the near future.

Social aspects

The favorable location of the field (near the railway and highway, power transmission lines, gas pipelines, water pipes) makes it very attractive, and the construction of an enrichment plant will provide a significant number of local people with work.

Particularly noteworthy is the extremely convenient position for the future integrated development of the Tebinbulak field. The cluster itself, with its infrastructure, including the main components (open pit, GOK, MK, roads, conveyors, dumps, auxiliary services) is located near the existing power lines, gas pipeline, drinking water conduit and the proximity of the Amu Darya River for industrial water, the A-380 international highway , the railway line as a whole is compact, and therefore economical.

Environmental aspects

The Land legislation (GOST 175103-86 “Protection of the Earth's nature” and the law “On land restoration”) provide for the rational use of all lands and their protection.

Field exploration works were carried out in the mountains, where the top soil layer is practically absent, and were attended by the movement of motor transport, borehole drilling, ditch cut, trenching, and test pit sinking. During these operations, the envisaged set of measures to protect the soil layer and vegetation was carried out.

Technological processes in the extraction and concentration of ores cannot be imagined without process water supply. When open pit mining, the natural process is mine drainage.

Considering the high evaporation potential in the area of an industrial enterprise construction, in order to improve environmental cleanliness, the periodical covering the tailings storage with loesslike soils is assumed by the project.

Tsentralny bituminous coal site

Economic aspects

The geological structure of the Tsentralny site and the morphology of bed No. 1 were studied with sufficient density and detail. The deposit area has favorable conditions for the operation and construction of a mining enterprise. The nearest Shurchi railway station is located in 60 km and the large Uzbek highway is in 8 km south-east from the object.

The feasibility study was compiled under the bed No. 1 of the Tsentralny site: the development method is mine, the average thickness of a bed is 1.42 m, the maximum depth is 2090 m, the amount of inclination is 5-18 degrees, the ash content is 8.4%, and the lower specific heating value is 7875 MJ/kg. The studied reserves with an annual productivity of 200 thousand tons for 55 years with a return to capital in industrial construction are 12 years. The total cost of 1 ton of coal produced is approximately 20 US dollars.

Social aspects

There are sufficient labor resources in the area.

The development of the facility as an energy resource sufficiently raises the economy of the region. Currently, the developed Baysunskoye field is one of the suppliers of energy fuel in the south of Uzbekistan. Providing energy resources to enterprises under construction and planned for the long term will require an increase in the capacity of the mining enterprise.

At present, the exploration of the facility provides coal for the mine, possibly due to proven reserves. Without a doubt, the developed infrastructure in the region associated with the energy resource serve as the solution to many social issues.

Environmental aspects

Works on the study of toxic components in coal and mine waters were carried out in accordance with the “Instructions for the study of toxic components during the exploration of coal and shale deposits”. Analyzes for determining the toxicity of groundwater showed that toxic elements in mine water (As, Ba, Be, V, Bi, W, Cd, Co, Mn, Cu, Mo, Ni, Pb, Sr, Sb, Tl, Ti, Cr , Zn) and in coal (S, As, Be, V, Co, Mn, Pb, Cr, Ni, Se) do not exceed the “critical concentration”. When in concentrated use of coal in large power plants, the large entry of toxic elements into the environment is not forthcoming.

The air-pollution control in the projected area of the mining enterprise operation is simplified by the underground mining method and coal handling by motor vehicles to a distance of not more than 10 km. The complex of measures for the protection of surface waters provides for the treatment of domestic wastewater and mine drainage waters. Their reset is possible along the Tuada sai. After preliminary disinfection and purification, the water can be used for household water needs.

After preliminary research, the wastes from mining, concentration and burning of coal is possible to use in the following ways:

- building materials and for the manufacture of building materials;
- valuable components (Al, Fe, P, etc.) extraction;
- production of lightweight concrete aggregates (agglomerate, expanded clay, etc.).

When performing mass searches, the radioactivity of the rocks does not exceed the background values for the region and no radioactive anomalies were identified.

FIELD PROJECTS STATUS AND FEASIBILITY

Tebinbulak titano-magnetite ores deposit

Technological feasibility aspects

The mining conditions of the Tebinbulak deposit allow carrying out open-cut mining – by a quarry. At the deposit the geotechnical complex of strong (intrusive rocks: pyroxenites, tebinites, hornblendites), rarer – medium-hard (metamorphic rocks: schists, marbled limestones and skarns) rocks is mainly developed.

Strata inclination and ore-bearing zones exposed by ditches and boreholes, consistent with the shape of the intrusion (lopolith) in a contact with the metamorphic rocks of the Lower Devonian: western – at 70-80°, eastern – at 65-75°. The rocks are slightly fractured, in the zones of tectonic disturbances and strongly fractured in the zones of weathering. The average density of the ore is 3.33 t/m^3, natural humidity is 1.0% (conditional), and the coefficient of fortress according to the scale of M.M. Protodyakonov is 7-9.

