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STRATEGY OF THE LONG-TERM DEVELOPMENT OF THE KYZYLKUM REGION

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This monograph lays put the results of research on the conceptual framework development with respect to the strategy for Kyzylkum region's innovative development with application of a systematic approach to exploit its aggregated resources on the example of the Navoi Mining and Metallurgical Combine as the main regional factor in the view of the national innovation system of Uzbekistan.

The state, being the owner of the subsoil, directs the mining enterprises to expand utilization of the potential resources of deposits, which results in a strong need to develop a strategy for development of resources. Based on the above, a research was carried out to analyze the mineral resources of the region, and laid out the data related to its geological development, tectonic zoning and forecast-metallogenic features. The paper provides the results of research on the status and prospects of usage of environmental, energy and water resources of the region. It has considered the issues of the regional structure formation as a natural and industrial system, preparation of the development strategy for the regional aggregated resources, the algorithm elaboration for selection of the development strategy for the Kyzylkum region based on the mining clusters.

The monograph is intended for a wide range of researchers and specialists engaged in the system analysis of large systems, development of regions and mining complexes, as well as undergraduates and postgraduate students of the relevant higher education disciplines.

ABBREVIATIONS

ICS	Industrial Control System
CAMS	Computer-Aided Manufacturing System
SCADA	Supervisory Control and Data Acquisition
AMMC	Almalyk Mining and Metallurgical Combine
GRP	Gross Regional Product
EM	Explosive Materials
WIPO	World Intellectual Property Organization
MC	Mining Complex
MPF	Mining and Processing Facility
HMP	Hydrometallurgical Plant
HP	Hydrometallurgical Production
GFP	Geological Field Party
GM	Geotechnical Mine
GRF	Gold Recovery Plant
ISOZ	In-Situ Oxidation Zone
IACS	Integrated Industrial Control System
ICT	Information and Communications Technology
HAC	High Angle Conveyor
LSU	Local Sorption Unit
MRB	Mineral Resources Base
MR	Mineral Resources
MW	Mineral Water
NMMC	Navoi Mining and Metallurgical Combine
NIS	National Innovation System
RA	Research Activities
R&D	Research and Development
NMBP	Navoi Machine-Building Plant
NSMI	Navoi State Mining Institute
TOM	Technical and Organizational Measures
OC	Organic Compounds
OMF	Organic Mineral Fertilizers
PTID	Production, Technical and Innovation Department

RIS	Regional Innovation System
RH	Radiation Hazards
SIZ	Special Industrial Zone
FIEZ	Free Industrial Economic Zone
SAP	Sulfuric Acid Production
BISL	Borehole In-Situ Leaching
NMA	Northern Mine Administration
FER	Fuel and Energy Resources
M&R	Maintenance and Repair
GHLP	Gold Heap Leaching Plant
CFT	Cyclic Flow Technology
CIT	Center for Innovative Technologies
CMA	Central Mine Administration
SMA	Southern Mine Administration

INTRODUCTION

The action strategy on five priority areas of development in 2017-2021, the Innovation Development Strategy of the Republic of Uzbekistan for 2019-2021, implementation of large-scale reforms in all areas of activity stipulate a transition to an innovative economy or a knowledge-based economy.

The prerequisites as necessary for this are available. The country hasa developed sector of academic and university science, which ensures implementation of fundamental and applied research, innovative projects. Uzbekistan possesses a huge intellectual, mental, cultural, industrial andresource potential. Then it comes to resource potential, it should be noted thatprimarily, applies to the mineral resources sector, which is fundamental for economy of numerous countries.

Uzbekistan is rightfully proud of abundance of its soil, almost every element of the Periodic table can be found here. As of today, more than 2.7 thousand deposits and prospective ore occurrences of various minerals have been identified, including about 100 types of mineral feedstock, of which more than 60 ones have already been brought into production. More than 900 deposits were explored with confirmed estimated reserves for USD 970 billion. It shall be noted that, the total potential mineral base amounts more than USD 3.3 trillion as per estimations. The soil of the country enables to extract minerals for around USD 5.5 billion annually, with growth of total reserves for USD 6.0-7.0 billion.

The necessity to boost the growth of regional competitiveness based on the potential of economy, education, science, design and engineering, minerals and institutions entailed the necessity to develop the Regional Innovative Systems (RIS).

In this respect, it is especially important to study the challenges of development of Kyzylkum region, the unique economic and geographic complex enjoying huge mineral reserves. Navoi Mining and Metallurgical Combine (NMMC), the major city-forming enterprise is the prime basis for social and economic development of Kyzylkum region due to its substantial contribution into social and economicdevelopment of the country through its significant production potential, extensiveinfrastructure, and multinational workforce.

The basic premise for successful implementation of the production program of NMMC is the infinite potential of accelerated development of Uzbekistan and the state innovation policy focused on stability, reliability and prospect. The Decree of the President of the Republic of Uzbekistan “On Action Strategy for further development of the Republic of Uzbekistan” gave a strong impetus for innovative activity and shaping for National Innovation System.

It shall be noted that every facility within the mineral resources sector with own aggregated resources is an integral part of natural and industrial system organized in hierarchic manner. The aggregated resources of the natural and industrial system are a systemic complex of all types of natural resources (materials, power and information), defining the profile of social life together with physical, financial and labor resources. The maintenance of the aggregated resources of the regions for which mineral resources sector is quite crucial, is based on special features, since the changes in resources are obvious and can be forecasted, as every deposit is always characterized with inevitable depletion of its reserves, whether sooner or later. The depletion of the mineral resources of the deposit results that influx of commodity and finance will decrease which in turn reduce tax charges and jobs. All the way, if the aggregated resources falls below a certain level, it means that natural and industrial system degrades too which urges to make a decision on the future of the mining complex, and prepare to it in due time.

Therefore, it is essential to conduct research activities in terms of conceptual framework of the strategy of Kyzylkum region‘s development through the prism of systematic approach to exploitation of aggregated resources based on the strategic analysis and forecasting since the mining works at the base deposits of Kyzylkum will naturally decline.

The control over aggregated resources of the Kyzylkum region, given the depletion of the existing gold deposits is expedient if it considered the development of the new types of mineral raw materials, that silver, phosphates, uranium, rhenium, osmium or shale rocks, sand and clay. The conceptual solutions for processing of man-made feedstock should act an important role in control over the aggregated resources of the region. Scientific research aimed at processing man-made feedstock of operating mining companies, refinement tailings and heap leaching, as well as of hydrometallurgical plants based on modern technologies, is a relevant issue for mining and metallurgical production of the Navoi MMC. The process properties of man-made feedstock in the Navoi Mining and Metallurgical Combine are well studied. Numerous recommendations for their processing have been developed. In our opinion, the problem of man-made feedstock processing is not so much scientific and technical as economic, social and organizational.

In addition to the establishment of new production facilities, the solution of control of aggregated resources will require the conversion of existing ones as well. The possible optimal solution of this set of problems is to generate new process solutions uninterruptedly, to introduce innovative methods in production within the innovation clusters, being an incidental component of the upcoming regional and national innovation systems of Uzbekistan. The measures required to balance the aggregated resources in the mineral resources sector cannot be taken without forward investment, though the amount of which is not always within the range of possibility of the mining and processing complexes or regions. Thus, the sources of such funds shall be identified in advance with confirmation of conditions on their drawing and return and that their scope is in line with the designated objectives.

The monograph brought to the notice of a reader outlined the research results obtained during t h e implementation of the OT-F7-045 fundamental research project "Conceptual framework of the strategy for Kyzylkum region's innovative development based on a systematic approach on the aggregated resources exploitation". The monograph is divided into four chapters: the first one considers certain aspects of the upcoming National Innovation System of Uzbekistan and provides retrospective analysis of individual features of regional innovation systems and innovation clusters. The second chapter outlines the research results in terms of current state of affairs and prospects for Kyzylkum region's development, serving as the basis for development the foundations of the regional development strategy with application of a systematic approach to exploit its aggregated resources. The third chapter lays an analysis of impacts from various components (natural, technical, social and economic) on the development of the Kyzylkum region. The fourth and final chapter is devoted to the design of an algorithm to select a strategy for the development of an aggregated resources of a natural and industrial system which requires a systematic approach and to be developed for each type and for the entire set of resources under exploitation.

This book was published in Russian in 2013. The new version of the book reviews the issues of investments, localization and inter-industrial co-operation considering the commissioning of new facilities in the Kyzylkum region as well.

The authors hope that this monograph would be valuable for researchers and specialists engaged in the system analysis of large systems, development of regions and mining complexes, and the undergraduate and postgraduate students of relevant disciplines and will appreciate the possible feedback with respect to the issues covered herein.

CHAPTER I

National and regional innovative systems, innovative clusters

The decree of the President of the Republic of Uzbekistan “On approval of the Strategy of Innovative development of the republic of Uzbekistan for 2019-2021” noted that “the key premise for dynamic development of the Republic of Uzbekistan is based on accelerated introduction of modern innovative projects and technologies into economic branches, social and other fields of social and state life of Uzbekistan and requires close support of the ongoing reforms grounded on the modern innovative ideas, developments and technologies which ensure prompt and qualitative breakthrough in order to become a leader of the global civilization”. Based on the global experience, the national and regional innovation systems[1], and innovation clusters of various types are the specific tools to implement the innovation policy and ensure transition to an innovative economy (Fig. 1.1).

The national and regional innovation systems, and innovation clusters can be established on grounds of a strong foundation represented by economic backgrounds, state support, developed science sector (both fundamental and applied), sound education system, industry, innovation infrastructure and a whole range of other components serving as catalysts of innovation development.

This chapter briefly highlights the features of a number of NIS sectors through the prism of the upcoming national innovation system of Uzbekistan. This chapter also provides a retrospective analysis of the experience of the formation of regional innovation systems and innovation clusters of foreign countries since the subject matter of research is the Kyzylkum region. Among the economic backgrounds required to form the national innovation systems, the first credit shall be given to the importance the mineral resources complex. The global mineral resources complex is still one of the leading components constituting the rate and quality of global economic growth.

[1] One of the most common definition of NIS: it is the set of institutes relate to the private and public sectors which stipulates the development and introduction of new technologies within the certain state either on an individual level or in cooperation with each other [3].

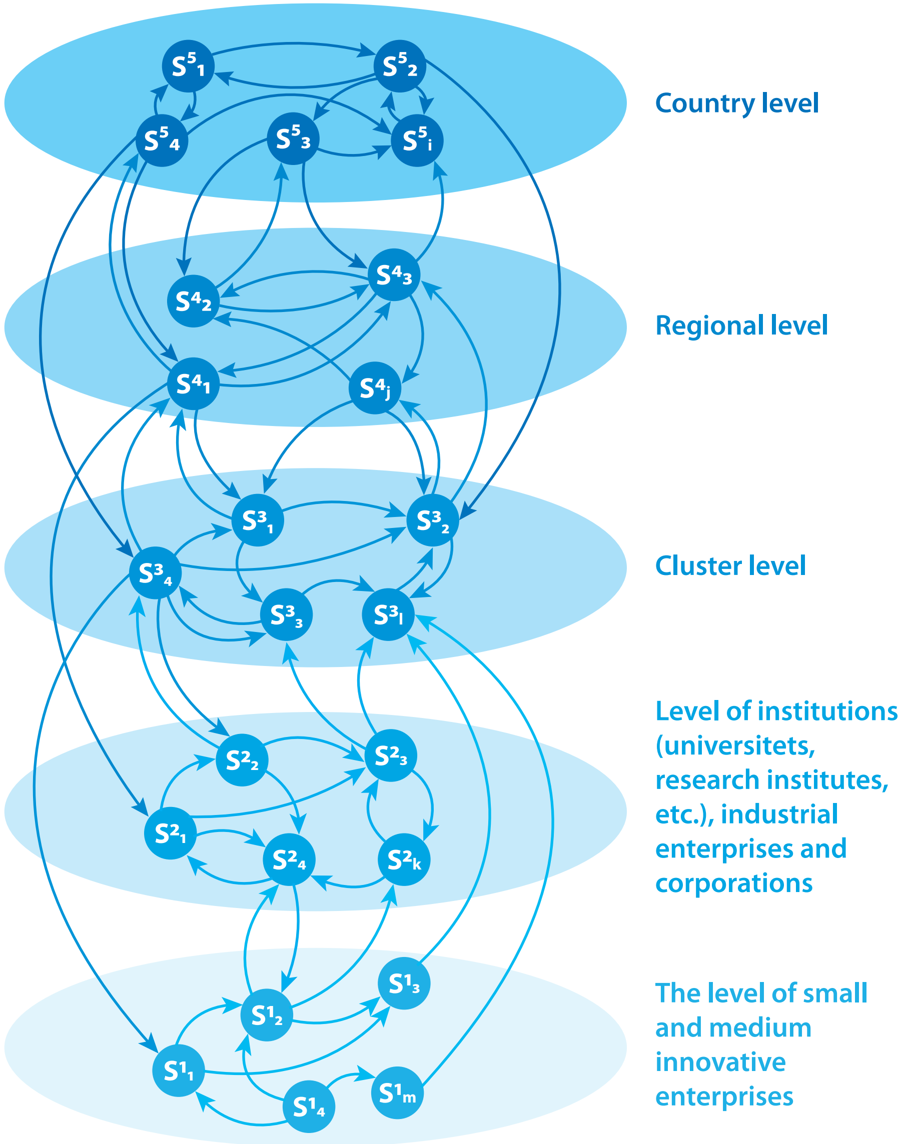

Fig. 1.1. Fragment of the structure of the national innovation system

Mineral raw materials are the source and the power stock for 70% of the entire assortment of the finished products manufactured by human society. It has no alternative for the existence and development of modern civilization. The annual world production amounts to around 280 billion tons of ore, fossil fuels and building materials, as well as more than 600 billion tons of host rocks [4].

In Uzbekistan, the mineral industry is a crucial element for the development and distribution of production forces, budgeting and, subsequently, the well-being of people, therefore, the competitiveness of the national economy is based on the application of modern tools of state regulation and innovative technologies in the development and reproduction of the mineral resources.

As all industrial sectors of our country, Navoi Mining and Metallurgical Combine is active in modernization of production facilities. At the initiative of the head of our state, the plant plans to implement 27 projects in 2017-2026. Among them, the construction of the 5th hydrometallurgical plant is one of the most crucial. This project with a total cost of USD 396 million, will create an opportunity for processing 5 million tons of ore per year, and create about 5,300 jobs. The President of our country noted the enormous social and economic importance of the construction of a new hydro-metallurgical plant. We also would like to note that a decision on establishment of the 6th hydro-metallurgical plant has already been taken.

Uzbekistan is one of the largest producers of gold, uranium, and copper mined by the Navoi and Almalyk mining and metallurgical combines. The mining industry is quite significant in the development of the economy of Uzbekistan. The country occupies leading places with respect to proven reserves of gold, uranium, copper, natural gas, tungsten, potash salt, phosphate rock, kaolin, not just in the CIS, but in the world as well. The country is ranked No. 4 in gold reserves, and No. 7 in its production in the world (second in the CIS); No.10 in copper reserves; and No. 7 in uranium. Explored reserves of uranium are sufficient to ensure its production for 50-60 years. Uzbekistan accounts for almost 75% of gas condensate and 40% of natural gas. The volume of explored hydrocarbon reserves is estimated at 3.5 billion tons of equivalent fuel, the degree of depletion is 32% and 37% for gas. The inferred hydrocarbon resources are estimated at 847.7 million tons of oil, 380 million tons of gas condensate and 5.9 trillion m^3 of gas. At current annual production rates (62.6 billion m^3 of gas and 5.4 million tons of oil and gas condensate), Uzbekistan's supplies with explored reserves of natural gas will be depleted in 31 years, oil in 21 years and condensate in 25 years. The explored reserves to 1.85 billion tons of brown coal amount and about 50 million tons of hard coal. The inferred coal resources are estimated at 5.7 billion tons. Three coal deposits Angren, Shargun and Baysun are developed in the country. Hydro power potential of Uzbekistan is 15 billion kWh/annum, the nominal installed capacity of power plants (12,359 MW) is almost 50% of the total generating capacity of power plants in Central Asia. The huge importance shall be given to the decision on construction of a nuclear plant with capacity of 2,400 MW in the Jizzakh region.

Favorable climate, vast mineral resources, large reserves of strategic materials and agricultural raw materials make Uzbekistan one of the richest countries in the region and the world and serve as a solid economic foundation for upcoming national innovation system, regional innovation systems and innovation clusters. We need to note that the initial economic backgrounds, development paths, formation periods (Table 1.1), structure of national innovation systems of various countries vary considerably.

Table 1.1

The periods of shaping national innovative systems in different countries

Country	**Commencement of deliberate actions by government**	**Significant economic growth**	**Period of „acceleration"**
USA	Early 1960s	1980s	25 years
Taiwan	Early 1960s	1980s	25 years
Israel	1980s	1990s	15 years
South Korea	Early 1960s	1990s	35 years
Singapore	1960s	Early 1990s	30 years
Finland	Late 1950s	1970s	10 years

Fig. 1.2. The main components (objects, subsystems, agents) of NIS

Yet, there is something in common, first of all it is the similarity of the problems of start, of infrastructure, of composition of national innovation systems (Fig. 1.2). We will consider certain aspects of the upcoming national innovation system of Uzbekistan through the prism of its components (otherwise: elements, sectors).

1.1. Innovation and simulation strategy of economic development

In every certain case, the strategy of national innovation system formation is based on the state innovation policy, the conditions of innovation culture in society, regulatory legal framework, the conditions of educational and scientific, technological and industrial potential, the level of information and communication technologies development, the innovative potential of small and medium-sized science-based companies and corporations, and the historical and cultural traditions of the country. Therefore, the number of countries, and implemented, upcoming, or hypothetical national innovation systems. At the same time, as mentioned earlier, the NIS in different countries have common features. Primarily, this is can be shown by the composition of the elements (otherwise: subsystems, sectors, agents, subjects). We would like focus on one more aspect. Traditionally, the publications devoted to NIS divides the countries depending on the adopted model of economic development, that is, simulative countries (having the strategy of "absorption" of borrowed technologies) and innovative countries (having the strategy of design of competitive technologies). Our analysis shows that the simulative countries have started their way to design the national innovation systems virtually from the scratch, "in the open field," without numerous components of the potentially upcoming NIS.

It brings to the question on the required scenario of economic development of countries that already have a developed fundamental science and education sector, workforce capacity, industrial potential and other components of a potential NIS. Obviously, the hybrid innovation-simulation strategy (hereinafter referred to as "inno-simulation") will the most optimal for such countries in terms of economic development. Such countries, design their competitive technologies within the limits of their achievable niches, but at the same time, they introduce borrowed technologies they carefully selected. In this connection, and given the existing circumstances, it is rather expedient to divide countries into the below types based on the economic development strategy in place:

– innovative countries
– inno-simulative countries,
– simulative countries.

Based on above, Uzbekistan shall be referred as the inno-simulative countries, considering its various sectors are potentially significant and promising for formation of the national innovation system.

For inno-simulative countries, the path of transition to the knowledge based economy and acceleration of the processes for designing the national innovation systems can be optimized through parallel, carefully weighted application of innovation and simulation scenarios, that is, combination of scenarios.

1.2. Some components of the upcoming NIS of Uzbekistan

During the years of independence, Uzbekistan achieved dramatic success in the formation of institutions and legal mechanisms of a socially oriented market economy. With this, special emphasis is given to education and research; state support of small business and private entrepreneurship; development of innovations and creation of infrastructure for innovations, the development of the information and communication technology (ICT) sector. Thus, there are all components to design the national innovation system. We will demonstrate this through a brief analysis of some of the sectors: education, science, industry, small business, ICT, innovative culture and infrastructure (research parks, Information and Innovation Support Centers only) of upcoming NIS, while we do not state that out description is fully complete.