Overburden rocks (pyroxenites, gabbroids) are planned to be processed into crushed stone and sand, and rock cuttings into cinder blocks. Also, the high-temperature zones of silicification (quartzite), suitable for the production of heat-resistant materials are developed in the host rocks.

Based on the obtained results and technological tests, the following was established:

- density – from 3.33 to 4.09 g/cm^3;
- bulk density – 2.71 t/m^3;
- water absorption – 0.10-0.51%;
- magnetic susceptibility – 49x10^{-6} m^3/kg;
- magnetization – 4.1 A m^2/kg;
- residual magnetization – 0.6 m^2/kg;
- network index of crushing – 36 kWh/t micrometer1/2;
- crushing index – 4.8 cm^3;
- coefficient of strength – 3.3-4.8 rock drillability;
- specific crushing work – 31-41 J/cm^3;
- primary specific work of destruction – 400-810 J/cm^3.

Detailed studies conducted

The developed ore processing scheme of the Tebinbulak deposit is almost similar to the ore processing scheme of the Kachkanar deposit (Ural), and included: 2 grinding stages with a final grinding coarseness of 95% of a class – 0.074 mm and 2 WMS operations, with a concentrate re-cleaning of the 2nd stage of WMS. Before the second separation operation, a deslimation operation is provided.

Tsentralny bituminous coal site

Technological feasibility aspect

In the coal-bearing stratum of the deposit, the industrial coal mineralisation is confined to sediments of the upper subsuite of the Gurudsky suite of the Jurassic period.

Prospecting and evaluation works were carried out in accordance with the approved project documentation and existing methodological guidelines. Ore body No. 1 was explored by lithological-facies sections in the adit – 1680 linear meters, lithological sections in the adit – 1530 linear meters, description of paleontological points – 30 points, mining works – 10,148 linear meters. A total of 155 ore samples, 400 trench channel samples, 2 technological

samples (1.5 t each), and 2 samples were taken to determine the bulk density as a whole. In total, 9 blocks were studied in the studied stratum No. 1. All blocks of the reservoir are between the horizons +1,700 and +1,850 m. Mass searches were made in the process of driving the underground mine workings.

Detailed studies conducted

Since 2018, a preliminary and detailed assessment has begun for studying the flanks and deep horizons of the area. Also, it should be noted that high quality coal may be the raw material for the metallurgical plant under construction.

At present, desk work is underway to process field geological materials passed through wells of previous years. In the process of drilling are 3 wells to open coal seams No. 1 and 2 to a depth of more than 1000 m.

All core samples taken from coal wells were sent to the laboratory of Uzbekugol JSC for coal chemistry analyzes in Angren.

LEVEL OF KNOWLEDGE / CONFIDENCE IN ESTIMATES

Tebinbulak titano-magnetite ores deposit

Geological and technical aspects

Tebinbulak deposit covers 5.2 km^2 and is composed of volcanic, terrigenous and mixed mass of the Paleozoic basement. In the geosynclinal era of the geological development of this region, ultrabasic and alkaline rocks of the Tebinbulak (C1-2) (peridotite, wehrlite, pyroxenite, tebinite, hornblendite, amphibole and pyroxene gabbro) and Jamansai (C2-3) (gabbro-syenite) complexes were occurred; this has exerted a significant effect on the ore content of the region.

Ore mineralization has been established to depths of 812 m (C-5), and according to geophysics (magnetic gravity exploration and induced polarization (IP) to depths of 900 m from the surface. This zone is composed mainly of disseminated ores (up to 97%) with a content of 10-20% titanomagnetite in them, with an admixture of pyrite, pyrrhotite and chalcopyrite (up to 1%). An impregnation of titanomagnetite of irregular, isometric shape with a size of 0.1-2.0 mm, sometimes 5-7 mm, develops along the boundaries of non-metallic minerals, filling the space between them. Disseminated ores consisting of 50-60% of ore minerals that contain: magnetite (92-95%), ilmenite (3-5%), chalcopyrite (0.5-1%), hematite (0.5-2.0%) are less common. Titanomagnetite is evenly distributed throughout the rock, filling the gaps between the grains of the rock-forming minerals. The grain size is 0.3-3.0 mm. Ores of this type form separate segregations in disseminated ores, and are also found among secant veins. Veins of massive titanomagnetite ores are found in the central part of the Western ore zone, less often in its northern part and in the east of the intrusion. The strike of the veins is, as a rule, submeridional, less often north-west, in the northern part of the massif is north-east, sometimes they fan out.

The length of the vein is traced within 20-114 m, at a thickness of 0.2-3.0 m. Ore minerals in them make up 85-95% and are mainly represented by a medium-grained (0.5-2.0 mm) aggregate of isometric precipitations of titanomagnetite with individual inclusions of sulfides.

The main parameters for estimation of predicted ore resources of the Eastern zone, uncovered by trenches on the surface, and to a depth of 400m by boreholes on a uniform network, are calculated as follows:

- for the ore zone of the titanomagnetite ores of the Tebinbulak deposit, the output of the parameters of the ore intervals for the workings was performed by the weighted average method;
- the average thickness of the ore zone is determined according to surface data and drilling results as arithmetic mean;
- the average volumetric weight of rocks with titanomagnetite ore is calculated as arithmetic mean with fluctuations from 3.3 to 4.09 t/m^3;
- the linear ore-bearing factor is defined as the ratio of the length of the conditioned ore intervals in the mine to the thickness of the ore zone, and in the case of an incomplete intersection of the ore zone – to the mine length.

Estimates of quantity and volume

Geological exploration was carried out on the basis of available geological data with the excavation of ditches, pits and drilling of core wells to determine the nature of geophysical anomalies, opening, testing, localization of ore bodies and calculating reserves for them.

A feasibility study has been developed for exploratory standards for calculating the reserves of titanium-magnetite ores in the Tebinbulak deposit. Standard geophysical surveys for wells (GIS) and pilot studies to determine the magnetic testing of drilled wells and core cores were carried out, with the preparation of instructions for this type of testing.

All topographic and geodetic works in the Western and Eastern zones were carried out according to the project and served as material for calculating reserves and constructing geological sections. To compile a feasibility study, a report was prepared as of 01.10.2017. with geo-economic, geological information, a characteristic of the quality of titanium-magnetite ores, mining and technical features, and reserves estimation for C1 categories. Calculation of forecast resources of titano-magnetite ores according to cat. P1 by direct calculation by the method of vertical sections from the horizon of 0.0 m to -100 m amounted to 243.27 million tons, with average Fe_2O_3 contents of 18.21%. As part of the report, a feasibility study was developed on the feasibility of developing the field and exploration conditions for calculating industrial reserves by categories B+C1.

The methodology for calculating reserves was adopted according to the documents: "Temporary instruction for applying the classification of reserves to iron ore deposits. T., 2003". According to it, the Tebinbulak deposit falls into the second group, subgroup 2B, in which the distance between exploration profiles of 200-400 m and a dip of 200-100 m is required to calculate the geological reserves of category C1. In the requirements of the instructions, the location of the profiles and the distance between the wells, the studied parts of the Western and Eastern zones fit. A total of 14 profiles were passed through 200 m each, with a distance between the wells of 100 m and a depth of up to 500 m (cf.), the surface was examined by ditches, which were used for continuous testing, including in ore-bearing zones by furrow testing.

When calculating the reserves of titano-magnetite ores by category C1, following the analogy with the well-known Kachkanarsky deposit, the following initial parameters were adopted:

- the on-board content of Fe_2O_3 total is 15% (on Kachkanar, the board is 18%);
- the average content of total Fe2O3 is 18.3%;
- average bulk weight of ore – 3.33 t/m^3;

The calculation of geological ore reserves by categories B+C1 of ore deposit No. 1 for the allocated blocks was determined by direct calculation. Calculation of geological ore reserves was performed in the outline of the selected block between sections 3-10. In both end profiles, the calculation of geological reserves was carried out in accordance with the requirements in half, i.e. not 200 m, but 100 m. Calculation of the geological reserves of titanium-magnetite ores within the Tebinbulak deposit between profiles 3 and 10 for categories B+C1, using vertical parallel sections on a tobasis scale of 1:1000. The calculation of geological ore reserves by B+C1 categories of ore deposit No. 1 for the allocated blocks was determined by direct calculation. The cutoff grade of the metal is 15%. The difference in reserves by B + C1 categories between the traditional calculation and the Micromine environment amounted to 7.22 million tons (1,703.04 million tons (Micromine) minus 1,695.82 million tons (traditional)).

Tsentralny bituminous coal site

Geological and technical aspects

The area of the site is composed of sedimentary rocks from the Upper Triassic (Keuper) – Lower Jurassic to the Quaternary sediment. At the deposit, the middle and upper sub-formations of the Gurudsky formation, as well as the lower and upper sub-formations of the

Dogibadamsky formation of the Lower Jurassic are coal-bearing (Annex I). Geologically, the Central Coal section is confined to the north-western part of the Baysun Trough (megosynclinal), which is a large modern negative structure of the type of intermountain depression. Tectonic movement dates back to the early Jurassic, causing a redistribution of areas again and accumulation. The uplifts that existed in the early Jurassic turned out to be areas of accumulation with an altered sedimentation complex of the Gurud and Ugibadi Dam.

In the composition of the Gurud Formation, the terrigenous materisal is finer-grained. The Gurudsky coal accumulation stage was characterized by peat accumulation in the swampy deltas, the periphery of the drift cones and on flat alluvial plains, the thickness of the strata is 0.6-2.5 m. On the alluvial plains, the strata are well-kept. Coal deposits and coal accumulations in the Surkhantau, Baysuntau, Kugitanga mountains and parts of the Yakkabag mountains are associated with the Gurud stage.