1.2.1. Education sector

It can be stated a priori, that education system is the most important component or basis of upcoming and implemented national innovation system. Therefore, the issues of education and its quality improvement is of high priority in Uzbekistan.

Upon Initiative and direct involvement of Mr. Shavkat Mirziyoyev, the President of Uzbekistan, the radical measures to reform the education system have been taken.

- The optimal three-phased structure of education management has been established. The education system is regulated by the Ministry of Pre-School Education, Ministry of Public Education and the Ministry of Higher and Secondary Special Education.
- A number of legal acts, decrees and resolutions of the President aimed at improving the quality of education at each stage of education were adopted.

Thus, the Presidential Decree „On measures for further improvement of preschool education in 2017-2021" and the Decree „On additional measures for improvement of the public education management system" defined the tasks for cardinal improvement of the quality of children's preparation for school, introduction of modern approaches to the education system, establishment of the conditions required for their intellectual, moral, aesthetic and physical development.

Following the results of the „Year of dialogue with the people and human interests", and given the proposals of numerous parents, teachers, students, and wide public, 11-year basic education was restored in Uzbekistan.

On November 26, 2019, it was adopted the Decree of the President of the Republic of Uzbekistan „On measures to create „Modern schools" which noted that *„in order to upgrade the basic secondary education by building the secondary educational institutions of a new type, and gradual adjusting the buildings constructed previously to the modern requirements, introduction of the modern pedagogical technologies into the education process and development of competition in the educational services market it is required:*

1. To approve the proposal of the Ministry of Public Education, the Ministry of Construction, the Ministry of Health of the Republic of Uzbekistan, as well as the ministries and agencies supervising the institutions of basic secondary education, on establishment of „Modern Schools" to be built and equipped on the basis of advanced architectural solutions and energy-saving technologies as intended for creation of the necessary conditions for high-quality education and upbringing of young people in accordance with the global requirements."

Uzbekistan will spend UZS 4.05 trillion in 2020-2022 for construction, reconstruction, repair and equipping of secondary schools under the „Modern School" project.

The Innovation, Technology and Strategy Center under the Ministry of Public Education of the Republic of Uzbekistan will issue certificates of conformity to the secondary educational institutions through their evaluation based on the requirements to the "Modern School" with the involving the representatives of local and foreign companies. The Center will launch an electronic platform to determine the rating of secondary educational institutions based on the requirements of the „Modern School". In addition, the Specialists of the Center will develop proposals for adjusting the secondary educational institutions in line with the requirements of the „Modern School".

The Decree of President „On additional measures for improvement of the quality of education in higher educational institutions and assurance of the active participation in the nation-wide reforms" was dedicated to the issue relating to the improvement of the quality of education in the higher education institutions, and provided a detailed system analysis of the current state system of higher education and approaches for radical improvement of the quality of education in higher educational institutions, assurance of their active participation in the nation-wide reforms and the consistent implementation of tasks defined in the strategy of actions with respect to five priority fields of development of the Republic of Uzbekistan in 2017-2021.

• It was approved the Concept of higher education system development in the Republic of Uzbekistan till 2030 (the Decree of the President of the Republic of Uzbekistan dated 08.10.2019) in order to determine the priority fields of systematic reforming of higher education in the Republic of Uzbekistan, to upgrade the process of training of independently-minded highly-qualified personnel having modern knowledge and high moral qualities, to modernize the higher education, to develop the social sphere and economic branches based on the advanced educational technologies.

This Concept stipulates:

– development of public and private partnership in the field of higher education, increase the level of higher education coverage by more than 50 percent based on arrangement of operation of the state and non-state higher education institutions in the regions, establishment of a healthy competitive environment;

– assurance of the establishment of the National University of Uzbekistan and the Samarkand State University as the flagships of higher educational institutions of the country;

– assurance that at least 10 higher education institutions of Uzbekistan to be included into the top 1000 universities in the list of higher education institutions as rated by the internationally recognized organizations (Quacquarelli Symonds World University Rankings, Times Higher Education or Academic Ranking of World Universities), with the National University of Uzbekistan and Samarkand State University to be included into the top 500 universities in these ratings.

• Establishment of new laboratories in educational institutions, improvement of the material and technical base, computerization and Internet connection of schools, colleges, academic lyceums and universities, as well as the creation of Industrial Control System for Universities (ICS-U).

The main goal of the Industrial Control System for Universities as created in our country is to improve the quality of Universities operation, the quality of educational processes and innovation management. Conceptually, we can set two areas of education informatization apart.

The first area is about the creation of Automated Information Systems (AIS) as intended for informatization of various components of educational processes. These are systems of the „electronic log/diaries" type.

At this stage of informatization in the education, the second area becomes as the relevant task, namely the transition to use of such Industrial Control System for Universities as ICS-U, which enables to automate all the processes of education as integral, but not separate parts.

• Rating system for evaluation of the work of institutions of higher education was introduced. The functions to compile the rating are assigned to the State Testing Center under the Cabinet of Ministers, which will submit annual analytical reports on the status of development of higher education in the republic to the government, based on the approved (temporarily) rating compilation methodology. The criteria to evaluate the universities are made with emphasis to the teaching quality level index and the scientific potential of universities, where the highest grade is 35%, and the students and graduates' qualification index prepared based on employers survey results, where the highest grade is 20 %. The remaining 10% is concluded through other parameters.

• In recent years, hundreds of young men and women are enrolled into the best foreign higher education institutions. Meanwhile, globally-recognized universities open their branches in Uzbekistan. For instance, currently, there are such universities in our country providing quality education that meets international standards as: International Westminster University in Tashkent, the branch of Lomonosov Moscow State University, the branch of the Gubkin Russian University of Oil and Gas, Management Development Institute of Singapore, Turin Polytechnic University in Tashkent, Inha University, the branch of the National University of Science and Technology MISiS, the Belarusian-Uzbek Inter-industry Institute of Applied Technical Qualifications in Tashkent, the branch of the D. Mendeleev University of Chemical Technology of Russia, the branch of the Moscow Power Engineering Institute (National Research University) in Tashkent, the branch of the Russian State University of Physical Education, Sport, Youth and Tourism in Samarkand-city, the Sharda University, the branch of the Moscow State Institute of International Relations in Tashkent, Ajou University in Tashkent, the branch of the ISMA University of Latvia in Fergana-city, the branch of the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) in Tashkent, Bucheon University in Tashkent.

1.2.2. Science and innovation development

Uzbekistan is recognized as a state where the science and culture has started to develop since the very ancient times. In particular, such sciences and crafts as astronomy, mathematics, medicine, chemistry, weaving, sculpture, source studies, philosophy, music, language studies, and literature studies have been widely developed. Currently, Uzbek scientists are interested in study of the scientific heritage left by the ancient scientists, and enrich Uzbek science with their works and scientific discoveries, thereby contribute significantly to the development of world science and culture.

As of today, Uzbekistan is a major scientific center in the Central Asia having a developed research material base, an extensive scientific fund, and qualified scientific personnel whose works have acknowledged throughout the globe.

The research complex of Uzbekistan includes hundreds of institutions of academic, collegial and industrial profile, including:

- research institutes of the Academy of Sciences;
- scientific research departments of Universities;
- sectoral research institutes;
- internal corporate science of companies;
- design organizations.

The core of the scientific potential is the Academy of Sciences of the Republic of Uzbekistan, which is the leading scientific and experimental center in the region. The structure of the Academy includes such unique scientific centers, which are successful in studies, as:

- Institute of Nuclear Physics,
- Research and Production Association „Physics-Sun“,
- The complex of high-altitude astronomical observatories on the Maydanak mountain,
- and a number of others.

The reputable scientific schools in various areas of modern science have been established and successfully developed within the Academy of Sciences of Uzbekistan for more than 86 years of its activity:

In terms of mathematics, research is carried out on the current problems of mathematical statistics and probability theory, differential equations, and functional analysis.

In terms of astronomy, research is carried out on the problems of Earth astrophysics (time service, pole movement), helioseismology, star formation and space geodynamics, and the structure and evolution of star systems and galaxies.

In terms of physics, fundamental research is conducted on nuclear physics, nuclear reactions, radiation materials science, activation analysis, interaction of nuclei, atomic particles, laser and solar radiation with matter and materials, including the physics of metals, semiconductors, dielectrics, inhomogeneous media, plasma, solutions.

In terms of theoretical and applied mechanics, research is carried out on the processes of movement of multiphase media and various mechanical systems of machines and mechanisms. The theories and practical recommendations are calculated and developed for earthquake-resistant construction of civil, industrial, transport structures and hydraulic engineering.

In terms of energy, theories, principles and automated control systems for electric networks and electric machines, electric drives and energy-intensive technological processes; the basics of energy-saving in industry; the methods for diagnostics of electric power systems and power plant facilities, as well as the problems of renewable energy sources applications are developed.

In terms of the information technologies and information theory, research is carried out on the problems of algorithmization and modeling of complex processes and systems, including systems of optimal automated control and artificial intelligence, the theory of image recognition, information processing and protection, creation of computer networks and information technologies.

In terms of Earth sciences, geology, seismology, water problems, and ecology, the research is carried out on the structure of the lithosphere, petrology, magmatism, metallogeny, ore formations, search and identification of mineral reserves, oil and gas geology, seismic zoning, modeling and long-term earthquake prediction, features of arid hydrology and hydrogeology, as well as problems of forecasting, management of search of unconventional water sources, and rational use of hydro resources.

In terms of chemical sciences, basic and applied research is carried out on methods of complex processing of fuel and mineral raw materials, processes in animal and plant organisms; new biologically active substances, fertilizers, polymers, catalysts, refractories, defoliants, hormones are created and their properties and mechanisms of action are studied; lipids, enzymes and new highly effective chemical and medical drugs and substances are created.

Biological scientists conduct basic and applied research in the field of microbiology and physiology, biochemistry and genetics of bacteria, viruses, growth factors, toxins, microbial biotechnology, plant breeding and create new bacterial and other biological products, the new high-yielding and disease-resistant varieties of cotton, wheat, methods of genetic engineering, as well as collections of phytopathogenic microorganisms and substances that counteract plant diseases and eliminate pests, immunogenetic markers and immune systems and improve the immune resistance of organisms, the genetic collection of new varieties of cotton, plant protection, development of methods of cell biotechnology, natural and synthetic biologically active compounds, the study the biodiversity of flora and fauna taking into account the specifics of the arid zones, with conservation of the species and rare collection of snakes, spiders and other invertebrates and vertebrates, herbarium and palaeobotanical collection, special features of introduction and acclimatization of foreign regional floras, and biological diversity and ecological peculiarities of the Central Asia.

In terms of social and humanitarian sciences, fundamental research is carried out in history, oriental studies, source studies, archaeology, language and literature, philosophy and law, as well as economics. Archaeological findings, historical processes of development of statehood within various periods on the territory of modern Uzbekistan, creation of statehood, language and literature, formation of cities, ethnography and ethnogenesis of Uzbek culture, scientific, literary, linguistic, cultural heritage, ancient historical monuments on the territory of Turkestan and manuscripts Oriental world are also studied and analyzed.

Along with the above-mentioned and other basic research, a wide range of scientific and applied projects for various sectors of the economy are implemented in Uzbekistan.

For Uzbekistan, it is impossible to establish its own state after getting independence, without implementing intensive reforms aimed at building a socially-oriented market-type economy and updating the society against the background of growing regional environmental problems, threat of a global environmental crisis, with possibility that significant environmental changes and unexpected events can occur in this century already, without scientific understanding of those processes, deep knowledge of the laws of development of society and nature. With this, the scientists in Uzbekistan make a decent contribution in addressing such problems.

The state scientific and technical policy encompass a full support of scientific research, development and innovative projects, as reflected in the relevant decrees and resolutions of the President Shavkat Mirziyoyev. As an example, on 17 February 2017, it was adopted the Decree „On measures for further improvement of operation of the Academy of Sciences, organization, management and financing of research activities“, to further strengthen the role of academic science in the innovative development of the economy, enhance the prestige and to improve the activities of the Academy of Sciences, shape a unified system of control and regulation of research activities and to increase the role of science, and the social and economic development of the Republic of Uzbekistan.

In accordance with the Decree of the President of the Republic of Uzbekistan No. PP-3059 „On measures for organization of the activities of the Navoi branch of the Academy of Sciences of the Republic of Uzbekistan“, dated 15.06.2017, Navoi branch of the Uzbekistan Academy of Sciences was established, with a purpose to address following tasks:

– carrying out a system analysis of the status of industry and agriculture in Navoi region (further - the Territory), identifying problematic issues and determining prioritized scientific areas for search of efficient solutions;

– organization and carrying out the scientific research that contributes to the technical and technological development of economic sectors of the Territory and ensuring the introduction of energy- and resource-saving technologies, reduction of the manufacturing products cost;

– coordination and monitoring of scientific research aimed at technological and socio-economic development of the Territory;

– participation in fundamental and applied research and innovative development in the field of geology, mining, metallurgy, chemistry, geotechnology, robotics, mechatronics, nanotechnology, biotechnology, agrochemistry, ecology, automation, energy and mechanical engineering, as intended for further development of the Territory;

– participation in training, retraining and capacity building of highly qualified scientific and scientific-pedagogical personnel, teachers of educational institutions and specialists of industrial companies of the territory;

– establishment of conditions that help to accelerate the integration of science with education and production;

– study and analysis of achievements of global and domestic science in the field of industry and agriculture, development of recommendations for their application, taking into account the characteristics and needs of the territory;

– organization of international cooperation within the framework of scientific research to address the problems of the Territory, involving foreign experts in joint scientific research.

The remuneration of scientists is the main direct impact on the results of research. The Government pays a great attention to this issue, as evidenced by the Decree of „On measures for improvement of the remuneration system for employees of higher educational and research institutions of the Republic of Uzbekistan“, dated April 5, 2018, and by significant increase in the salaries of scientists in the country.

In order to regulate relations in the area of science and scientific activity, the Law of the Republic of Uzbekistan „On science and scientific activity“ was adopted (October 29, 2019, No. LRU-576).

1.2.3. Small business

Development of entrepreneurship and small business is one of the priorities of state policy in Uzbekistan. As the President Shavkat Mirziyoyev noted, we can achieve progress and prosperity through active entrepreneurship, tireless work and dedication only.

Small business and private entrepreneurship are an important factor in the development of economy, increase in employment and income of the population. Over the past two and a half years, more than 50 Presidential decrees and resolutions have been adopted in order to fully support the entities of small business.

In particular, state registration of business activities, obtaining permits and many other procedures have been simplified. For greater convenience, the Agency for State Services and its local centers have been created. The institution of the Commissioner for the Protection of the Rights and Legitimate Interests of Business Entities (Business Ombudsman) has been introduced.

Reception offices of the Prime Minister were established in every region to review applications from entrepreneurs. The State Fund to support the development of business activities has been created within the structure of the Cabinet of Ministers, with allocation of UZS 200 billion and USD 50 million dollars for its operation. Lending to entrepreneurs from commercial banks has also expanded.

Those practical measures are producing results. Small businesses produce almost 60 percent of gross domestic product, one-third of industrial output, 98 percent of agricultural output, and contribute half of the investment. Small businesses account for a significant share of export. Within 6 months of 2019, the number of business entities increased by 60 thousand.

As a result of fundamental reforms to support entrepreneurs and improve the business environment, Uzbekistan took 69th place in the World Bank's Doing Business 2020 ranking, with rising by seven positions, and became one of the top 20 Reformers. For the first time, our country has taken an eighth place in the world in terms of the convenience for new business opening.

Thanks to the created opportunities, 91 thousand new business entities were created over the past ten months of this year, which is twice as much as in 2019 (Table 1.2.).

Table 1.2

Share of small business and private entrepreneurship

(in % to the total volume)

Years	GDP	Industry	Construction	Employment	Export	Import
2000	31.0	12.9	38.4	49.7	10.2	27.4
2001	33.8	12.5	40.4	51.8	9.3	26.9
2002	34.6	15.4	42.0	53.5	7.5	24.9
2003	35.0	10.8	39.9	56.7	7.3	33.7
2004	35.6	11.0	49.6	60.3	7.3	32.7
2005	38.2	10.0	50.9	64.8	6.0	33.7
2006	42.1	10.9	52.1	69.1	10.7	34.0
2007	45.7	13.2	55.4	72.1	14.8	32.0
2008	48.2	14.6	58.4	73.1	12.4	35.7
2009	50.1	17.9	42.4	73.9	14.6	42.5
2010	52.5	26.6	52.5	74.3	13.7	35.8
2011	54.0	28.6	67.6	75.1	18.8	34.3
2012	54.6	29.7	70.0	75.6	14.0	38.6
2013	55.8	33.0	70.6	76.7	26.2	42.4

Continuation of table 1.2

2014	56.1	36.8	69.5	77.6	19.8	45.4
2015	54.5	40.6	66.7	77.9	27.0	44.5
2016	57.3	45.3	66.9	78.2	26.0	46.8
2017	54.9	41.2	64.8	78.0	27.2	50.2
2018	59.4	37.4	75.5	76.3	24.1	53.6
2019	60.2	41.1	78.9	77.4	25.6	54.7

1.2.4. Information and communication technology sector

In a nutshell, the national innovation system and informatization are two sides of the same coin. It is impossible to say that the modern NIS exists at all without informatization of all its components. Indeed, the countries with a formed national innovation system are distinctive with wide-spread application of informatics, information technology, and telecommunication systems not in industry, economics and finance alone, but in management, politics, science, education, culture, and health care as well.

A systematic approach to address the actual problems experienced by society makes it obvious that computerization or informatization in general, serves as a catalyst and one of the cornerstones of innovation, since it is the most important tool to support decision-making. For example, when general economic tasks are viewed as items of system analysis and synthesis of balanced solutions, it can be noted that they are featured with multi-stage, abundance of linked subtasks, large human, material, financial, energy, transport and other flows, huge document workflows and arrays of information. It is clear that in such conditions it is impossible to rely on the experience or intuition of the leader when decisions are made. The leader needs a support. Only powerful modern computers, "stuffed" with specially developed algorithms (programs), are able to process huge volumes of information and to find and "hint" the best solution from a multitude of possible options.

Besides the task to address the general economic issues, it is obvious that the most important tasks of informatization are to address the issues of the defense complex (automated border monitoring systems; automated air defense systems; combat simulation systems and finding optimal options for combat operations; training of staff on electronic simulators, etc.); to design automated systems for forecasting and anticipating emergency situations, to make operational decisions (ACS of emergency situations); to ensure the monitoring of the status of chemical objects hazardous to public health, to monitor large-scale hydraulic structures and many other objects and processes.

Education, science, medicine, the entire production sector, the entire financial sphere, customs, tax structures - these are another major areas, the basis for the development of which are information technologies and systems. Current trends in the global market show that the introduction of innovations in the field of information and communication technologies, as well as their skillful application backs the enhancement of managerial and engineering processes in companies; create new and expand existing markets for goods and services in various sectors of the economy. Telecommunication services are increasingly intertwined with the global Internet, its accessibility contributes to a more intensive exchange of information and knowledge between people, which leads to the formation of a knowledge-based society. Consequently, the development of telecommunications services, in particular the Internet, contributes to a more successful integration of Uzbekistan into the global social and economic community and an increase in the standard of living of the population.

Analysis of global development trends shows that innovations, innovation activity, and the knowledge-based economy (or innovation economy) play a key role in addressing the entire range of strategically important problems of various countries in the XXI century. Such countries as the United States, China, European countries, Japan, and a number of South-East Asian countries could succeed in transition to the path of sustainable development through a comprehensive intensification of innovation processes on the basis of a system-forming mechanism, created in those countries, which K. Freeman, called as „National Innovation System“ (NIS). The effectiveness of the NIS is determined by both effectiveness of individual elements and their integrity.