The Degibadam stage arose against the background of the first major marine transgression in the upper Bajos. The rocks are represented by a gamut of marine, submarine, wave-breaking, lagoon facies. Deltaic rocks caused the flowering of lake landscapes and the formation of peatlands. However, the subsidence of the territory did not favor sustainable peat accumulation (coal seams of working capacity are not found in the Baysunskoye field).

Estimates of quantity and volume

Prospecting and evaluation works have been carried out on the site. 4 benches were studied at the deposit, and bench No. 1 is the most - productive. The deposit has been explored by adits. According to the existing classification, the bench No. 1 by thickness refers to thin (0.71-1.20 m) and medium thickness (1.21-3.50 m), to the “relatively seasoned (persistent)” group. According to the bedding conditions, the bench belongs to gently sloping (dip coal 18º) monoclinal. Actual incidence angles are 5-18º.

The total inflow of water at the mouth of the adit is from 4.4 l/s (15.8 m^3/h) to 7.8 l/s (28.2 m^3/h) with a total length of about 7000 linear meters.

The main quality characteristics of coal are as follows:

- mass fraction of working moisture – 0.82%;
- ash content – 14.72%;
- devolatilization – 14.3%.
- mass fraction of total sulfur – 0.59%;
- the highest specific heat of combustion – 8,689 kcal/kg;
- the lowest specific heat of combustion – 7,809 kcal/kg.

At the deposit, reserves were calculated by categories B+C1 amounted 6,986.0 thousand tons and by category C2 – 5,707.0 thousand tons. When calculating reserves, 1.5 t/m^3 volumetric mass was applied.

CLASSIFICATION OF SELECTED PROJECTS USING UNFC

Tebinbulak titano-magnetite ores deposit

Review of socio-economic information including social and environmental (E-axis)

The Tebinbulak iron ore deposit according to the criteria of economic and social viability of the project (E axis) is a commercial project.

In total, 245 holes have been drilled on the Tebinbulak iron ore deposit. The reserves of the deposit are calculated to a depth of 350 m. The cutoff grade of the metal is 15%. Extraction of iron in concentrates is 65.82%. The development method is open-cut mining (quarry) (Annex II). It should be noted that the Tebinbulak deposit is located in a very favorable infrastructure: nearby there is a highway, a railway, power transmission line, a water conduit and gas pipeline lines.

The scheme for obtaining final commercial products is as follows: (1) obtaining iron concentrate; (2) cast iron (middle link); (3) steel (finished product). Upon steelmaking up to 1.5 million tons annually, the estimated reserves will last for 40 years. The payback period is 17.8 years. The average annual income from sales is 1,140,616.5 thousand US dollars. The development of the deposit is expected not only to meet the domestic demands for steel in the Republic, but also provides for its export; provision is made for attraction of foreign investments with a view to deposit development.

The region has sufficient labor resources. Mining of iron ores invariably benefits people and inflicts damage the environment. The following environmental problems arise as a result of production: air pollution, soil degradation, water pollution and impact on flora and fauna. The main production processes in the quarry (drilling and blasting operations, excavation and loading of rock mass, traffic, etc.) are accompanied by emissions of dust and gases. These works stipulate dust- and- gas-protective measures: wet drilling, use of TNT-free explosives, sprinkling of bottom-hole, roads, sites, and ventilation. All this reduces the negative impact on the environment and stabilizes the atmosphere. The maximum permissible emissions are established for each source, ensuring that the established maximum permissible concentrations (MPC) are not exceeded (Tab.7).

Tab.7 – List of noxious substances and their gross emissions

	Name of noxious substance	MPC m.s. SRLI mg/m^3	Class of hazard	Emission of substance, t/year
1	Overburden dust	0,37	3	137,243
2	Iron oxide	0,2	3	0,0094
3	CaO	0,15	3	10,94
4	Benzopyrene	1*10-6	1	0,000125
5	Aldehydes	0,035	2	1,707
6	Hydrocarbons	1	4	9,176
7	Carbon monoxide	5	4	82,799
8	Nitrogen dioxide	0,085	2	40,9613
9	Sulphurous anhydride	0,5	3	17,066
TOTAL:				299,902

In order to reduce emissions of harmful substances into the atmosphere, the feasibility study provides following measures:

- strict geological surveying and technical supervision of compliance with the adopted parameters of the development technology system, as well as the implementation of environmental protection measures;
- specify the geological structure and contours of the enclosing rocks in mine plans;
- wet dust suppression during all loading and hauling, drilling and blasting operations;
- purification of aspiration air at reloading nodes;
- ensuring the operative condition of mining-and-winning and transport equipment to prevent the ingress of fuels and lubricants into a soil. When equipment repair, wastes (waste oils) must be collected in special containers and transported to places for oil collectors established by the sanitary and epidemiological station;
- on diesel equipment (vehicles, loaders, bulldozers, etc.), devices are installed to neutralize the exhaust gases;
- installation of special pit privies and other structures for the discharge of utility fluids.