A new round of innovative development was caused by the digitalization of all spheres of human activity and the use of a wide range of knowledge, equipment, and technologies. We can say that the entire economy is subjected to the digitalization, that is, the digitalization of industry, transport sector, agriculture, education, healthcare, and such branches as: mining („digital mine“, „smart quarry“, etc.), oil and gas, chemical, hydrometallurgical, aviation, construction, and others.

In order to highlight the essence of digitalization, we will briefly focus on the digitalization of the industrial sphere, which marks the onset of the fourth industrial revolution and is a combination of industry and digital technologies, which results to establishment of digital production or smart factories.

The concept of the fourth industrial revolution was formulated in 2011 by Klaus Schwab, the President of the World Economic Forum in Davos. The term „Industry 4.0“ is a synonym to the fourth industrial revolution. Under this name, the projects belonging to the fourth industrial revolution are combined and implemented in the enterprises. This direction was created in Germany, which is the leader in the development of Industry 4.0. Similar programs exist in other countries as well, for instance: „Made in China 2025“ in China, „Connected Factories“ in Japan, which means connecting factories to the network, „Industrial Internet“ in the United States, etc. These programs will dramatically increase the competitiveness of the manufacturers in these countries, and they will become market leaders. That is, the countries that initially formed their national innovation systems as a result of the digitalization of industry will have an additional powerful impetus to strengthen their leadership further.

Prospects for digitalization. In a nutshell, it is: strengthening of national innovation systems, intellectualization of society, increasing labor productivity and reducing the cost of production, transition to a personalized market, which is production of items tailored for individuals.

At this stage, when the world is entering the era of the fourth industrial revolution, the issues of development of information and communication technologies are considered in symbiosis with the issues of digitalization, as can be seen from the decrees and resolutions of the President Shavkat Mirziyoyev:

– Decree No. PP 3549, dated 19.02.2018 „On organization of activities of the Ministry for Information Technologies and Communications Development of the Republic of Uzbekistan“ (it is stipulated an establishment of the Main Department on Digital Economy Development within the structure of this Ministry);
– Decree No. PP 3832, dated 03.07.2018 „On measures for development of the digital economy in the Republic of Uzbekistan“;
– Decree No. PP 3927, dated 02.09.2018 „On establishment of the

„Digital Trust“, the Fund for Digital Economy Development Support“;

– Decree No. UP 5598, dated 13.12.2018 „On additional measures for introduction of the digital economy, e-government, and information systems in the state administration of the Republic of Uzbekistan“;

– Decree No. UP 5624, dated 10.01.2019 „On measures to further improvement of the activities of the National Agency for Project Management under the President of the Republic of Uzbekistan“ (it is stipulated establishment of the Center for project management in terms of e-government and digital economy);

– **Draft** Resolution of the President of the Republic of Uzbekistan „On approval of the Concept of the national strategy „Digital Uzbekistan 2030“, dated 27.11.2019

It should be specially noted that digitalization of industrial enterprises is possible only if basic automation has already been implemented based on the introduction of integrated automated control systems (IACS) and specialized ICS.

Let‘s explain the above on the specific examples.

Integrated Industrial Control System (IACS) are the systems which integrally cover the level of production and economic activity - into various sectors, covering together the level of production and economic activity – the **CAMS** and the level of control of engineering processes – **SCADA**. In a macro-plan, integrated systems are complicated hierarchical systems, combination of information and dynamic interaction, containing the aggregated unity of information-computing and industrial digital networks, automatic control systems, technological processes and the “carriers” of the latter – engineering equipment and engineering networks.

The development and implementation of an IACS requires that a large complex of tasks related to the design of scientific, mathematical, software, organizational and other types of supplies to be addressed, which can be made by the organizations with highly qualified scientific and engineering personnel, scientific, technical and production potential. Such an integrated system was implemented at the hydro-metallurgical plant No. 2 of NMMC, the flagship of the Uzbek industry (Fig. 1.3, 1.4).

Undoubtedly, in addition to the integrated automated control systems, **specialized automated control systems shall play an important role** in addressing the relevant tasks related to the Program on Wide-scale Modernization of Technical and Engineering Upgrade of Industrial Facilities. For the sake of preciseness, we will give a concise general information on the Industrial Control System for maintenance and repair of electrical equipment (ICS-Electro) of the Uzbek Metallurgical Combine (Fig. 1.5).

The system "ICS-Electro" is employed on the basis of local networks, united by the corporate network of the combine. It has a single electronic database and more than 250 interrelated software modules covering the corresponding set of functional tasks of the area in question. The main goal to design the ICS-Electro system is strategic one; it is to maximize the profit of Uzmetkombinat OJSC by employing the functions by the system as follows:

- creation of a tool to keep an electronic database of repair and maintenance certificates for electrical equipment;
- recording a database of regulatory documents on repairs and maintenance of electrical equipment;
- obtaining up-to-date operational technical information on each unit (M&R) of electrical equipment;
- submission of retrospective information as required to make decisions during the maintenance and overhaul of electrical equipment to administrative, operational and maintenance personnel;
- increase in promptness and quality of planning and preparation for maintenance;
- anticipation of pre-emergency situations;
- collection and storage of data about occurred events (breakdowns, accidents);
- analysis of the causes of accidents, breakdowns and the elaborations of solutions to mitigate them;
- creation of an effective tool for planning the necessity in spare parts and materials;
- reduction in the time and costs of maintenance and repairs,
- submission of up-to-date reliable information on the availability of spare parts, materials and electrical equipment in the warehouses of the plant.

The solution proposed by the Intersectoral Center for Strategic Innovations and Informatization is a single complex of six subsystems that implement the functions of maintenance and repair management: “Manual”, “Electrical Equipment”, “Planning and Accounting for Repair of Electrical Equipment”, “Requests and Monitoring Execution”, “Regulatory reference”, “Administration”.

The developed algorithms and software modules are of a universal nature and can be adjusted to address similar challenges of companies active in various branches of the economy. Let us explain this by taking of one of the 250 tasks as example: “Maintaining an electronic database” of the “Maintenance-operational passport” task.

This module is required for any type of block, equipment or vehicle, regardless of their intended purpose, to ensure reliable, safe and economical operation.

Since, figuratively speaking, it enables you to keep a “finger on the pulse of the equipment”.

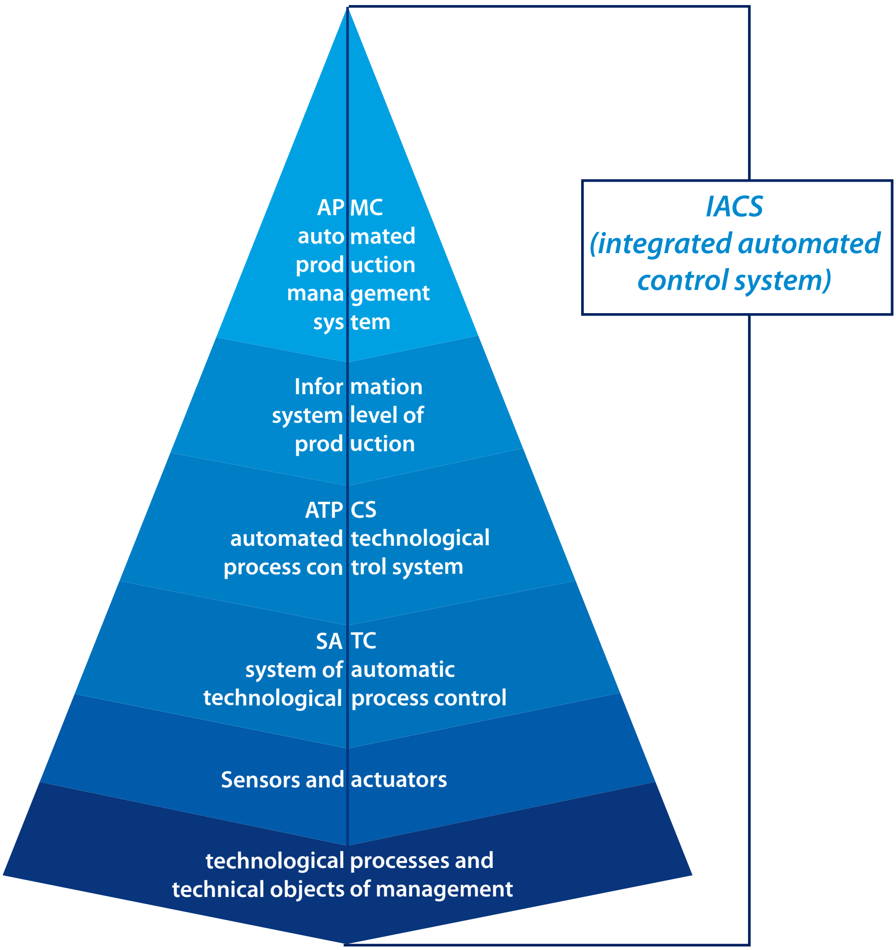

Fig. 1.3. Macrostructure IACS of hydro-metallurgical plant No. 2 of the Navoi Mining and Metallurgical Combine

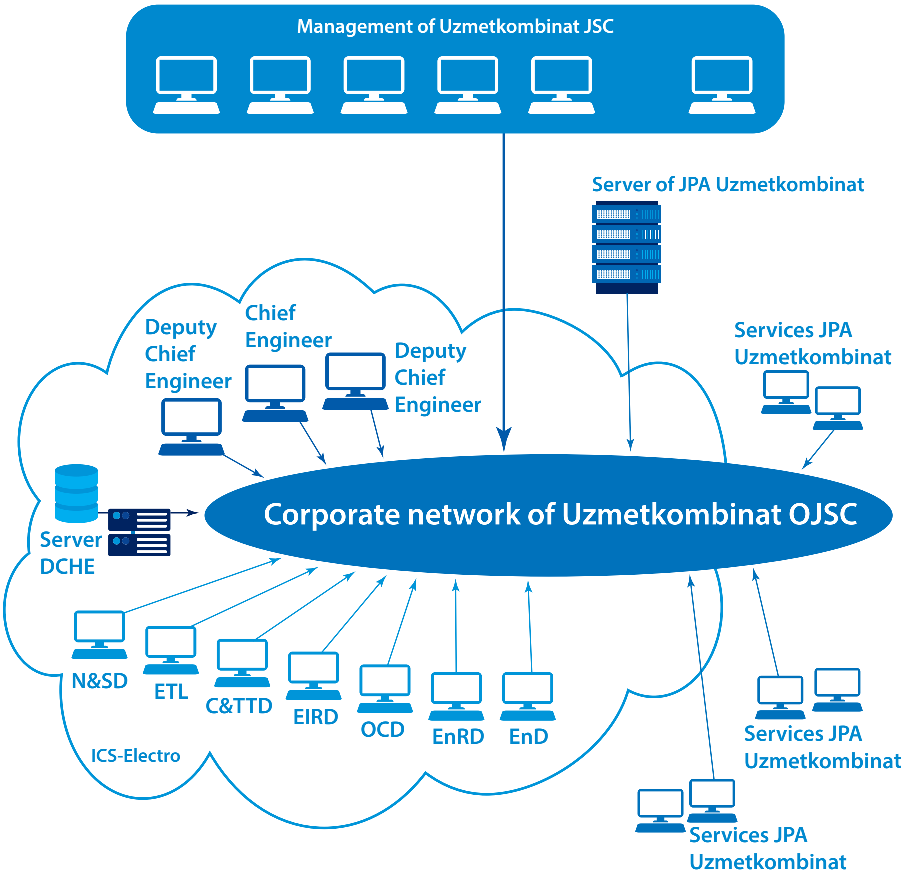

Fig.1.4. "ICS-Electro" in the corporate network of „Uzmetkombinat OJSC"

1.2.5. Industrial park

Industrial park is a new form of territorial integration of science, education and production in the form of an association of scientific organizations, design agencies, educational institutions, industrial enterprises or their in-house divisions. Industrial parks often include business incubators (Fig. 1.6). Industrial park is created in order to accelerate the development and application of scientific, technical and technological achievements through concentration of highly qualified specialists, use of equipped production, experimental and information base; and often enjoy preferential taxation.

Figures 1.6–1.8 show, respectively: the structure of an industrial park; its founders and the results of its activity.

The industrial parks were originally created in the United States in the early 50s, when the Stanford University Science Park (California) was organized. The University has found how to use an empty plot of land that was in its possession. Land and premises were leased to stand-alone small businesses and active companies that were booming due to military orders from the federal government to accommodate their high-tech units. The leasing companies had close working contacts with the University.

It took 30 years to complete the construction, create the infrastructure, and lease all land which the Science Park had. This project was a long-term one, that is, it required patience and dedication. The results were also relevant, this Science Park became famous for its phenomenal achievements in the development of the high-tech industry sector, and marked the beginning of the famous Silicon Valley. Well-known companies such as „Hewlett-Packard“ and „Polaroid“ started their life in this industrial park.

In modern conditions, with development of such means of communication as the Internet, it is possible to combine geographically isolated elements into a single one, and therefore we can say that „virtual“ industrial parks have appeared, that is, industrial parks that are not necessarily located within the same compact territory.

Carriers of ideas

New small companies and ideas converted into an economic product

External objects of business incubators

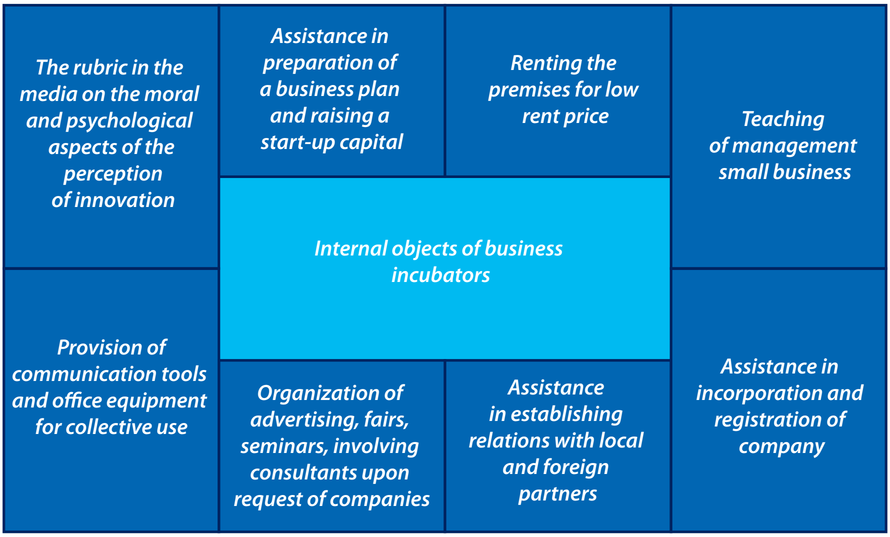

Fig. 1.5. Structure and functions of business incubators

In Europe, industrial parks appeared in the early 70s. Among the first were the Heriot-Watt University Research Park in Edinburgh; Trinity College Science Park in Cambridge; Louvain-la-Neuve in Belgium; Sophia-Antipolis in Nice and the Zone for Research, Scientific and Technological Productions (ZIRST) in Grenoble.

They repeated the early model of US industrial parks, the peculiarity of those is the presence of a single founder, and the main activity is the leasing of land to the owners of knowledge-intensive companies.

This approach disappointed enthusiasts of the industrial park, as it was moving slowly. Therefore, industrial parks started to construct more, so-called „technology business incubators", that is, the buildings accomodating numerous small start-up innovative companies. Incubators provided production facilities to the prospective entrepreneurs, a set of services, and have them connected to a local university or research center, and to the financial circles.

It should be noted that the rapid development of industrial parks in Europe began in the 80s of the last century only.

At the same time, the ideas of the industrial park began to spread rapidly in the rest of the world: tech parks were created in Canada, Singapore, Australia, Brazil, India, Malaysia, China, and Japan.

In China, the creation of industrial parks, as a tool that outpaces the development of technological entrepreneurship, has been „taken under its wing“ by the state.

At the present stage, Uzbekistan pais a big attention to the establishment of industrial parks. For instance, following the visit of Head of Uzbekistan to the Yashnabad district of Tashkent in 2017, he gave an instruction to establish the eponymous innovative industrial park, pursuant to which it was adopted the Decree of the President of the Republic of Uzbekistan No. PP-5068, on 5 June this year, and the Resolution of the Cabinet of Ministers, No. PKM-468, dated July 5, 2017. According to this document, the territory of Tashkent is conditionally equated to an innovation zone, and any company intending to produce innovative products in Tashkent can apply for obtaining the status of a resident of the Yashnabad Industrial Park, even if it is located in other areas of the capital.