In addition to the aforementioned measures, a reduction in gas contamination is also achieved by selecting fuel for the gas balance for open-cut road transport and organizing strict control over the work of the latter.

To ensure environmental protection in the part of the repair and storage facilities and auxiliary facilities, it is planned to purify the air during the operation of grinding machines by means of dust suction units and use water recirculation system for washing equipment and cars after wastewater treatment in local treatment facilities.

The relief of the site is submontane, that seals on the wind regime, creating natural ventilation. The size of the sanitary protection zone (SPZ) is 500 m for dispersing of harmful substances into the atmosphere.

In order to prevent disturbance of the soil cover during the movement of vehicles and technological equipment, the construction of pit roads with hard surface is planned.

In general, taking into account the payback period and average content approved for the development of the Tebinbulak iron ore deposit, it can be classified as E1.2 in accordance with UNFC.

Review of project feasibility information (F-axis)

The project feasibility (axis F) plays an important role, especially when it is referred to huge construction on giant fields' development. The Tebinbulak iron ore deposit has substantial reserves, and its development requires the construction of an overlarge ore mining and processing enterprise.

According to the feasibility study, the payback period will make up 17.8 years and is commercially viable.According to the Technical Design Assignment, the calculations are carried out prior receipt of the final commercial products (rolled metal, slabs, sheet steel and pipes); based on this, the feasibility study provides for the construction of a mining-and-metallurgical combine.

Iron ores of the deposit are supposed to be developed by open pit mining with further processing of an ore by process stage. Large, medium and small crushing is carried out in the crushing department, and then the ore is conveyed along the conveyor line to the magnetic separation workshop. The resulting concentrate is processed into pellets, then the iron is smelted in an unconventional way (nonblast-furnace iron-making), steel products are

produced in the converter plant, which are further processed into metal rolling and other steel products. Simultaneously, vanadium-containing concentrate is melted out.

The annual productivity of the open pit by ore is determined from the target level of development of the designed mining and smelting complex, which determines the production of 1.1 million tons of steel per year, and makes up 8.58 million tons of ore per year.

The development period of explored reserves is 77.4 years. Considering the scale of the project enterprise, financial and economic calculations were carried out for a period of 23 years (3 years of investment and construction period and 20 years of production).

At present, a Bankable Feasibility Study is being prepared by specially invited experienced companies.

Based on the above, the object can be classified as F1 according to UNFC.

Review of geological knowledge / confidence in estimates (G-axis)

The Tebinbulak deposit has a fairly high exploration maturity – a detailed assessment. At the same time, the estimated ore reserves by B+C1 categories amount to 1,695.82 million tons (of which by B category are 269.2 million tons).

The ore has been studied to a depth of 900 m. The length of the vein is traced 20-114 m apart, at a thickness of 0.2-3.0 m. Ore minerals in them make up 85-95% and are mainly represented by a medium-grained (0.5-2.0 mm) aggregate of isometric precipitations of titanomagnetite with individual inclusions of sulfides.

Thereby, the quantities can be estimated with a high degree of confidence and assigned G1 according to UNFC.

Classification of the project using UNFC scheme

As Tebinbulak deposit qualifies as E1.2 F1 G1, the project is classified as “commercial”.

Tsentralny bituminous coal site

Review of socio-economic information including social and environmental (E-axis)

The geological structure and morphology of the bed have been studied with sufficient completeness and detail. Mode of occurrence of the coal-bearing strata and coal seam are determined by continuous measurements at a distance of up to 3 km along the strike.

The geological structure of the bituminous coal site, the seam No. 1 of the Tsentralny site, according to the grade composition refers to lean sintering coal (“T”) and is a high-quality power fuel. Coal has a low ash content, low humidity, low grit, and high calorific capacity and refers to energy fuel with high heat engineering qualities. Coal does not have close-burning properties and does not apply to coking. The content of rare and trace elements in coal within clarke, toxic elements are present within the limits allowed by GOST. Works on the study of toxic components in coal and mine water was carried out in accordance with the "Instructions for the study of toxic components in the exploration of coal and shale deposits". Analyzes for determination of the groundwater toxicity showed that toxic elements in mine water (As, Ba, Be, V, Bi, W, Cd, Co, Mn, Cu, Mo, Ni, Pb, Sr, Sb, Tl, Ti, Cr , Zn) and in coal (S, As, Be, V, Co, Mn, Pb, Cr, Ni, Se) do not exceed MPC. In concentrated using of coal in large power plants, large releases of toxic elements into the environment are not expected. The air-pollution control in the projected area of the mining enterprise is simplified by the underground method of mining and coal delivery by motor vehicles to a distance of not more than 10 km.

In accordance with the compiled feasibility study, the cost of 1 ton of coal makes approximately 20 US dollars, the payback period is 12 years at an annual output of 200.0 thousand tons, and the reserves will last for 35 years. Underground mining of the deposit is profitable, and the development of the project improves the economy of the region.

The deposit area has favorable conditions for the operation and construction of a mining enterprise. There are local building stones (quarry stone, clay, sand, gravel, etc.). The nearest Shurchi railway station is located in 60 km, and the large Uzbek tract is in 8 km to the south-east of the deposit. Also, there are sufficient labor resources in the area.

In this regard, the economic and social viability of the project corresponds to category E1.1 in accordance with UNFC.

Review of project feasibility information (F-axis)

Quite detailed studies were carried out at the Tsentralny coal deposit, and feasibility study substantiated economic efficiency of its development by underground mining (scheme of opening the coal seam No. 1 (1:2000) is presented Annex III).

It should be noted that a preliminary and detailed assessment is currently underway to study the flanks and deep horizons with the calculation of industrial reserves; and the transfer of the available reserves (C2) to the higher categories (C1) will undoubtedly increase the attractiveness of the deposit. These exploration works are planned to be completed by 2022.

Thus, the deposit corresponds to category F1.2 in the UNFC classification.

Review of geological knowledge / confidence in estimates (G-axis)

The 1982-1986 prospecting and appraisal works calculated reserves in the following categories: B – 1,102 thousand tons, C1 – 5,884 thousand tons and C2 – 5,707 thousand tons at an average thickness of 1.46 m. The economics is calculated according to B+C1 categories (total 6,986 thousand tons; reserves of C1 category are assigned to the category with an average degree of reliability).

The Tsentralny deposit is sufficiently studied and is considered promising for the construction of an exploration and production enterprise.

Based on the above, the deposit is classified as G2 according to UNFC.

Classification of the project using UNFC scheme

In view of the foregoing, the deposit can be classified as E1.1. F1.2. G2, and thus be considered as “commercial project”.

ALIGNMENT TO SUSTAINABLE DEVELOPMENT GOALS IMPLEMENTATION

National approaches

The geological industry is the basic component of the country's economy, which is a combination of management structures, production and scientific organizations that meet the needs of the state and society in the field of geological study of the territory of the Republic of Uzbekistan, reproduction of the country's mineral and raw material base, monitoring and protection of mineral resources, as well as mining relations.

The product of exploration is industrial mineral reserves in the subsoil. Minerals, being the material basis for the development of the state's economy, serve as the country's natural advantage and ensure human welfare.

In general, geological research, being in the initial chain of identification and development of raw materials, is intimately associated with the activities of industries engaged in the extraction, processing and production of mineral raw materials with the further organization of production with high added value based on them.

Currently, not only in the mining or mining-and-geological branch, but also in all sectors of the Republic, there are conceptual frameworks for development until 2024, a strategy until 2030, and a concept for a long-term development strategy for Uzbekistan until 2035 [3].

Industry approaches

In the exploration industry, researches are currently being conducted upon the medium-term program 2018-2019, and a program 2020-2021 has been developed taking into account the transition to openness and attracting investments in the mining and geological industry. In addition, provision is made for extension of exploration works in new promising and inaccessible areas of the Republic with the aim of forming a reserve search pool of strategically important minerals (gold, silver, uranium, copper, tungsten, polymetals) and new types of minerals (ferrous, non-ferrous, rare and rare-earth metals and etc.) by identifying promising new facilities that ensure the priority development of exploration and industry in these territories.

International consulting companies were involved and strategies for the development of the mineral resource base of the Republic of Uzbekistan were developed taking into account the introduction of modern international standards and international best practices.

Currently, more than 120 promising areas are proposed for geological exploration and about 30 deposits of gold, uranium, tungsten, iron and lithium are offered for industrial development with the attraction of foreign investments.

It should be noted that starting in 2020, for individual projects (of prospecting works) exploration works will be carried out taking into account international reporting standards.

Application of the UNFC system certainly serves for efficient attraction of investments, conducting international research in the field of energy and mineral resources, carrying-out of an analysis in the field of resource management, industrial process planning and efficient allocation of capital.

Case study projects' specific aspects

The projects considered in this study play a special role in the rapidly growing pace of the country's economy. The objects are interconnected, since the development of the Tebinbulak

titanium-megnetite deposit requires high-calorie coal. Coal Tsentralny bituminous coal site just meet the requirements.

The uneven formation and collection of scrap across regions of the country, as well as the significant volatility of scrap procurement from the timely withdrawal and repair of fixed assets, price and other market factors create additional risks in the supply of scrap metallurgy.

This requires covering the deficit through imports or the active development of production of mining and processing of own mineral raw materials.

A feature of the current state of ferrous metallurgy is that it does not have its own stable mineral resource base.