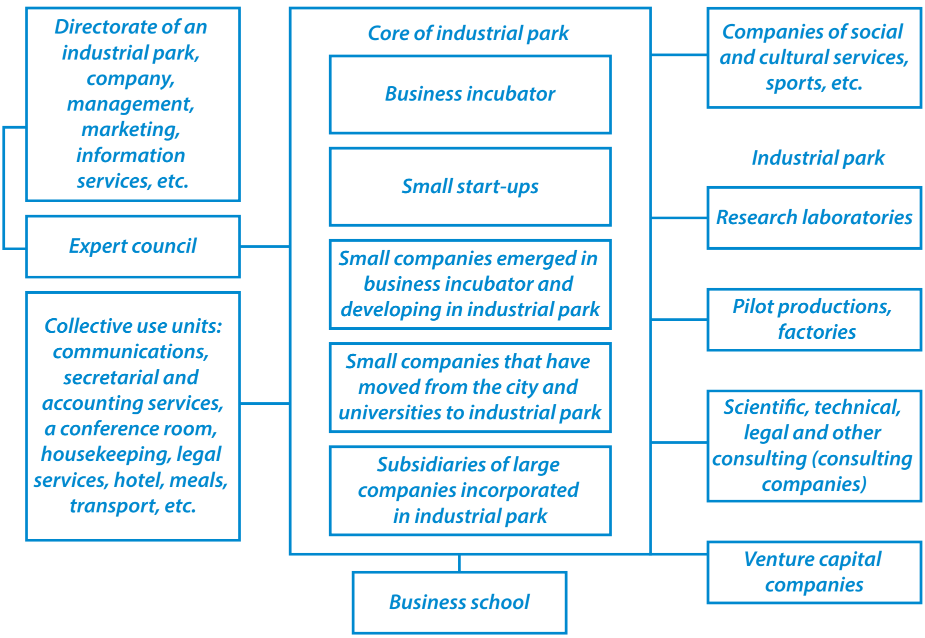

Fig. 1.6. Structure and functions of an industrial park

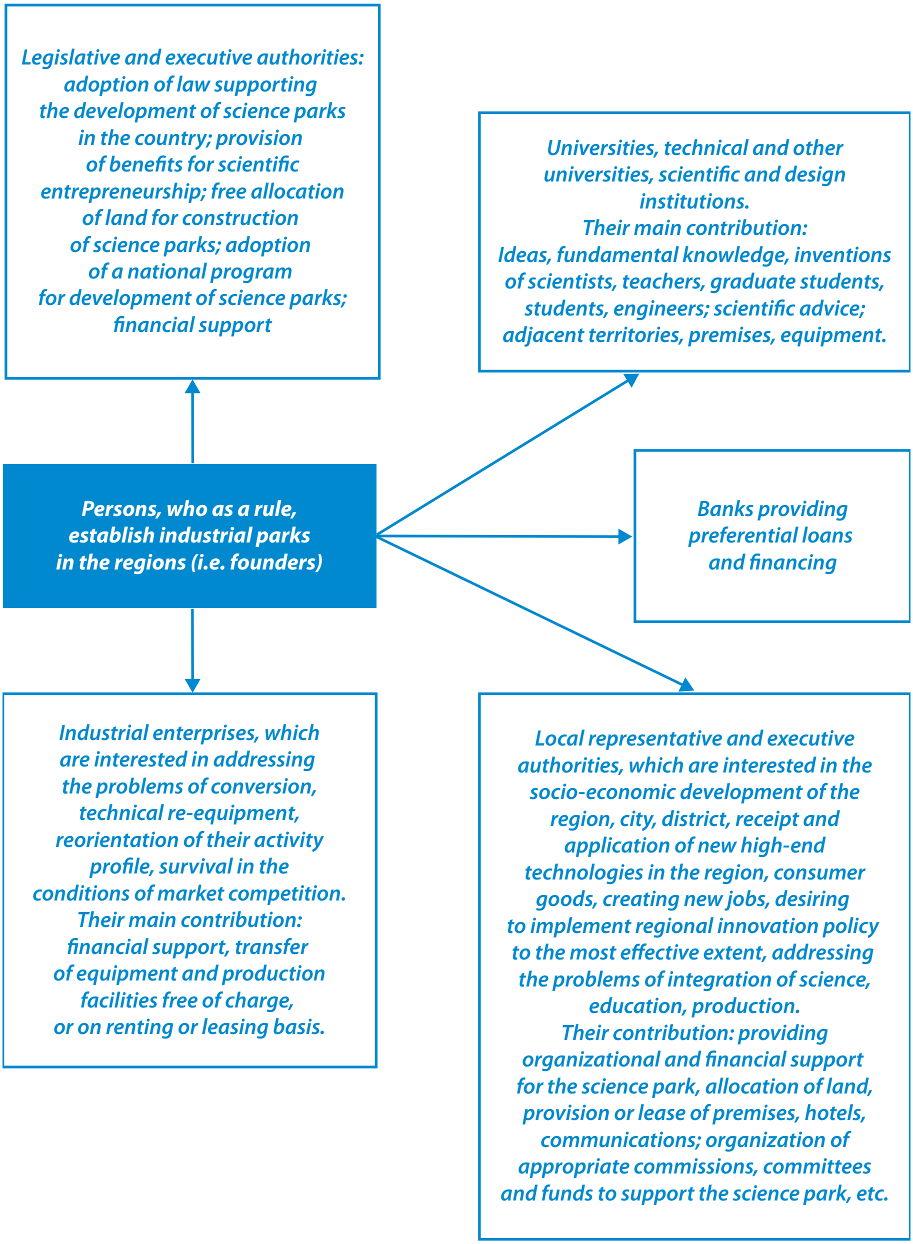

Fig. 1.7. The founders of industrial park

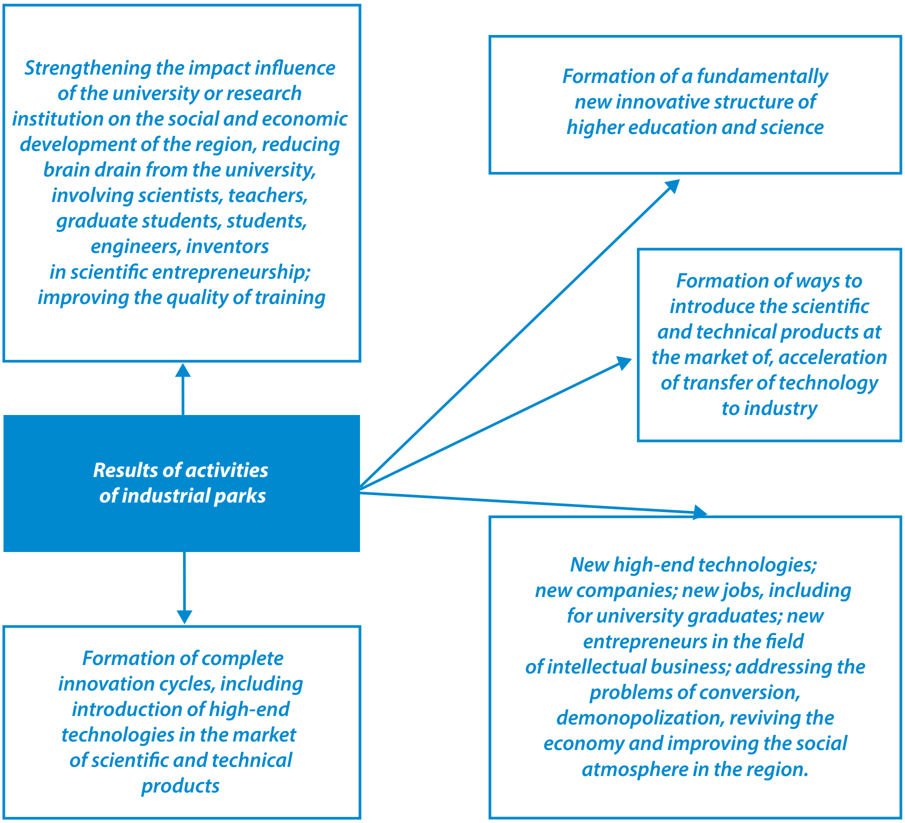

Fig. 1.8. The results of the activities of industrial park

The residents of the Industrial Park are given the tax benefits in the form of exemption from a single tax payment for a period of up to 10 years, preferences in the form of the possibility to obtain the loans at 7%, and production areas.

To date, the following industrial parks have been established in Uzbekistan:

- Industrial park „Yashnabad" in Yashnabad district of Tashkent
- Innovative Industrial Park „Khorezm" at Urgench University
- Industrial Park of software products and IT (IT Park) in Mirzo-Ulugbek district
- Industrial Park „Yakkasaray"
- Industrial Park „Sergeli"

- Industrial Park „Yunusabad“
- Industrial Park „Oklon“ in Shayhantahur district of Tashkent city
- Educational and practical textile Industrial Park at Tashkent Institute of Textile and Light Industries.
- NAPA Tech Industrial

It was also decided to establish industrial parks in all regions of the country.

1.2.6 Intersectoral multifunctional centers for informatization and innovation support

As noted earlier, informatization and innovation are two sides of the same coin. At the same time, it is necessary to know “what soil the seeds are planted on,” that is, what is the status of the innovation and information culture, what is the degree of **“computer literacy” (computer skills)**. In other words, it is necessary for various segments of the people to commit and be ready to use computers in the services sector, in the Internet, and in the real economy based on the “intellectual stuffing” of computers created by highly qualified specialists in the form of mathematical, algorithmic, information and software. Therefore, it is important to create structures that contribute to the formation of innovative and informational cultures, with support provided to innovations, and to address the issue of computer literacy of various segments of the population. Taking into account the above, as well as local conditions and the experience of creating the first business incubators, the Center for Strategic Innovations and Informatization developed the **Projects of Intersectoral Multifunctional Centers for Informatization and Innovations Support**, which in addition to the functions of classical business incubators encompassed the functions of a mechanism for the formation of an innovative culture among young people and the general people through the introduction of the Internet; organization of courses, clubs, seminars; implementation of various training programs and support for the computerization of professional activities (Fig. 1.9).

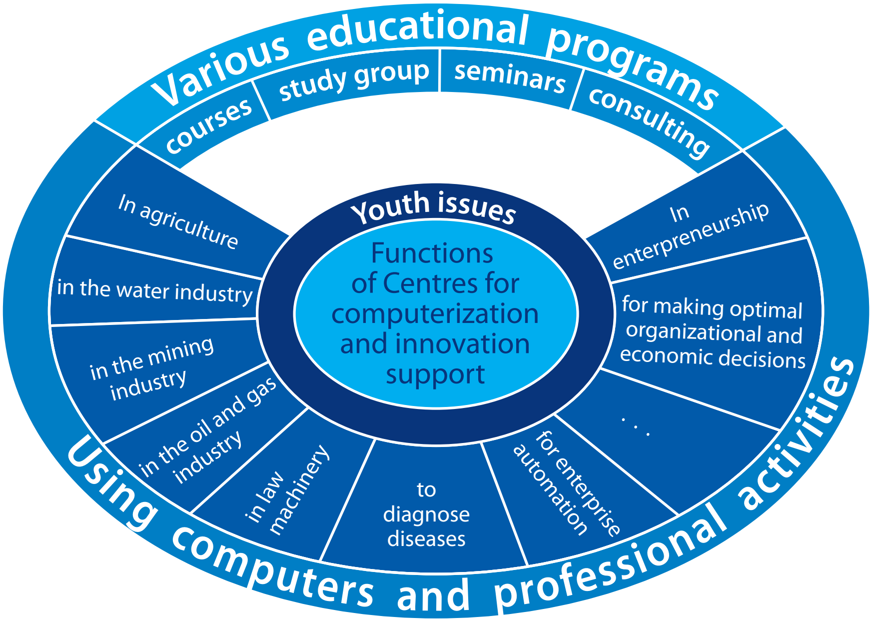

Fig. 1.9. Functions of Intersectoral Multifunctional Centers Informatization and Innovation Support

Projects of intersectoral centers of computerization and innovation support were developed in 1998-1999 for Navoi, Namangan, Kashkadarya regions, as well as for a number of areas of Kashkadarya and Namangan regions (Fig. 1.10). Knowledge bases act as the intellectual core of the Centers, and technical implementation is carried out on the basis of computers, local and corporate networks. The centers have a hierarchical three-level structure (republican level, level of regions, level of districts). In the macro-plan, the technical aspects of computerization are mainly related to financing. The issues of introduction of the computerization ideas for a wide segment of people, training their computer literacy and the subsequent rational use of computers as a multi-purpose tool to address specific functional problems from a particular subject area is by far more long-term and complicated challenges. The accomplishment of such goals is the reason the Centers for Informatization and Innovation Support are intended for.

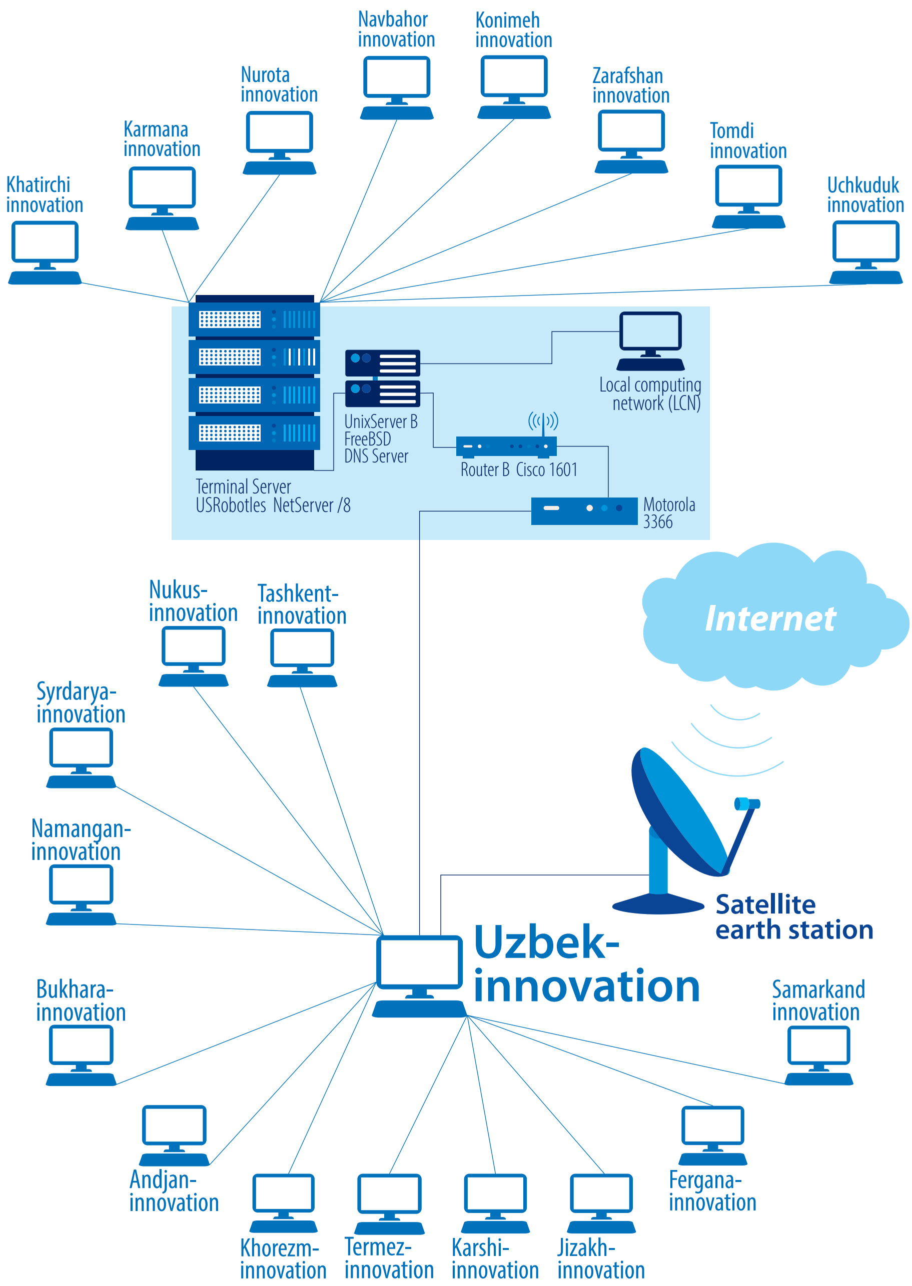

Fig. 1.10. Structure of the "Uzbek Innovation" Center

1.2.7. Mechanisms to shape the innovative culture

The natural mechanisms to form an innovative culture are educational, scientific, industrial and other communities, where a respectful attitude is formed towards innovations and their carriers, innovative proposals are morally and financially stimulated, and assistance is provided in bringing them to practical implementation. Important role of the media shaping an approach for people that attitude of every person to innovations is an attitude to wealth, dignity, and their safety, safety of their children and the state. It is certain that formation of an innovative culture in the country is facilitated by Republican Fairs of Innovative Ideas, Technologies and Projects, various industrial and international exhibitions held since 2008, and business incubators and innovation centers, republican and international scientific and practical conferences devoted to a wide range of basic and applied research.

For example, since 1996, according to the initiative Project, the Center for Strategic Innovations and Informatization annually hosts international scientific and practical conferences “Innovation” in the areas as follows.

- Problems of Youth and Education;
- Innovative processes in economic branches;
- Innovative Technologies and Methods for addressing the issues of rational use of natural, mineral, raw materials, fuel and energy;
- Mining and metallurgy;
- Automatic and Industrial Control System for engineering processes and facilities;
- System analysis and mathematical simulation;
- Information technologies and systems, and their applied aspects (distance education, electronic commerce, etc.). Information security issues;
- Water – Desert – Ecology. Problems and solutions.

At the present stage, the most significant results can be obtained **at the tie-in point of various scientific fields and interdisciplinary research** based on the mutual understanding of ideas, methods, and developments. This is the very idea why such conferences covered the said areas of major importance for science and practice.

At these conferences, they were tested and got a start in life for dozens of promising innovative projects that gave the country multimillion-dollar economic effects; the intellectual elite of the country was supplemented by a number of doctors and candidates of science, whose dissertations were the subject of detailed analysis and discussion at plenary and breakout sessions; on the innovation field of conferences, interdisciplinary projects of fundamental and applied research were born; international contacts were established for cultural, scientific, technical, business cooperation between specialists, scientists, industrialists, businessmen. The role of these conferences is also positive in promoting the formation of an innovative culture in the country.

The information outlined in Sections 1.1 and 1.2, shall be considered as an individual touch only to a small number of elements of the "portrait" of what is called the "National Innovation System". At the same time, even these individual touches show a measure of the complexity and diversity of problems, a measure of usefulness and the vital need to form a national innovation system, taking into account the particularities of the country, the background of economic development, financial condition, available intellectual potential, state of science and education, degree of development of small and medium-sized innovative enterprises and many other factors.

As already noted, national innovation systems are arranged in their own way in every country, and cannot be copied. However, there are common features in the structure and composition of the NIS. Thus, the NIS is formed goes in parallel with the shaping the regional innovation systems and innovation clusters in all countries. Figuratively speaking, national innovation systems "grow" with their regional innovation systems and innovation clusters. Therefore, the analysis of the experience of foreign countries in the formation of these "large parts" of the NIS is of considerable interest. Especially if we take into account that the monograph is devoted to the innovative development of Kyzylkum region.

The following sections of the chapter are devoted to a retrospective analysis of individual aspects of regional innovation systems and innovation clusters of foreign countries.

1.3. Regional innovation systems

The need to actively stimulate the growth of regional competitiveness, based on economic, educational and scientific, personnel, technical and technological, mineral and raw materials and institutional potential, stipulated development of regional innovation systems (RIS). According to the definition of Philip Cook from the Center for Special Studies of Cardiff University (UK), **the regional innovation system** is a "set of nodes in an innovation chain that includes firms generating knowledge directly, as well as organizations and enterprises that use (apply) this knowledge, and various structures performing specific intermediary functions: infrastructure support, financing of innovative projects, their market expertise and political support". Figure 1.11 shows the composition of the main RIS subsystems.

The growing interest in regional innovation systems has also been fueled by multiple empirical evidences that the most important components of the innovation process (such as, for example, the generation of innovations, technology transfer, etc.) tend to be geographically localized and therefore, bring the regional dimension to the fore.

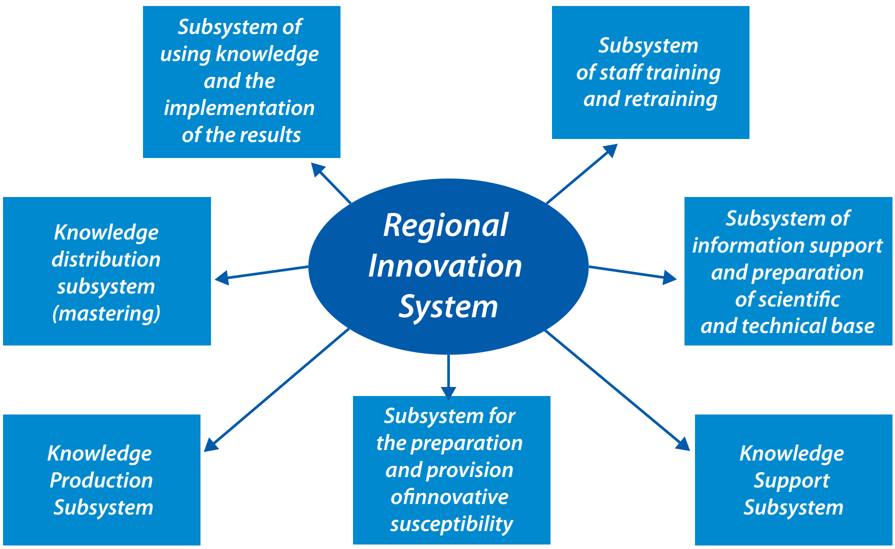

Fig.1.11. The composition of the subsystems of the regional innovation system

For example, the well-known American economist Michael Porter postulated that “sustainable competitive advantages of firms at the global level are often ensured by their strong positions “in-situ”: the concentration of highly specialized industries, personnel, supporting institutional structures, suppliers, customers, etc. in individual regions“.

At the same time, it is noted that the basics of the RIS concept were largely borrowed from the more theoretically developed concept of the National Innovation System (NIS). In particular, almost the entire set of basic recommendations for successful construction of functioning RIS repeats the well-known NIS schemes, artificially reduced to the regional level.

Perhaps the most significant new element of the RIS concept compared to the NIS schemes is only a much clearer emphasis on their cluster component: unlike the national innovation programs, regional, sort of, should, in the first place, rely on the active development of a strictly limited number of programs prioritized strong industries for such a region (and this aspect is especially obvious for small and medium-sized regions).