This explains the import of iron ore. Given this, one of the priority areas for the development of the local raw material base should be an effective solution to the issue of providing raw materials for metallurgical production, with optimally balanced imports from neighboring countries (Russia, Kazakhstan, China) and further work on the search and development of local raw materials.

It is planned to begin development of the Tebinbulak field by 2025.

The Tsentralny coal deposit is considered as additional sources of energy raw materials in the region.

CONCLUSIONS ON THE UNFC CLASSIFICATION OF PROJECTS IN THE FIELD OF ENERGY AND MINERAL RESOURCES IN UZBEKISTAN

Advantages of UNFC at national and project-level decision making

Application of the UNFC in the exploration industry of Uzbekistan will require a reassessment of solid minerals reserves of all previously explored and being explored deposits based on the criteria of a market economy. Similar works are already being carried out at the facilities of existing mining and metallurgical plants. And also, during 2019, additional studies on the Tebinbulak iron deposit are conducted according to international reporting standards (they are already being completed); that will increase the reliability of the facility.

Significant scales and broad prospects for the development of the mineral resource base of the Republic with the existing developed infrastructure based on the application of the latest techniques and technologies of subsoil integrated geological exploration, as well as attracting capital of republican and foreign investors on mutually beneficial conditions, will achieve maximum results from the use of natural resources of Uzbekistan.

In connection with the above, the country is very interested in application of the UNFC system. Yet when deciding on the adaptation of the Uzbek classification to UNFC, the great responsibility is placed on the prospect evaluation – first of all, objectivity, with provision for the mining parameters of the object, especially such huge objects as the Tebinbulak deposit.

Constraints in the use of UNFC

Currently, the lack of national staff for the UNFC system implementation restricts its widespread use. At this time, some works are underway in the industry for capacity building.

In order to eliminate restrictions, the annual program of development and reproduction of the mineral resource base of the Republic of Uzbekistan provides for training. And also, an appropriate budget allocation is provided. When training personnel, selection requires the coverage of qualified geologists from all territorial regions of the industry.

Benefits in using UNFC for alignment to SDGs

The main benefits of UNFC application for harmonization with the Sustainable Development Goals are:

- upon the openness and economic development of the country on the fast track, UNFC is the only classification for international research;
- the adaptation of the national classification with UNFC is carried out without special efforts, on the condition of availability of certain knowledge (geological, economic priority of the country, completeness of minerals development, resource conservation, normative legal documents of the industry, etc.);
- upon an active policy of attracting foreign investments in the mining-and-geological sector of Uzbekistan, the UNFC system application is one of the most productive positions.