1.3.1. Standard concept of regional innovation system

According to foreign publications, the standard RIS concept contains the items as follows:

• adoption of a set of measures aimed at the active growth of the number of regional universities and research institutes (so called knowledge providers – new technologies, promising scientific research, etc.), university spin-out companies and/or helping in close linking of local firms to external sources of this knowledge;

• attraction of highly qualified labor resources to the region and active stimulation the growth of professional qualifications of existing staff;

• creation of networks of business incubators to support small innovative enterprises;

• creation and/or long-term financing of a research organization that regularly monitors key markets and technologies for the most important regional industrial clusters;

• design of effective mechanisms for operation of the system of interaction and collaboration between regional companies, research organizations and government agencies;

• assurance of frequent contacts within the local business elite, that is, the development of formal and informal network organizations;

• assurance of active flow of venture capital to the region (in the early stages of financing – creation of business angels networks).

The above shall also be added the necessary, yet not always sufficient prerequisite for normal operation of RIS, that is, existence of a strong regional control center for various innovative programs. In addition to defining strategic priorities for regional innovation policy (the very basic function that seems to be self-evident), the local administration (or a special body authorized by it) develops various R&D financing programs (through direct budget allocations for these purposes and also by application of various preferential lending and tax benefits tools) and a set of measures to enhance the interaction between key participants in the innovation process in the region.

1.3.2. Problems of formation of regional innovation systems

The countries that embarked on the path of market development, relatively recently, have rather common challenges which the developers of RIS have to deal with. **Since that, in this document we show the results of analysis of the problems for a certain country, which is, Russia**, carried out by the Institute of Regional Development.

1. There are no activities aimed at creating long-term planning tools and current management of RIS, and, as a result, there is no sound budget allocations in key areas supported by the regional government.
2. There are no real indicators assessing the effectiveness of programs, which is determined by the lack of government statistics on these issues (lack of a legal framework).
3. The legal framework for innovation has not been sufficiently developed, in particular, there are no legally enshrined concepts such as an innovative product, an innovative project, a high-tech industry (production), etc.

4. There is no clear distinction between federal and regional functions in the field of innovation.
5. There is no relevant information about the created national innovation system.
6. Most regions have no strategy of innovative development, and therefore, the formed development programs, as a rule, do not meet the expected result.
7. Most regions have no mechanisms for integration of regional and national innovation systems and the inclusion of RIS into the international networks.

Thus, the regions did not have a developed innovation system, did not have a full-fledged strategy of innovative development, and, accordingly, could not develop effectively. The lack of a clear distribution of functions between the federal and regional authorities in the field of joint strategic development of regional and national innovation systems was also noted.

1.4. Innovative clusters

According to the world practice, an active process of formation of innovative clusters in various developed and developing countries, in small and large countries, has been on going over the past two decades. For instance, the Scandinavian industry is fully clustered. More than a half of US companies operate under this model of interaction, clusters are also important in the economies of Germany, France, Great Britain and other countries. This chapter is a brief summary of the individual issues related to the clusters.

1.5. Definition and essence of clusters. The role of clusters in the formation of an innovative economy

The clusters are one of the components of the innovative systems hierarchy (Fig. 1.12).

We will show the conceptual aspects of the “cluster of enterprises” based on the definition given by M. Porter. In a detailed analysis of the relationship between the degree of development of the clusters and the competitiveness of a region or country, M. Porter defined clusters as “groups of geographically interconnected companies and related organizations operating in a particular area, characterized by common activities and complementary to each other”.

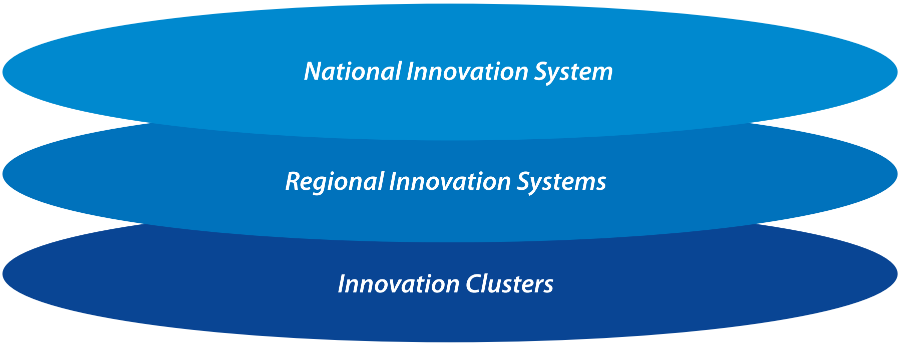

Fig. 1.12. Fragment of the hierarchy of innovation systems

Thus, a real cluster is a group of enterprises that are not just geographically adjacent, but also united in a network aimed at achieving a certain common result, and, as a rule, this network shall have the companies representing different industries (not on random basis, but according to the principle of complementarity of resources and competencies).

A careful study of the special characteristics of existing clusters shows that a developed modern cluster is a **strategic interorganizational network of a sectoral or intersectoral nature, combining resources and key competencies of the participating organizations.**

The clusters are complex systems, with components combining material, information and financial flows. At the same time, clusters cannot be characterized as associations consisting of enterprises only. This is confirmed by the results of all researchers who carefully studied the structure and composition of the real clusters. Accordingly, it is possible to speak of a cluster as an inter-organizational network, which is characterized by a number of features:

- existence of a group of geographically concentrated enterprises, combined by direct and feedback connections;
- *network of public and private institutions* that support economic agents operating within the cluster.
- sectoral specialization (most often – a group of companies operating in complementary or allied sectors);
- common cultural and social environment.

1.6. Criteria for classification of clusters. Experience in establishing the largest innovative mining and metallurgical cluster based on NMMC

The cluster approach to economic development is a global trend, which is typical for both developed and developing countries, and for both small and large states. The palette of different types of clusters is very various. Thus, as a result of the analysis of various types of clusters, the following general criteria for classifying clusters have been identified: type of industries, type of products, results of operations, the accumulation of knowledge within companies, the structure of the relationships inside of the cluster, the scale of production, the degree of concentration of production, the type of market conduct, the stage of development of clusters, the dynamics of jobs change, background for formation and other criteria. At the same time, each of the criteria characterizes a certain set of clusters. For example, the „industry type" criterion covers a variety of mining and processing clusters based on the production and processing of natural resources, and other industry clusters.

At the present stage, a special place among clusters is taken by the innovative clusters, which are characterized by continuous production and implementation of innovative ideas, projects and technologies, optimal production management schemes and decision-making that ensure constant sustainable competitiveness. Depending on the classification criteria, the innovation clusters are also divided into many types: dependent or reduced, industry-specific, innovation-specific, pro-innovation, innovation-oriented, and others. Each of those types covers many clusters of its class. For example, a dependent or reduced cluster includes those that consist of several technologically interconnected enterprises, sometimes significantly separated geographically, and whose activities are limited to a set of typical functions (resource extraction, processing, enrichment, and dispatch).

Despite the above diversity, clusters are classified into two types according to the type of models that originate their creation: either a liberal or a dirigiste model. When it comes to a liberal model, the role of the state is minimal and does not involve its direct intervention in the development of the cluster. This model is typical for the USA, Canada, the Great Britain, Australia, and Italy. The dirigiste model is typical for countries that play a more active role in the process of cluster formation (Germany, Finland, France, China, Japan, India, Austria, Sweden).

However, not all clusters, primarily innovative ones, fit to the framework of those two types of cluster policy models. For instance, the economy of Switzerland, which is consistently one of the ten richest countries in the world, is also developing on the basis of clustering. At the same time, innovation-territorial clusters were formed in Switzerland naturally, some of them, within the decades. The government of the country did not participate in the formation of clusters, but only created a favorable business environment and provided political stability. In this regard, it is advisable to introduce the concept of an evolutionary model of cluster formation for such clusters.

This example clearly demonstrates the fact that the phenomenon of cluster innovation depends on the type of model, either liberal or dirigiste, only partially. In this regard, we emphasize that: clusters can be created with varying degrees of government involvement. Which in itself is an innovative positive solution from an economic point of view. **However, it takes a long time for a newly created cluster to become innovative, and requires a whole range of fundamental factors that form the „innovation“ of the cluster.**

The study of the role of the factors in the evolutionary and innovative formation of clusters is an urgent problem. However, there are very few publications that analyze the factors that ensure the formation of an innovation cluster.

The most important fundamental factor in the formation of innovation clusters is the „innovation culture“.

The formation of innovative clusters of an evolutionary type is directly related to, and parallel to the formation of an innovative culture in an organization and in society as a whole. In the context of innovative development, the countries attach great importance to the innovation culture as a state of people's receptivity to new ideas, their readiness and ability to support and implement innovations in all spheres of life.

The formation of an innovative culture is primarily associated with the development of creative abilities and the realization of the creative potential of the person – its subject. At the same time, there are many other factors and conditions that can significantly contribute to the effectiveness of innovation.

There is an unlimited range of manifestations of innovation culture – from creating conditions for effective use of innovative potential (person, enterprise, organization) in the interests of society's development to assurance of maximum balance in its reforming. The innovative culture can really contribute in achievements in a specific economy, that is, acceleration and increase of efficiency of introduction of new technologies and inventions; in the field of management – the real counter to the bureaucratic trends; in education – facilitating in the revealing the innovative potential of personality and its implementation; in culture – the optimization of the ratio between traditions and new things, various styles and types of cultures.

Innovative culture has a powerful creative charge and is one of the most important fundamental factors in the formation of innovative clusters. That includes, the formation of the largest mining and metallurgical cluster based on NMMC.

The innovative mining and metallurgical cluster of Uzbekistan is based on the country's flagship industry – the Navoi Mining and Metallurgical Combine (NMMC), which is one of the world's top ten gold and uranium producers, and is the only mining enterprise that manages the full production cycle – from exploration of reserves in the subsoil, ore extraction and processing, to production of uranium oxide and finished gold bars of the highest quality. The innovation cluster is located in five regions: Navoi, Samarkand, Bukhara, Khorezm and Jizzakh regions. It combines the features of industrial, research and production, and educational clusters, and creates an excellent basis for implementation of new forms of integration of knowledge and technologies, the emergence of breakthrough scientific and technological directions, the maintenance of education and science, and small and medium-sized innovative entrepreneurship. The cluster macrostructure is shown in the Figure 1.13.

As a rule, when clusters are considered, the authors of numerous publications miss the main component of the cluster – a set of fundamental factors for formation of innovation clusters, which includes: cluster management policy wih respect to the personnel; socio-economic development; state of innovation culture in the team; innovation activity; internal intellectual potential; international scientific and technical relations; socio-cultural traditions; internal environment factors and other factors.

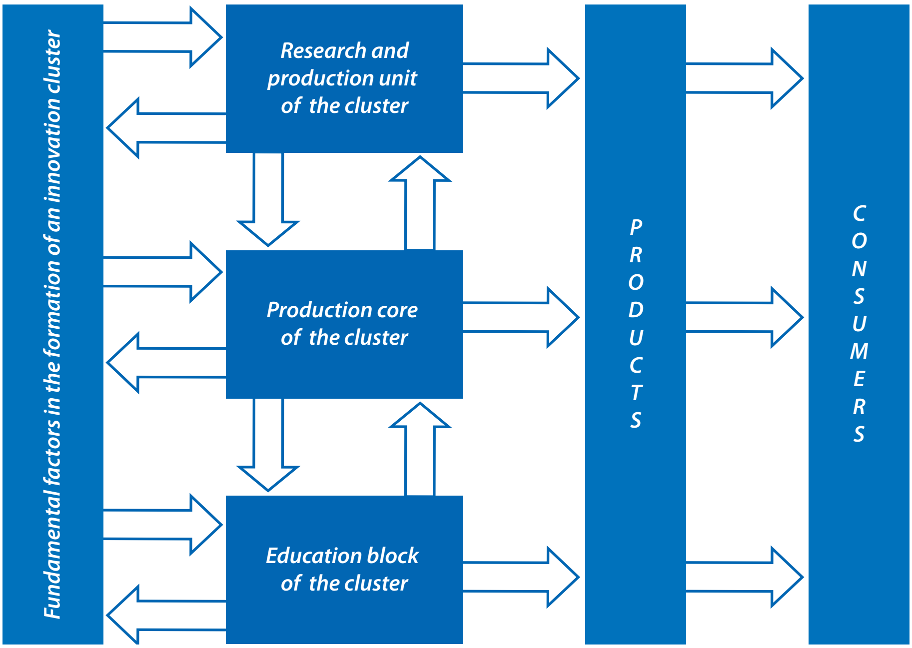

Fig. 1.13. Macrostructure of the innovative mining and metallurgical cluster

Fundamental factors that ensured the formation of an innovative mining and metallurgical cluster.

The largest innovative mining and metallurgical cluster based on the Navoi mining and metallurgical combine is appeared due to a surge in innovation and breakthrough results in production activities, primarily thanks to the combination of fundamental factors of the evolutionary model of cluster formation. Therefore, we will start the description of the activity of the innovative mining and metallurgical cluster from the disclosure of the fundamental factors of the innovative formation of its core – the Navoi Mining and Metallurgical Combine.

High level of innovation culture.

The innovative development of the plant is based on purposeful activities aimed at forming an innovative culture within the team. That is, the state of people‘s receptivity to new ideas, their readiness and ability to support and implement innovations in all their manifestations. A high innovation culture at the plant is formed through application of the various mechanisms, including:

- regular meetings and conversations of the plant‘s Director with representatives of the older generation and with young people devoted to discussion of the strategy of innovative development of the plant;
- conducting intra-combine fairs and competitions of innovative ideas and projects of young specialists and scientists with awarding of winners and wide coverage of their achievements;
- continious informing people about the achievements and problems of the labor team through the newspaper „Konchilar khayoti“, which plays an important role in strengthening the foundations of the team, reveals historical milestones in the development of a unique enterprise, the contribution of veterans and youth of the plant to the economic and social development of the Kyzylkum region and the country as a whole;
- providing in-depth and comprehensive information to the entire team about the development strategy of the plant and involvement in the implementation of large-scale projects intended for introduction of innovative technologies and modernization of production, ensuring the quality and competitiveness of products, maintaining high production rates and profitability;

• publication of the „Gorny Vestnik“ magazine, which regularly covers innovative technologies and developments of numerous representatives of the plant, as well as scientists and specialists from Uzbekistan and foreign countries.

• since 1997, preparation and holding together with other organizations of the country, the annual international scientific and practical conferences „Innovation“, where, at the plenary and sectional sessions, many innovative developments of scientists and specialists of the plant were heard and recommended for implementation;

• in pursuance the Decrees of the President of the country, establishment of the Fund of support of innovative activity of the plant and the Fund of innovative development and innovative ideas, which are used to finance activities related to the development of new technologies, implementation of innovative ideas and developments. In 2018, the Combine allocated more than UZS 16 billion for these purposes.

Personnel is the main factor of innovative development of the cluster.

Navoi Mining and Metallurgical Combine combines a powerful team engaged in high-tech technologies for mining and processing gold and uranium ores. It has always relied on professionals, and people hardened by the extreme conditions of working in the desert. Although, the desert has long been paved with roads and railways, water pipelines, power plants and power lines, with appearance of modern cities and towns, the spirit of romance and labor enthusiasm has always remained in the team of the plant. Over the past decades, the plant has faced serious challenges in increasing production, and although the mining and geological conditions of ore production have naturally deteriorated, the volume of their production and processing has still been systematically increasing. For this purpose, innovative technologies, control systems were invented and implemented, and the latest models of mining transport equipment were introduced, new enterprises and new trains were built at existing production facilities. Thus, the sense of pioneering did not weaken and did not leave the employees of the plant ever. The scientific and production potential and dedication of the plant‘s staff is highly appreciated by Mr. Sh. Mirziyoyev, the President of the Republic of Uzbekistan.

The plant‘s production facilities enjoy many remarkable organizers of the production from the older generation.

Next to them, there is a young change of managers and specialists who reliably and confidently perform the tasks entrusted to them. These are young people who graduated from higher education institutions 10-15 years ago and started their career, as a rule, from working positions, and now, they are ready and able to take on the burden of great responsibility of managers of labor collectives. To date, about 93 percent of all employees and more than 90 percent of management personnel are young specialists, which is a clear result of the far-sighted policy of the country‘s leadership to train the necessary engineering personnel for the mining and metallurgical industry in the state.

Huge intellectual potential for innovative development.

The plant employs more than 10,000 people with university degree, including 31 candidates of science and 7 doctors of science. In 2017, for the first time in the history of the mining and metallurgical industry of Uzbekistan, the employees of NMMC and Navoi Mining Institute received a gold medal „for invention“ by the UN world intellectual property organization. The gold medal was awarded for the development and implementation of the „Method for extracting gold from refractory sulfide gold-arsenic ores“. The plant has virtually unlimited innovative opportunities, thanks to its strong human resources, scientific and technical potential, large investments, and the availability of experimental facilities and educational institutions.

There is a wonderful Central research laboratory where experimental and industrial tests are conducted. It is here, where hundreds of methods have been developed for the analysis of ores, technologies, and the quality of finished products, and the effectiveness of which is confirmed by the certificates. The Central Engineering Agency, the Central Design Bureau, the Central Physical and Chemical laboratory of the Northern Mine Administration, the Central plant laboratories at HMP-2 and HMP-3, and the unique GAA (gamma activation analysis) laboratory at the Muruntau mine are also operating successfully within the plant‘s system. Accordingly, a management system has been established that ensures a close relationship between innovation, production and marketing activities. Innovation technology services have been formed in all major divisions.

In 2018, in order to develop research and innovation activities, the plant established an Innovation Center and adopted the NMMC‘s Innovative Development Program until 2026, which includes 105 investment projects in 11 areas of activity. It was developed on the basis and in pursuance of the Message of Mr. Sh. M. Mirziyoev, the President of the Republic of Uzbekistan to the Oliy Majlis, dated 22 December 2017 and other guidelines, including a number of Decrees of the President of the Republic of Uzbekistan, Resolution of the Cabinet of Ministers of the Republic of Uzbekistan, No. 24 „On measures for creation of effective mechanisms of introduction of scientific and innovative developments and technologies in production“, dated January 12, 2018. The program of innovative development of the plant contains a set of interrelated activities aimed at developing and implementing new technologies that meet the global standards, as well as creating favorable conditions for implementation of innovative development of the plant.

Decision-making is a basis for Analytics and System Analysis.

The plant has established an innovation management system. The main management body for innovation is the Scientific and Technical Council of the plant.

In the innovative activity of the plant, special attention is paid to the search for the most effective options for implementing projects based on analytics and a comprehensive system analysis of the subject in question, considering possible changes in the future. It is not a secret that introduction of modern innovative technologies requires significant financial investments, which is the reason why the specialists of the plant carefully analyze, study and examine each new project, with involving the scientists of the Academy of Sciences of Uzbekistan, the specialists of leading design organizations, research institutes, universities of the country and foreign companies in this process.

A coherent system of training, retraining and capacity building.

A coherent system of training, retraining and capacity building of specialists and workers enables to satisfy the need in personnel at all levels of the enterprise. More than ten thousand employees of various categories are trained and re-trained in the training centers throughout the year.

Capacity building of the specialists with university degrees for the Navoi plant is carried out in Universities of the Republic, and in certain, especially popular specialties – in foreign and CIS universities. Training of specialists with secondary special and vocational education is carried out in the academic lyceums.

The plant has great prospects and opportunities for professional growth of young specialists.

This is facilitated by the program in the country approved for the comprehensive development of the higher education system for the period 2017-2021, quality and cardinal improving the level of higher education, modernization and strengthening of material and technical base of higher educational institutions, provision of modern teaching and research laboratories, information and communication technologies.

NMMC is the industrial basis of the Innovation cluster.

The structure of NMMC includes five main mining and metallurgical enterprises, which served as the basis to built the cities of Navoi, Uchkuduk, Zarafshan, Nurabad, Zafarabad, and Zarkent.