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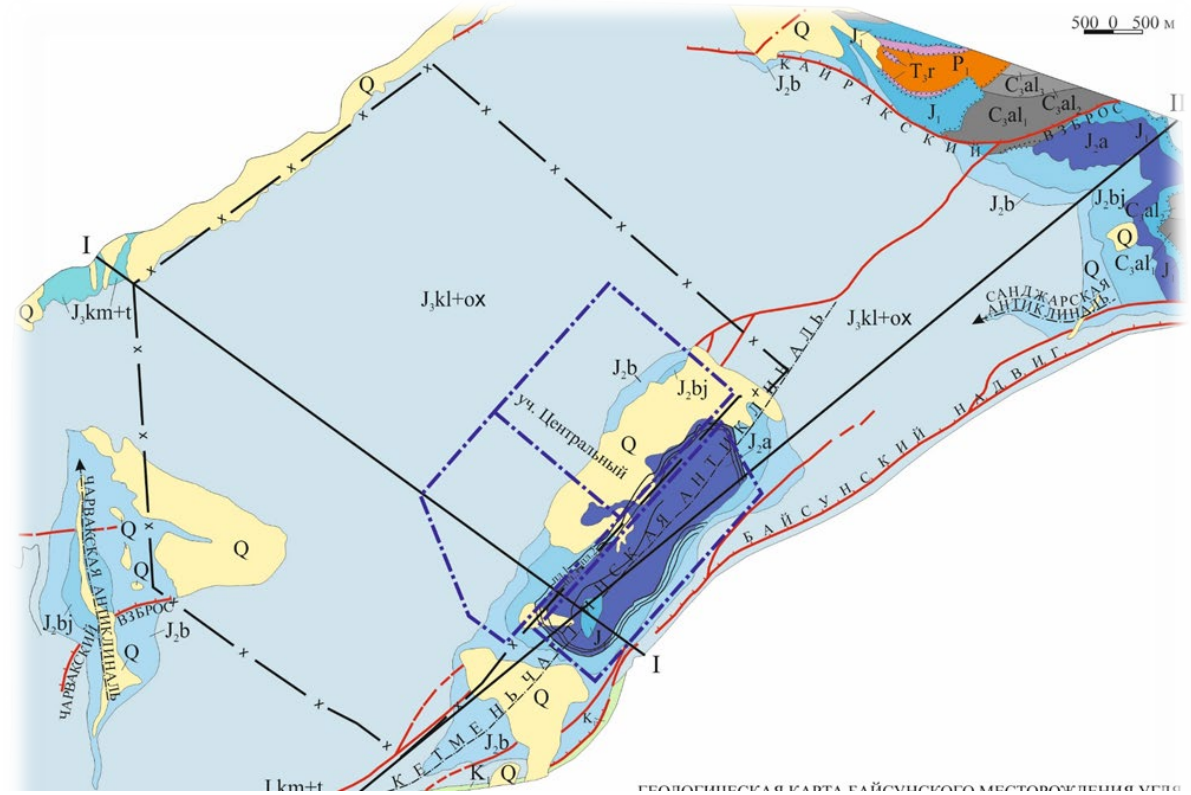
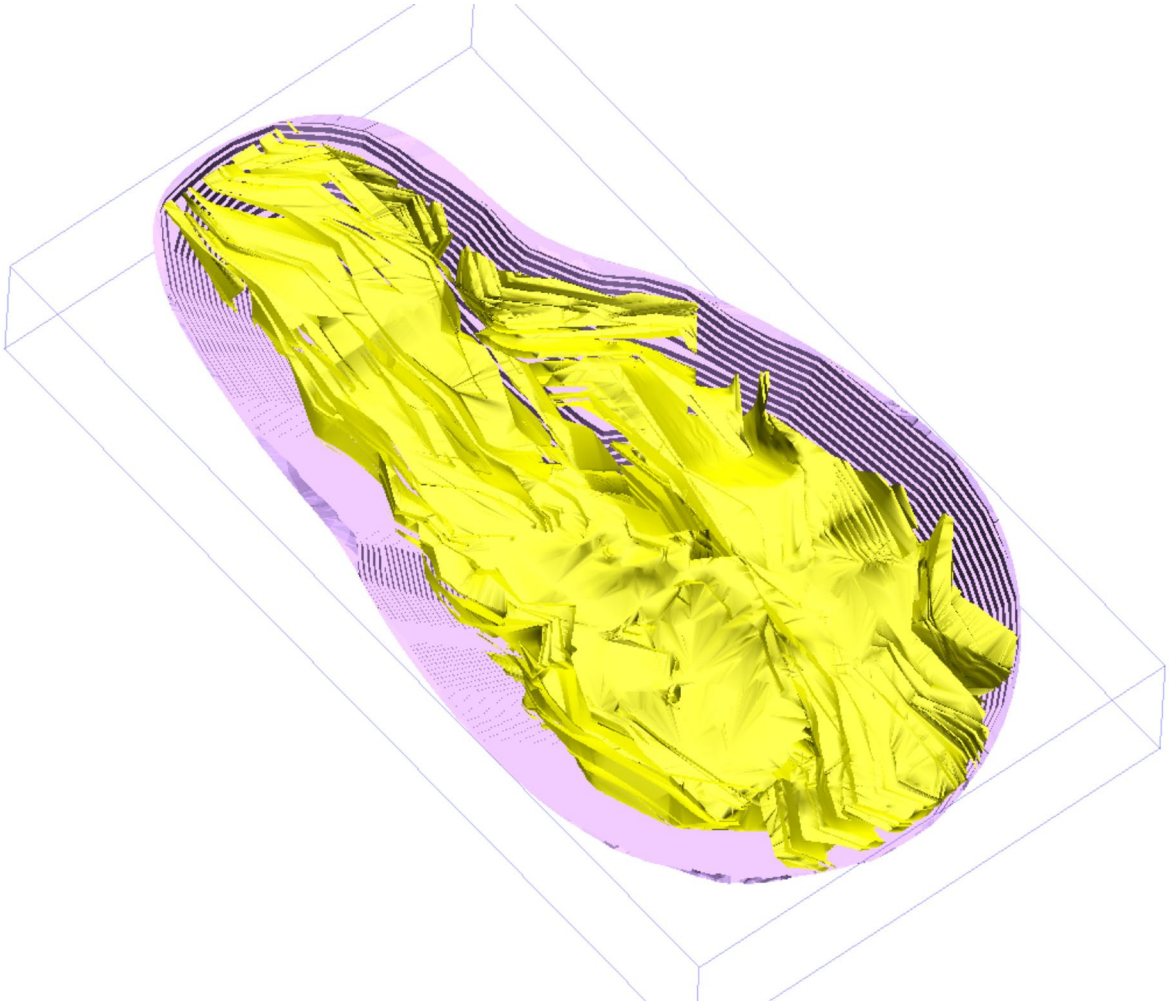
3. http://uzbekistan2035.uz
4. Geological materials of SE “Regional GSPE”.
5. Geological materials SE “Hissargeologiya”.

ANNEX

Annex I – Geological map of the Tsentralny site



Annex II – Quarry scheme for Tebinbulak titano-magnetite ores deposit



Annex III – The scheme of opening the coal seam No. 1 (1:2000)