The Central Mining Administration is the largest among the five mining departments forming the plant‘s structure, where about thirty divisions of the main and auxiliary production are engaged in the production activity: „Hydrometallurgical Plant No. 2“, „Muruntau“ mine, „Gold Heap Leaching Plant“, „Auminzo-Amantoy“ mine, etc.

Hydrometallurgical Plant No. 2 is one of the world‘s largest hydrometallurgical plants engaged in processing the gold-containing ore and producing the refined gold. The plant carries out a full cycle of ore processing – from grinding the base ore to producing the finished product in the form of gold bars of the highest grade. Due to the ongoing set of measures intended to improve technological processes, the annual output of the ore processing plant has increased to 40 million tons per year. The products meet the „London Good Delivery“ standard adopted by the London Bullion Market Association (LBMA).

NMMC specialists have accumulated extensive experience in operating the combined road, conveyor and railway transportation of rock mass. The Muruntau quarry is one of the global leaders in terms of the volume of transportation of rocks and ores. Since 2011, it successfully operates a complex of CFT-ore with a steeply inclined (370) conveyor (HAC), which is a unique in the world and has a lifting height of 270 m. Introduction of this system enabled to reduce the distance of transportation of rock mass by road by 3.5 km, at average, and the cost of transportation of ore mass has decreased by 30%. Gas pollution on the mine has been reduced. The quality of the ore stream during loading and transport operations in the Muruntau quarry is managed through an automated vehicle management system, which, fully resolves the problems of managing the excavator-vehicle complex thanks to the modern GPS satellite navigation system.

In overall, in the technological complex of ore preparation for processing, the drilling and blasting operations are one of the main issues. The quality of drilling and crushing rock mass during the explosions depends on the subsequent operations of the technological cycle, which are associated with excavation, loading, transportation and processing, and ultimately determine the total energy costs. This task is achieved by application of emulsion explosives (EE) of own production with an annual output of more than 80 thousand tons, and patronized EE of the NOBELIT 216Z type of four sizes. **The Central laboratory of gamma-activation analysis (CLGAA) operating at the Muruntau mine** is unique and has no analogues in the world analytical practice. This laboratory performs rapid analysis of the content of gold, silver and other metals in geological samples through an electron accelerator. The reconstruction was completed with introduction of a linear electron accelerator and, it is expected an introduction of an automatic crushing and abrasive system. In order to organize a multi-element analysis of geological samples, the CLGAA has started development and creation of a set of methods for determining silver, yttrium, cerium, neodymium, lanthanum, molybdenum, tungsten, rhenium, vanadium, and uranium, and other rare, rare-earth, and radioactive metals.

The Northern Mine Administration takes the second place in terms of capacity and value. The Northern Mine Administration is considered as the cradle of the Navoi Mining and Metallurgical Plant. The industrial development of the subsoil of the Central Kyzylkum has began here, in 1958. The district was characterized by a lack of energy sources, water, roads, human resources, and severe climatic conditions. A large deposit, discovered by the geologists of Uzbekistan in 1952, was located near three wells of the ancient caravan route, from which it received the name Uchkuduk. Today, the Northern Mining Administration has a developed infrastructure and carries out the extraction and processing of gold and uranium-containing ores, production of sulfuric acid, and consumer goods.

Hydrometallurgical plant No. 3 is part of the mine administration and one of the world‘s largest hydrometallurgical plants active in processing refractory gold-sulfide ores through a package of technologies. It processes ore in „Kokpatas“ and „Daugystau“ mines.

The plant successfully implemented a method developed by NMMC specialists for extracting gold from refractory sulfide gold-arsenic ores containing carbonaceous substances. The essence of the method is neutralization of arsenic in the process of bio-oxidation, cyanidation of bio-pulp, oxidative firing of the tailings of sorption cyanidation with subsequent gold recovery.

The Southern Mine Administration is the third in terms of feedstock processing, which includes mines for extraction and processing of gold-containing ores, uranium in-situ leaching sites, and production of polyvinyl chloride and polyethylene products. The Zarmitan gold zone continues its rapid development due to the commissioning of the Zarmitan, Guzhumsay and Urtalik mines. This ore zone is the basis for succesful operation of Hydrometallurgical Plant No. 4, where the ore is processed by using the technology of intensive gravity and intensive leaching of gold-containing concentrate. „Mardzhanbulak“ mine operates a train for processing the refractory sulphide ores by gravity-flotation-roasting scheme.

Mine Administration No. 5 is the largest uranium mining entity. It is equipped with advanced technologies and powerful modern equipment. The mine administration includes four geo-technological mines for in-situ uranium leaching, develops 17 deposits, and intends to launch a site for processing rare and rare-earth elements in 2018.

The HMP-1 mine administration appeared six years ago only, based on the processing facilities of the Hydrometallurgical Plant No. 1. Significant results have been achieved within this short period of time. Due to technical re-equipment and reconstruction of existing technological processes, ore processing has increased by 1.5 times.

It processes the gold-containing ore of „Karakutan“ and „Aristantau“ deposits.

Gold-containing ore is processed by using direct sorption cyanidation technology to obtain a saturated ion-exchange resin as a finished product, followed by further processing. In addition, it operates one of the largest plants in the world for production of refined-pure nitrous oxide-uranium oxide obtained by processing the chemical concentrates of in-situ leaching mines through extraction technology.

The Zarafshan Construction Department has a special place in the structure of NMMC. Zarafshan builders perform all construction, installation, and repair work in the plant‘s divisions. They have built the cities of the Kyzylkum region, social, cultural and sports facilities, and other unique enterprises and buildings in other cities of the Republic.

Addressing the problems of man-made feedstock processing is one of the key activities of the innovation cluster

The use of minerals is a complex process that includes exploration, extraction and processing of minerals, storage of tailings (non-valuable part of the ore), reclamation and closure of the mine. Non-ferrous and precious metals – copper, gold, lead, zinc, selenium, tellurium, cadmium, rhenium, palladium, uranium, rare-earth metals and others, are important for the national economy of the Republic. Extraction and processing of these metals from ore results to the generation of a large number of different types of waste. In the new economic conditions, Uzbekistan needs to rethink urgently the strategy of using its natural resource potential. Today, along with the development of mineral resources, the problem of involving man-made feedstock in processing is important for the Republic and includes saving non-renewable mineral resources in nature, reducing the anthropogenic footprint on the environment, and the health of future generations. The intensification of use of waste from mining and metallurgical industries is an important reserve to increase the use of mineral resources. The main volumes of man-made resources of precious metals on the territory of Uzbekistan are located in the Central Kyzylkum mining district, which has a long history of development of precious metal ores. Since the beginning of mining of mineral deposits by Navoi MMC, more than four and a half billion tons of man-made waste, production waste and substandard mineral raw materials have been accumulated in warehouses and tailings of the plant.

As can be seen from the above, the volume of gold mining waste is huge. It is very difficult to estimate how much waste is generated by the mining industry worldwide. But everyone will agree that this volume is unimaginably large. For example, the production of 1 ton of copper, generates more than 100 tons of ore waste, while production of 1 kg of gold, generates more than 1,000 tons of ore waste. Therefore, it is a matter of concern what to do with so much waste. In our opinion, it is time to conceptually assess the situation created by human activities and to involve natural resources in circulation. Scientific research aimed at processing of man-made raw materials of existing mining enterprises, tailings of enrichment and heap leaching, as well as hydrometallurgical plants based on modern technologies, is an important activity of the mining and metallurgical entities of Navoi MMC. Numerous recommendations for their processing have been developed. For additional extraction of minerals, and in general, for integrated development of the subsoil, it was developed and proposed the solutions to the problems of processing waste from mining and metallurgical production. The developed proposals guide manufacturers to find solutions for the involvement of man-made raw materials in further processing, allow them to solve problems related to the development of the mineral resource base, environmental protection, and determine ways and means of solving problems.

Educational component of the cluster.

Navoi State Mining Institute (NSMI) is the only University in Uzbekistan that has the status of a mining University. Until today, thousands of qualified specialists who have successfully graduated from the Navoi Institute are working in various industries and production, in science and in the education management system.

For the economy of the Republic, the Navoi State Mining Institute is not just a leading higher education institution that provides training in mining and metallurgical, technical and economic areas, but also a major research center for the integration of education, science and production.

The Industrial Park specializing in the mining and metallurgical industry in the Institute, was constructed on the basis of the production Association „Navoi Machine-Building Plant“ at the expense of NMMC. The industrial park is equipped with modern laboratory equipment and is designed for conducting experimental and practical classes, as well as research work by professors and teachers. There are laboratory sections of departments for specialties, as well as rooms for practical classes. All conditions for students to study simultaneously in different directions have been created.

The Institute provides training in the dual system, which is not practiced in other higher educational institutions of the Republic. Training in this format is carried out on the basis of a schedule approved by the NMMC (customer company): during each academic year, two times for third-year students. The advantage of this system is that before sending students to work practice, they have the opportunity to get real information about the activities of territorial production enterprises and listen to lectures by leading experts directly on site. The connection between the educational process and the production plays an important role in the education of qualified personnel, who should contribute to the development of the domestic mining industry in the future.

Navoi State Mining Institute was established by the Decree of the President of the Republic of Uzbekistan No. UP-1203, dated July 7, 1995 and the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 289, dated July 26, 1995.

The Institute operates 3 faculties: mining, energy-mechanical, chemical-metallurgical and 14 departments.

The new building of the Institute, commissioned in 2016, is fully equipped with modern educational and scientific laboratory equipment at a cost of USD 6 million.

At present, the Institute has 3,359 students in total, including 2,842 students in 13 bachelor‘s degree courses, 223 students in 6 special correspondence courses, 216 students in 10 correspondence courses, and 96 students in 10 master‘s degree courses.

According to the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 925, dated November 13 2018, Nukus branch of the Navoi state mining Institute was established from the 2019/2020 academic year, and 48 students were enrolled in two specialties: „Mining“ and „Chemical Technology“.

In the 2019 - 2020 academic year, 11 bachelors and 4 masters in total, were enrolled in joint educational programs based on the 2+2 scheme for bachelors and 1+1 for masters in the Ukrainian National Technical University “Dnipro Polytechnic” in 1 bachelor‘s and 1 master‘s degree specialties, and in the Belarusian State Technological University in 1 master‘s degree specialty.

In order to develop integration between science, education and production in regional industrial enterprises and organizations, it has created the branches of specialty departments, including within divisions of the NMMC State Enterprise, Navoiazot, Electrohimiya, Navoi Thermal Power Plant, Navoi Electric Grid and Kyzylkumcement.

In these branches, the theoretical and practical parts of the specialty are taught to final year students by leading production specialists, together with professors and teachers of the Institute, in turn, the Institute organized a dual training system.

On the territory of the Navoi Machine-Building Plant of the NMMC, State Enterprise, the Industrial Park was created for students of the Institute.

In the last academic year, 631 bachelors and 40 masters graduated from the Institute, with a total of 663 students, of whom 641 or 96.7% were employed.

In the 2018/2019 academic year, the Institute had 662 bachelors and 39 masters, that is 701 graduates in total, most of them are currently working and applying for jobs.

The Institute employs 217 professors and teachers, including 21 doctors and professors, 60 candidates of science and associate professors, and their scientific potential is 37.3% (the average level in the Republic is 34.5%).

Navoi State Mining Institute has developed a promising program for continuous training of scientific and pedagogical personnel.

In addition, one foreign citizen defended his doctoral dissertation under the supervision of Professor K. Sanakulov, Doctor of Technical Sciences.

It is planned to increase the scientific potential by 4% in the 2019/2020 academic year, and bringing the total scientific potential to 42%.

In 2019, within the framework of the state scientific and technical program, it has implemented 7 state grants for total amount of UZS 1,147 million, and 12 contracts focused on solving production problems of the Navoi Mining and Metallurgical Combine, „Navoiazot“, joint-stock company, for a total amount of UZS 1,380 million, and also research work on two international grants for total amount of UZS 232 million.

In pursuance of the Decree of the President of the Republic of Uzbekistan „On organization of the activities of the „El-Yurt Umidi“ Foundation for training of the specialists abroad and dialogue with compatriots under

the Cabinet of Ministers of the Republic of Uzbekistan“, UP-5545, dated on June 4, 2018, 11 professors of the Institute participated in the competition announced by the Ministry of Innovation, and 10 of them were victorious. The winners of the competition will study in foreign higher education institutions, 2 of them in doctoral studies, 2 are attending a training course and 6 are attending a capacity building course.

To date, 11 professors of the Institute, who participated in the competition of the Ministry of Innovation, have passed training and advanced training courses in higher educational institutions of the Republic of Belarus.

In order to effectively implement 5 important initiatives proposed by Mr. Sh. Mirziyoyev, the President of the Republic of Uzbekistan, 57 study groups were organized this year in accordance with the interests of the Institute‘s students and 1,466 students participated in these groups.

In the past academic year, the faculty of the Institute organized international trips to USA, Germany, Russia, Ukraine, Belarus, Kazakhstan, Kyrgyzstan, with involving 5 foreign professors from USA, Russia, Ukraine, Kazakhstan into the educational process of Navoi State Mining Institute.

For students of the Institute, there is a dormitory with 500 beds, which was completely renovated this year with a sponsors contribution UZS 1.6 billion.

The former alumni fund was created in June of this year, and about UZS 150 million have been received to date. These funds cover the expenses Institute‘s publications prepared by the teaching staff.

Research and production component of the cluster.

The research and production component of the cluster is primarily based on the internal intellectual potential, which includes 7 doctors, 28 candidates of science, and 10,000 highly qualified specialists with university degree. Secondly, it is the scientific and pedagogical staff of the Navoi State Mining Institute. Thirdly, it is the employees of the regional branch of the Academy of Sciences of the Republic of Uzbekistan.

The highly qualified scientific and pedagogical personnel are repared through doctoral programs that are organised in the Navoi State Mining Institute in the following specialties: Technology of inorganic substances and materials based on them; Technology of organic substances and materials based on them; Processes and devices of chemical technologies and food production; Geotechnology (open, in-situ and construction); Mineral Processing; Automation and management of technological processes and production; System analysis, management and processing of information; Materials science in mechanical engineering. Foundry. Heat treatment and pressure treatment of metals. Metallurgy of ferrous and non-ferrous metals.

Highly qualified specialists and scientific and pedagogical personnel receive the state certification through the specialized Council for awarding scientific degrees of Doctor of Sciences (DSc) and Doctor of Philosophy (PhD) in the specialties as follows: Geotechnology (open, in-situ and construction); Mineral processing (in Technical Sciences); Mine surveying (in Technical Sciences).

The innovative way of development of the plant, whose effectiveness is recognized by international experts, is an invaluable experience accumulated by the team, and the foundation of breakthrough achievements of the largest innovative mining and metallurgical cluster.

With a high scientific and human potential, rich experience in the succession of generations, the innovative mining and metallurgical cluster is confidently achieving new heights of progress in the 21st century, being a leader in the deep development of mineral resources, increasing the volume of high value products and intensive development of new types of production.

CHAPTER II

State and development prospects of the Kyzylkum region as an integral part of the national innovation system of Uzbekistan

The Kyzylkum region is a unique economic and geographic complex, bounded by the Kyzylkum desert, it does not have administrative-territorial status. The Kyzylkum desert within the borders of the Republic of Uzbekistan is located on the territory of the Republic of Karakalpakstan, the Bukhara and Navoi regions, and each of them has its own administrative and territorial structure (Fig. 2.1). With this, a significant territory of the Kyzylkum desert is occupied by Navoi region, located in the central part of the Republic of Uzbekistan.

Fig. 2.1. Map of Republic of Uzbekistan. Kyzylkum region

The Navoi Mining and Metallurgical Combine, the State Enterprise is the key business component of the Kyzylkum region, both in production and in social aspects.

Without depreciation the role of regional factors such as the business climate, the development of agriculture and urban agglomerations, it should be noted that the activity of the NMMC is not only the main factor of regional education, but also a factor of regional development of Kyzylkum.

In this regard, the Kyzylkum region means the complex combination of numerous parts of production systems and social infrastructure, combined by a single territory of the Kyzylkum desert, the economic organization of the NMMC and the corresponding social and economic structures.

2.1. Formation of the structure of the region as a natural-industrial system

The interaction of a particular type of production with the environment leads to the formation of natural-industrial systems, among which mining production is the most characteristic and informative of them, because it directly affects the environment in the process of extracting useful minerals, and the changes that occur to natural components are often very clear [1].

The essence of the functioning of such a natural-industrial system is the transformation of mineral resources into resources for social and technological purposes. The state is concentrating its efforts on the transformation of raw materials extracted from the depths into new technologies, education, health care, public welfare, etc. At the same time, the state, being the owner of the subsoil, is interested in increasing the efficiency of such a transformation, which entails the requirement of rational use of the mineral and raw material potential of the fields both in qualitative and quantitative terms.

In this regard, when studying the conditions that ensure the formation of a mechanism for the sustainable development of the mining complex (MC) in modern conditions, it is advisable to consider a three-tier system "State – Region – Mining and processing facility (MPF)" (Fig. 2.2).

Such an understanding of the essence of the system under consideration contributes to the correct placement of accents in studying the processes occurring in it, which it is advisable to begin with an analysis of its functional structure to understand the role of each element in the implementation of the objective function.

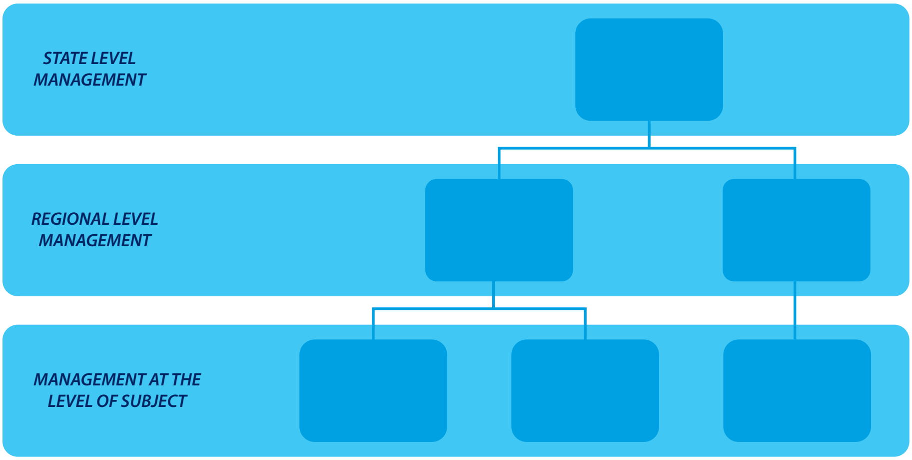

Fig. 2.2. Scheme of the natural-industrial system „State – Region – MPF“ (Source: GFMS: U.S. Geological Survey, NMMC)

2.1.1. NMMC is the basis of the social and economic development of the region

The economic potential of the region (EPR) structurally includes natural resource, investment, innovation and labor potentials, each of then is characterized by a certain quantitative and qualitative state of the corresponding types of economic resources. Various indicators can be selected from the set of features that scientists identify when they assess the degree of use of EPR in the context of its components. For example:

• natural resource potential: mineral raw materials – the volume of output of the extractive industry per person; water – the volume of fresh water consumption per person; the share of the volume of recycled and reused water in the total volume for production needs; land – the volume of agricultural production per 1 ha; natural-recreational – the number of places in sanatoriums and boarding houses with treatment in houses and in recreation centers;

• investment potential: factors for updating and entering fixed assets (FA), the cost of liquidated FA per capita, the degree of depreciation of the FA, the cost of the region's FA per capita, the expiration rate of the FA, the amount of investment in fixed capital per capita, the return on capital;

• innovative potential: the share of specialists performing R&D activities in the total number of employed people; the volume of R&D activities performed by organizations with their own efforts per capita; the share of inventors, authors of industrial designs and innovation proposals in the total number of employed people: the number of applications for issue of copyright protection documents submitted to the patent office; the number of introduced advanced technologies and commissioned production of new products; the share of industrial companies engaged in innovation activities and implemented innovations;

• labor potential: the employment rates of population and employable population of working age, respectively, economic activity of population, unemployment rate; the load on one free workplace or vacancy; accordingly, the share of persons of working age with higher education in the total number of able-bodied population of working age, and students in general population; factors of natural population growth rate and migration.

Taking into account the fact that Navoi region occupies a significant territory of the Kyzylkum region and the main part of NMMC's interests is concentrated in this area, it is advisable to consider the main macroeconomic indicators of the region.

Navoi region was established on April 20, 1982 and is located in the central part of Uzbekistan. The area of the region is 110.8 thousand square kilometers, or 24.8% of the total area of the Republic. The Navoi region borders with the Republic of Kazakhstan and the Jizzakh region in the North and East; with the Republic of Karakalpakstan in the West; with Samarkand, Bukhara and Kashkadarya regions in the South. The North-Western part of the region is occupied by the Kyzylkum plateau, the Nurata mountains stretch to the East, and the Zarafshan river edges the South of the region. The climate of the region is sharply continental and dry, summers are dry and hot, winters are relatively cold and snowless.

To date, the population of the region is 878 thousand people, 60% of them live in rural areas. The average age is 25 years. The number of employed people in the region is 389.2 thousand people or 80.8% of the population of working age. 68.4% of the employed population are workers and employees of enterprises and organizations, 20.8% are employed in agricultural production, the rest – in small businesses or are students of working age. The number of unemployed people is 6.4% of the working population. Representatives of more than 100 nationalities live in the region.

Transport infrastructure is well developed in the region: there are 8 railway stations, 9 automobile stations and a developed network of highways. The length of railways is 390.7 km, roads – 4.1 thousand km, of which, 3.3 thousand km are paved. The Tashkent-Turkmenistan and Tashkent-Uchkuduk railway lines pass through the region. The Navoi region is crossed by international transport corridors that are associated with all Central Asian countries and Afghanistan, then the roads go to the Middle East, Southeast Asia and the Asia Pacific region, as well as to the ports of Russia, Baltic States and Iran.

Navoi airport meets international standards in terms of its technical equipment and is able to accept aircraft of any take-off weight. To date, the existing runway has been reconstructed to the size of 4000 m, width of 45 m; taxiways, and radio and lighting equipment of the airfield has been installed, which allows to receive aircraft in the second category of ICAO.

The region includes 8 districts: Kanimekh, Kiziltepa, Navbahor, Navoi, Nurata, Tamdyn, Uchkuduk, Khatyrchi and 6 cities: Zarafshan, Karmana, Kyzyltepa, Navoi, Nurata, Uchkuduk.

The administrative center of the region is the city of Navoi, which is located in the Zaravshan river valley and was built according to a single master plan in the 1960s.

The banking and financial sector of the region is represented by 13 branches of commercial banks and 23 insurance companies.

The region occupies an important place in the system of state regulation of the placement of production forces, economic and export potential of the Republic. This is due to the high scientific and technical, socio-economic, production and demographic potential of the region.

In the Navoi region, such cities as Navoi and Zarafshan are primarily focused on industry, while Uchkuduk, Tamdyn, Nurata and Kanimekh districts specialize in cattle breeding and Karakul farming. Karmanin, Navbahor, Khatyrchi and Kiziltepa districts are mainly engaged in agriculture: cotton and grain growing.

The region has rich natural resources, which are not used enough. Those resources are divided into two large groups.

Underground resources, the main of which are deposits of quartz sands (over 1.5 billion tons), granite (19 billion cubic meters), marble (420.0 million cubic meters), phosphorites (1.5 billion tons), precious and rare-earth metals, uranium, bentonite clay, basalt, kaolin rocks, limestones, dolomites, wollastonites, feldspar, natural pigments, raw materials for production of building materials and a number of other minerals.

The purity of gold produced at the Muruntau Deposit is guaranteed by four nines – 9999. Bullion produced at the company receive the status of „optimal supply of gold" from Arbitration laboratory of the London Bullion Market Association, as well as the from Tokyo Commodity Exchange. The main reserves of mineral resources of the Republic of Uzbekistan are concentrated in the Kyzylkum region.

On the territory of the Central Kyzylkums, more than 50 occurrences of kaolin rocks were detected, whose reserves make up 240.8 thousand tons at an average yield of 35%.

Deposits of oil shale and dolomitized limestone have been explored, and feldspar is being extracted from the Lyangar deposit, which has reserves of 9.2 million tons. There is also a deposit of salt – Lyavlyakan, which is located in Kanimekh district and Taskuduk in Uchkuduk district.

There are deposits of construction and ornamental stones in the region: marble – Gazgan and Nurata, granite and gabbro – Lyangar and Karasoi, granite for facade materials – Azlartar and Karasoy, wollastonite.

Deposits of phosphates, such as Jeroy-Sardan Janahmet and Tashkura have a high content of P_2O_5.

The main basalt deposit in the region is Aidarkul, one of the sections of which has been explored and its reserves are estimated at 1.9 million cubic meters.

In addition, the reserves of fresh, mineralized, artesian and non-pressure groundwater have been explored and evaluated.

On the basis of these resources, mining metallurgy, chemical industry, mechanical engineering, construction materials and structures industry, etc. have been developed in the region.

Above ground resources. The main types of agricultural resources are: cotton, grain, fruit and vegetable and melon crops, grapes. The main branches of agriculture are cotton growing, grain growing, vegetable growing, melon growing, viticulture, Karakul growing and sericulture. The region has developed meat and dairy farming, poultry farming and pond fish farming.

The region annually produces about 110 thousand tons of raw cotton, 247.2 thousand tons of grain and 270 thousand tons of fruit and vegetable products, including more than 100 thousand tons of vegetables, 30 thousand tons of potatoes, about 40 thousand tons of grapes, 50 thousand tons of fruits, 30 thousand tons of melons. About 20% of the total volume of fruit and vegetable products is processed.

The share of agricultural production in the total volume of production of the Republic was: for grain – 3.0%, vegetables – 2.0%, potatoes – 2.1%, melons – 3.7%, fruits – 2.4%, grapes – 3.6%, Karakul – 32.2%.

More than 500 thousand pieces of Karakul krimmers are produced in the region every year. The region ranks second in the Republic after Bukhara for production of such krimmers. The number of large cattle is more than 326 thousand, sheep – 1.8 million and pigs – 17 thousand, which enable to develop skin processing.

Based on these resources, the region has developed the cotton-cleaning and cotton processing industries, fisheries, textiles, food processing, including meat, dairy, oil and fat, flour milling, wine making, canning, confectionery industry etc.

The largest volume of gross domestic product belongs to such areas as industry – 45%, construction – 25%, agriculture – 22%, etc.

Navoi region is one of the most industrially developed regions of the Republic of Uzbekistan. The share of industrial production in the region's gross regional product is more than 51%, and in national production – 11.2%.

In total, 1,147 industrial enterprises with an annual production volume of more than USD 795.2 million are currently operating in the region. The region's economy is based on such industrial enterprises as NMMC, chemical industry enterprises (Navoiyazot JSC, Electrokhimzavod Joint Venture), construction materials production enterprises (Qizilqumcement JSC), machine-building and electrochemical plants, thermal power plant (Navoi Thermal power plant JSC), textile and food industry enterprises.

Those enterprises are featured with gradual expansion of international cooperation with using of high potential and advantages focused on the extraction and deep processing of local raw materials. In general, the region's economy is developing rapidly. In traditional industries, such as mining, chemical, textile, and construction materials, the share of processing enterprises is increasing.

Industrial enterprises of the region produce more than 50 major types of industrial products: ammonium nitrate (70% of national production), polyacrylonitrile fiber (100%), sulfuric acid (25.4%), crop protection chemicals (4.1%), ammonium sulfate (1%), cement (50%), precast concrete products (4.2%), cotton fiber (3.5%), hosiery (1%) and knitted (0.5%) products, wall materials (6%), food products: bakery products (2.4%), meat and meat products (2.1%), confectionery (1.3%), beer (2.6%), etc.

According to the statistical data, there is an increase in foreign trade turnover of the region, which was due to an increase in export of chemical products, non-ferrous and ferrous metals, machinery and equipment, cement, as well as through the import of technologies. At the same time, it is increasing the share of export in foreign trade, the main volume of which is accounted for chemical products and plastics. The import structure is dominated by machinery and equipment – 50.2%, chemical products – 15.2%, non-ferrous and ferrous metals – 16.5%.

Foreign trade relations are maintained mainly with the foreign industrialized countries, which account for 64.5% of the total turnover of the region. 81.0% of all export was exported to these countries, while and 39.2% of all import was imported.

A significant share of foreign trade is accounted for Europe (66.0%), Asia (20.0%) and America (11.6%). Navoi region has huge opportunities for attracting foreign investment, which contributes to the creation of enterprises with foreign investments.

Today, there are 40 enterprises with foreign investments in the region, the largest number of which is concentrated in the cities of Navoi and Zarafshan, incorporated with participation of investors from the United States, Panama, China, Russia, and Ukraine. Basically, these companies operate in the food industry – 7 companies, chemicals – 6, transport and communications – 5, production of construction materials – 4, mechanical engineering – 4, light industry – 4, trade – 3, non-ferrous metallurgy – 2, agriculture – 1, etc.

The prospective areas for attracting investment in the economy of Navoi region are as follows:

reconstruction, technical re-equipment and expansion of existing enterprises, creation of new types of products, carrying out a set of environmental measures;

- construction of new enterprises in order to increase the integrated use of raw materials and products produced in the region;
- further development of mineral and water resources.

It is advisable to proceed with further development of economic and export potential in such industries as mining, chemicals, production of construction materials, as well as in the processing industries of agriculture in the region.

Navoi region occupies one of the leading positions in terms of the volume of attracted foreign direct investment, as well as the projected volume of investment needs. The volume of foreign investment was more than USD 100.0 per capita.

In the Republic of Uzbekistan, foreign investment enjoys the national treatment which ensures conditions for foreign investments not less favorable, than conditions for investments made by legal entities and physical persons of Uzbekistan.

It should be emphasized the promising role of tourism for many countries as important and profitable sector of the national economy and contributing to the development of the basic industries of construction, transport and communications, trade, public utilities, provides employment to the working population.

Navoi city, as well as Samarkand and Bukhara, located 100 and 200 km away, are promising regional centers for international business and tourism.

The presence of many objects of historical value and recreation areas that can attract a significant number of tourists, give huge opportunities for tourism development in the Navoi region, in particular, by organizing tourist trips to the city of Karmana, Nurata, Sarmishsay mountain tract, the desert zone of the village of Yangikazgan, as well as camel rides in the desert, recreation on Aidarkul lake, fishing, and others.

The ongoing structural changes in the economy of Navoi region are aimed at overcoming the raw material orientation of exports with a focus on the production of competitive finished goods that are in demand not only within the Republic, but also abroad.

The mining and metallurgical enterprises of NMMC are the pillars of the integrated development of the Kyzylkum region as intended for long-term perspective. NMMC is in the top ten of the world's leading companies for the production of gold and uranium, is the largest mining and metallurgical company in Uzbekistan, and possesses a developed industrial and social infrastructure, sound engineering and human resources.

Today, the combine has advanced production facilities, as well as a modern scientific and technical base for conducting research and experimental-industrial works on the creation and introduction of new technologies into production and makes a significant contribution to the regional development and social stability of Uzbekistan.

NMMC is a diversified company of a new technical level, uniting such industries as mining, metallurgy, chemical, geological exploration, mechanical engineering, machine-tool construction, jewelry, and agricultural. The corporate structure of NMMC includes five mine administrations, geological survey expedition, construction administration, six hydrometallurgical plants and one gold extraction plant, a central research laboratory, machine building, jewelry and sulfuric acid plants and other industrial and auxiliary facilities (Fig. 2.3).

The mineral resources base (MRB) of NMMC is characterized by a further significant increase in the depth of mining operations (the current depth of Muruntau quarry is 640 m, it will exceed 735 m in 2025, and 950 m in 2035), complicated environmental conditions of the newly developed Kokpatas, Daugyztau, Guzhumsay, Intermediate deposits, a 1.3 times decrease in the content of useful components in the Muruntau deposit, an increase in the content of harmful impurities, an increase in share of refractory minerals by 5.0-10.0% (Kokpatas, Daugyztau deposits), and by 7.0-10.0% (Charmitan, Guzhumsay, Promejutochnoye deposits).

The annual growth dynamics of gold ore processing, renewal of the production processing capacity and investment in fixed capital of NMMC is shown in Fig. 2.4.

The Central Mining Administration located at the industrial site in Zarafshan city includes a hydrometallurgical plant No. 2 (HMP-2) with an annual processing capacity of 42.0 million tons of gold-containing ore with the open-pit mine of Muruntau and the heap mine gold leaching with an annual capacity of 14.2 million tons; Muruntau mine exploration.

The Northern Mine Department includes a hydrometallurgical plant No. 3 (HMP-3) with an annual ore processing capacity of 7.3 million tons with the Vostochny and Daugyztau open-pit mines; geotechnological mine; sulfuric acid plant with an annual capacity of 500 thousand tons.

The Southern Mine Administration includes hydrometallurgical plant No. 4 (HMP-4) with a projected annual capacity of 1.8 million tons and Mardzhanbulak gold extracting plant with an annual capacity of 1.2 million tons; the Zarmitan underground mine with a capacity of 850.0 thousand tons per year, the Guzhumsay underground mine which is under construction (projected capacity is 550.0 thousand tons per year), the Intermediate underground mine, which is in the stage projection, with a projected capacity of 400.0 thousand tons per year; the Mardjanbulak mine; the geotechnological mine Sabirsay; a plant for the manufacture of polyvinyl chloride and polyethylene pipes; stone cutting plant, as well as the production of agricultural and livestock products.

The mine administration number 5 (MA-5) includes four geotechnological mines of underground leaching (UL) of uranium and the department for rare and rare-earth metals processing within Geotechnical Mine 4.

Since April 2012, the NMMC has operated the Ore Administration of HMP-1, which includes the Karakutan and Aristantau mines and Hydro metallurgical Plant No. 1.

Based on local feedstock, the production of building materials is organized: facing products from gabbro, marble and granite, crushed stone, concrete, asphalt concrete, molding sand, limestone and others.

The association “Navoi Machine-Building Plant” manufactures products both for the combine’s own needs and for external consumers: milling, turning, drilling, grinding, woodworking machines, submersible pumps, construction metal structures, spare parts, welding electrodes, lining for ball mills, household appliances and much more; also provides equipment repair services.

CENTRAL MINE ADMINISTRATION (Zarafshan)

Muruntau open pit mine		Hydrometallurgical Plant No. 2
Gold heap leaching plant		
Plant for the production of emulsion explosives	Exploration Party No. 3	Exploration Mine Muruntau
Knitwear and yarn production enterprise		Jewelry Factory

NORTHERN MINE ADMINISTRATION (Uchkuduk)

Open pit mine at Kokpatas, Daugyztau and Adzhibugut deposits	Hydrometallurgical Plant No. 3 for gold ores processing
Uranium In-situ Leaching Mine	Sulfuric Acid Plant

SOUTHERN MINE ADMINISTRATION (Nurabad)

Uranium In-situ Leaching Mine		
Zarmitan gold mine	Mardzhanbulak gold mine	Mardzhanbulak gold recovery plant, Hydrometallurgical plant No. 4
PVC and polyethylene pipes production plant		

MINE ADMINISTRATION HMP No.1 (Navoi)

Underground mine Karakutan Open pit Aristantau	Hydrometallurgical Plant No. 1 for the production of uranium oxide, rhenium and gold

MINE ADMINISTRATION No.5 (Zafarabad)

Uranium In-situ Leaching Mine

ZARAFSHAN CONSTRUCTION ADMINISTRATION (Zarafshan)

Construction and installation management	Reinforced Concrete Plant	Administration of mechanized work

Management of production and technological equipment

INDUSTRIAL SITE (Navoi)

Central office – Administrative-management center of NMMC

Production Association „Navoi Machine-Building Plant“

Central Research Laboratory	Agrocompanywith livestock farm

Exploration Party (Navoi)

Fig. 2.3. Production structure of NMMC

The plant produces sulfuric acid, gold and silver products, which are in great demand in the local and foreign markets. The production of explosives, polyvinyl chloride and polyethylene pipes, liquid glass, iron sulphate has been mastered.

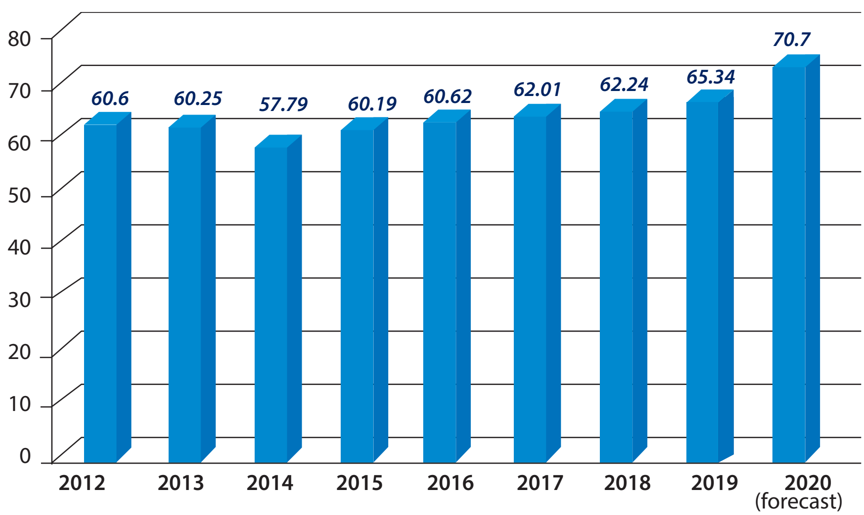

Fig. 2.4. Dynamics of growth of gold ore processing at NMMC by years

The combine also produces drinking and technical water, carries out cleaning and fine-tuning of wastewater, transportation of water, heat and electricity for industrial needs and for the provision of departmental settlements.

One of the components of the plant is food production.

The combine is engaged in the production and processing of agricultural products of vegetable and animal origin.

In NNMC, a considerable attention is paid to import substitution. In order to reduce the import of industrial goods for technical purposes, a program was approved for localizing production and optimizing imports at the plant, which provides for:

- organization of production of previously imported components and spare parts for mining and technological equipment based on local raw materials;
- reducing the cost of purchasing imported spare parts, components and assemblies for the repair industry enterprises of the industry through the purchase of import-substituting products from domestic manufacturers;
- the creation of additional workplaces in the industrial enterprises.

The success of the localization program can be seen on the example of PA (Production Association) “Navoi Machine Building Plant”, which is a structural unit of Navoi MMC, that produces more than 10 thousand product items for more than UZS 100 billion per year, including:

- in machine-tool production: metal-cutting and woodworking machines, mining equipment of various modifications;
- spare parts for drilling rigs, excavators, compressors, fans and other technological equipment for mines and spare parts for them;
- various types of pumps and their impellers weighing from 5 to 1,200 kg of cast iron and special alloy;
- welding electrodes, bushings from non-ferrous metal alloys, fabricated metals, capacitive equipment from carbon and stainless steels, titanium and aluminum alloys, sliding bearing shells and rubber products of 3000 names;
- mounted plows for agriculture of the republic and much more.

It is impossible to expand the production and engineering potential without competent and long-term political, economic and social development programs in place. Therefore, the production sphere of activity is very closely connected with the assurance of normal social and living conditions for the plant workers and their families.

NMMC owns a housing fund of five towns, six medical and sanitary facilities, more than fifty educational institutions, children's town and out-of-town summer recreation camps, two health centers, a recreation facility and a care home, modern sports complexes and cultural palaces.

The economic independence granted to the combine enabled to maintain economic ties with the CIS countries and to gain recognition from the business circles of the global industrialized countries. NMMC has successful experience of operation with well-known foreign companies in acquiring modern mining and transport and basic engineering equipment, invention and introduction of advanced technologies, creation new ones, and establishment of new facilities with the involving the foreign investments.

The plant cooperates with more than 80 foreign companies representing almost the entire planet, from the USA and Canada to Australia and Japan.

According to the results of fairs of innovative ideas, technologies and projects held in the Republic of Uzbekistan, NMMC signed and implemented 33 agreements for development and implementation of research and engineering products.

The specialists of the combine are engaged in 50 projects (R&D and innovative projects), aimed at resolving issues on the main activities of the plant. The expected economic effect from the implementation of these projects is about UZS 7.5 billion per year. NMMC pays much attention to further strengthening and developing relations with the Academy of Sciences of Uzbekistan, research and design organizations and universities of the Republic of Uzbekistan and foreign countries.

Below is a list of the main research and innovation projects carried out at NMMC.

Together with the Tashkent State Technical University, the projects to determine the geomechanical parameters of the system for improving the cut-off reserves of the Muruntau quarry by open-pit and underground methods; the study of the nature and patterns of formation of foci of underground catastrophes, (rock bursts) at the Zarmitan gold mine; on the creation and implementation of energy-saving devices for asynchronous electric drives of power plants of various capacities; testing of cermet antifriction sliding bearings of domestic production.

Together with scientists from the Institute of Nuclear Physics, Academy of Sciences of the Republic of Uzbekistan, research on the development of processing technology for sulphide ores and concentrates in the microwave electromagnetic field “microwave cavitation” with the aim of destroying the sulphide film and directly extracting gold by cyanidation.

Together with scientists from the Institute of Microbiology of the Academy of Sciences of the Republic of Uzbekistan, studies out on the extraction of uranium from used underground leaching (UL) units using bacterial solutions.

The introduction of bacterial leaching will allow increasing the recovery rate and uranium content in the waste wells, increase production, and extend the operation of productive wells and blocks, thereby reducing the cost of production.

At the same time, additional extraction of Uranium is expected to increase by 70% from used wells, and there will be more UL units, and uranium production will increase by 2.4 times.

Together with OJSC Irgiredmet (Russia), a comprehensive survey of the state of the technological processing of HMP-3 was carried out with the definition of the direction of work to improve the total gold recovery; a complex of laboratory and pilot tests to determine the operating parameters and indicators of coal-in-leach technology for the processing of bio-oxidation products was carried out; Work is underway on the reconstruction of HMP-3 for the implementation of coal-in-leach technology.

Together with the specialists of the JV “IVS” CJSC (Russia), research was carried out to improve the flotation technology by using highly effective reagents in the processing of gold ores from the Kokpatas and Daugyztau deposits at the HMP-3 in order to increase gold recovery in the flotation concentrate. According to the results of laboratory tests, the specialists of NMMC implemented an improved flotation circuit of HMP-3.

The Central Research Laboratory of NMMC develops a process for selective mining and storage of ores by technological grades under conditions of mining of gold deposits and their processing using individual technologies, which will allow us to increase the degree of gold recovery.

The implementation of this project will expand the raw material base of the combine and provide additional output. The development of the technology started in 2011 and will continue until 2015.

The aim of economic and production activities of NMMC is to increase the economic potential of the country. Despite the wide range of products, the main production is focused on the extraction and processing of gold, uranium ores and phosphates. The combine accounts for about 80% of all gold produced in the country, and 100% of uranium ore and phosphate mining.

2.1.2. Retrospective and prospective view on modernization and engineering re-equipment of production at NMMC

Since the independence of Uzbekistan, the conditions in the Kyzylkum region, and first of all in NMMC, has become one of the most important priorities of the state's economic policy. ШIn the early years of independence, NMMC has begun and continues to implement an ambitious program of modernization and technical re-equipment, based on world experience gained in the industry and its own developments, representing "know-how" (Table 2.1).

For the first six years of the modernization program, the combine has spent USD 250 million for purchase of new machinery and equipment, introduction of processes based on the latest scientific and engineering developments.

Mutually beneficial partnerships have been established with more than 90 large foreign companies. As a result, the companies worked out detailed contracts not only supplying machinery and equipment, but also assembling them, opening their offices in the divisions of the combine, teaching local personnel skills in working with new technology. New technologies appeared in almost all divisions of NMMC; this primarily affected the gold mining complex.

Table 2.1

Modernization, engineering and process re-equipment implemented by Navoi MMC

Description	Cost, USD, mln
Reconstruction of the Muruntau quarry (IV-V trains)	
Technical and technological re-equipment of auxiliary and service facilities	
Expansion of existing production and processing facilities	
Reconstruction and expansion of sulfuric acid production	
Technical re-equipment of railway transport to increase the transportation of products of sulfuric acid production	
Replacing mountain-transport equipment of the quarry	
Expansion, technical and technological re-equipment of gold heap leaching plant	
Expansion and reconstruction of tailing equipment HMP-2 (stage 1)	
Reconstruction and expansion of individual flotation and sorption of HMP-3	
Technical and technological re-equipment of the main production units of the plant (stage 2)	
Upgrading (replacing) obsolete equipment in the divisions of the plant	
Total	**470.65**

The open cast mining process applied in the deep quarry of Muruntau has proved its high efficiency and corresponds to the world level. The fourth phase of construction was the reconstruction of the northeastern side of the Muruntau open-pit mine with ore transportation from the horizon of +285 m to the KNK-270 steeply inclined conveyor to a lifting height of 270 m, with a capacity of 14.0 million tons of ore per year with the transshipment point from the conveyor belt to railway transport. Implementation of KNK-270 in the open pit made it possible to reduce the cost of transporting the ore, to increase the productivity of the excavator-automobile complex, to ensure cost-effective development and further development of the Muruntau open pit to a depth of 900-1000 m (Fig. 2.5).

A crushing and transshipment point on the horizon of +405 m with an inclined conveyor focused on the transportation of overburden was built on the southeastern side of the pit.

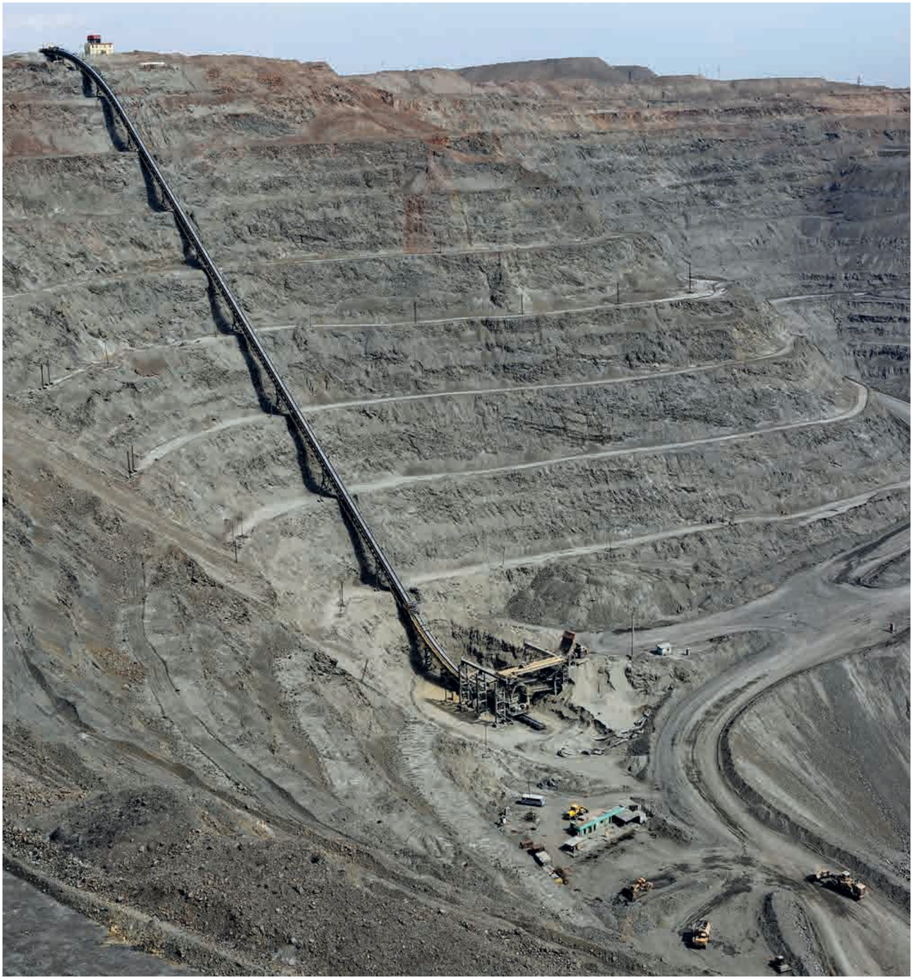

Fig. 2.5. High Angle Conveyor in the Muruntau mine

All this was a logical continuation of the development of the complex of the CFT, which has been working at the mine for 29 years.

The activities are ongoing on delivery of poor ore stocks from external warehouses accumulated since the beginning of operation of the quarry for processing. In the southeast of the Muruntau open-pit mine, the separation of the pit wall is expected for the joint mining of the Muruntau and Myutenbay deposits through a combined open-pit with a single working space.

The scheme of distribution of cargo flows in the combined open pit after complete reconstruction of the conveyor transport system is shown in Fig. 2.6.

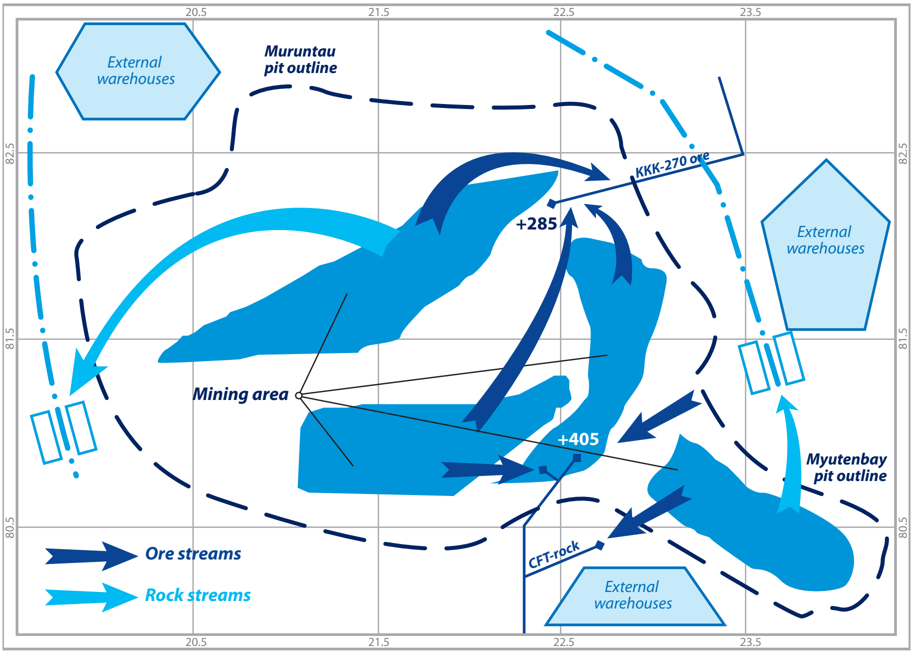

Fig 2.6. Distribution scheme of freight traffic in the joint Deposit Muruntau-Myutenbay

According to the development strategy of gold production in the Muruntau-HMP-2 open-pit mine system, further development of the deposit is associated with changes in the structure of the ore mass processed at the HMP-2 over time, involving off-balance and poor gold-bearing ores in the processing with the transition to open-underground and underground mining (Fig. 2.7, a), as well as the use of man-made resources, that is overburden and heap leaching tailings in the amount of 800 - 1000 million tons (Fig. 2.7, b).

Considering that the construction of new mining and processing industries in undeveloped areas in modern conditions requires significant investment, replenishment and expansion of the raw material base of the existing HMP-2 is advisable due to involvement in the development of medium and small fields, such as Myutenbay, Besapantau, Boiklik, Triada located in a radius of 50 km from the HMP-2.

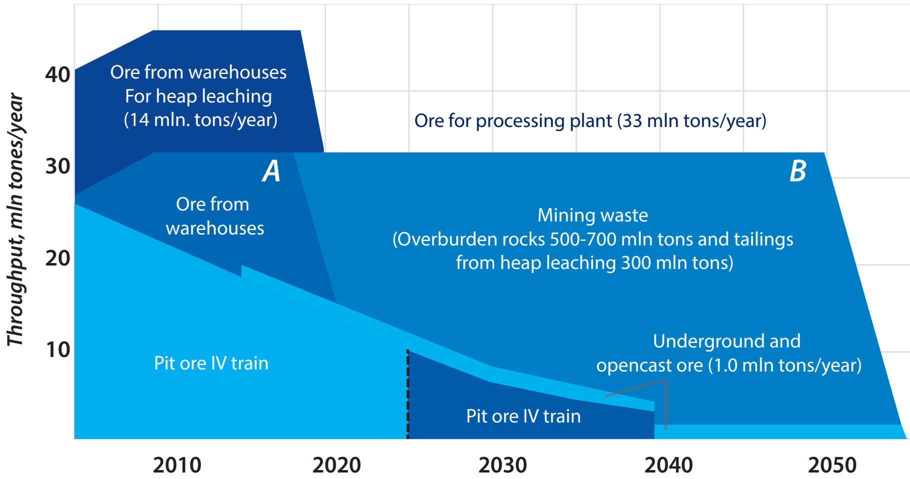

Fig. 2.7. Time scheme of changes in the structure of the processed ore mass in time: a) the basic version; b) moderate version

In order to increase the profitability of production, the specialists are continuously searching and implementing new resource-saving technologies and technical solutions aimed at improving the efficiency of mining and hydrometallurgical ore processing. The reconstruction and expansion of HMP-1 is carried out with an increase in the production of uranium oxide by 33% compared to 2011. The expansion and reconstruction of the NMP software is underway. The range of products consistently expanding, new models are putting into practice, while existing ones are upgrading. Processing off-balance ore of the Muruntau deposit with application of the heap leaching (HL) method enables to ensure waste-free production and is one of the new processes introduced in NMMC. Engineering and process re-equipment of the HP gold workshop is underway in order to increase reliability of operation and reduce operating costs, design with subsequent construction of the next leaching layer.

According to the long-term development program of NMMC, the further increase in gold output will be achieved through the implementation of investment projects: construction of mining and metallurgical production at the combined raw material base of the Kokpatas and Daugyztau gold deposits (Phase 2) and construction of a mining complex based on the Zarmitan gold ore deposits with the construction of underground mines (Table 2.2).

Table 2.2

New investment projects

Description of the project	Cost, USD, mln
Construction of mining and metallurgical enterprise in the combined resource base of gold deposits of Kokpatas Daugyztau (2nd queue).	
Construction of a mining complex based on deposits of the Zarmitan gold zone. Stage I – Zarmitan mine; Stage II – Guzhumsay mine; Stage III – Promejutochnoye mine.	
Uranium production. Construction of geotechnical mines and a plant for the manufacture of polyvinyl chloride pipes.	
Total	**640.0**

In order to engage in processing refractory arsenic-containing sulfide gold-bearing ores from the Kokpatas and Daugyztau deposits, a project was implemented on an industrial scale to equip the technological scheme of the HMP-3 with flotation processes and the bacterial-chemical oxidation of flotation concentrate.

At present, a mining-metallurgical facility was constructed on the combined feedstock base of the Kokpatas and Daugyztau gold deposits (start-up complex)

According to the project of the start-up complex, at the first stage, only Kokpatas deposits are involved in the processing at HMP-3, using the technology of vat biological oxidation only. The design decisions of the feasibility study of the second stage envisage increasing the total capacity of the mining complex to 8.0 million tons of ore per year and the processing complex to 6.4 million tons per year.

The forecast of ore processing at the Kokpatas and Daugyztau deposits - the basic version is shown in Fig. 2.8, ***a***, and, ores of reserve deposits and accumulated waste of off-balance and poor ores – Fig. 2.8, ***b***.

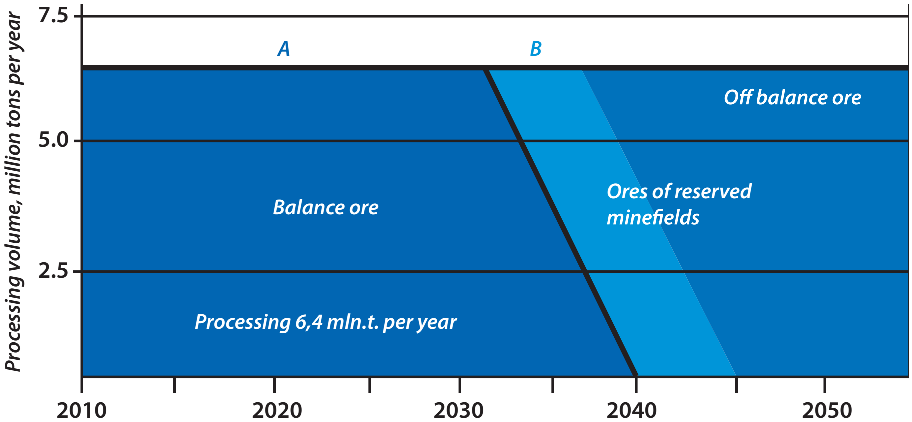

Fig. 2.8. Ore processing forecast for the Kokpatas and Daugyztau deposits: a) the base case, reserve ores and accumulated off-balance and low-grade ores; b) moderate variant

At the Kokpatas deposit, it is planned to process reserves of sulphide ores of existing and newly commissioned quarries with a total production capacity of up to 5.0 million tons per year. The disconnected spatial arrangement of the ore deposits implies their mining by a group of quarries, the total number of which currently stands at 28 units.

At the Daugyztau deposit, an industrial mining of the sulphide ore reserves of the Daugyztau open-pit mine is planned, leading its production capacity to 3.0 million tons per year.

In order to reduce the volume of ore shipped for processing and to increase the gold content, the method of X-ray radiometric sorting is used. It includies self-dumping sorting at ore control stations and lump sorting at the ore separation complex to produce an enriched product in the amount of 6.4 million tons per year.

It is planned to involve in the processing of ore reserve deposits and accumulated mining waste – off-balance and low-grade ores (Fig. 2.8, ***b***).

The implementation of the project for the reconstruction and expansion of HMP-3 in recent years has made it possible to increase gold output at HMP-3 by 4.4 times, with maintaining the trend of increasing the share of refractory hard-to-recover reserves.

The main directions of the large-scale project "Construction of a mining complex on the basis of the Zarmitan gold ore deposit" are: expansion of the production capacity of the existing Zarmitan mine through the organization of mining by the open and underground method; increasing the volume of mining, processing of ore and gold production through the construction of new mines – Guzhumsay, Promejutochnoye and plant HMP-4 (commissioned in 2010).

The construction of the mining complex, the technical re-equipment and modernization of equipment, implemented in the Zarmitan gold-mining zone, will increase the gold output by 7.25 times (Fig. 2.10).

The OzGEORANGMETLITI Institute has carried out a detailed project for the opening of reserves of a horizon of 780 m of the Charmitan deposit. The deposit is opened by a sloping transport congress (trunk), which allows repair and restoration work in the existing vertical "Main" and "Auxiliary" shafts and works on the underlying horizons simultaneously with the extraction of ore. In the future, to open the lower horizons of the field, the inclined shaft will deepen to the projected depth of the mine, which will amount to 700 meters in the future. Ore processing is envisaged at the HMP-4 with a capacity of up to 1.8 million tons per year. The forecast of changes in the structure of the ore mass processed over time is shown in Fig. 2.9. The immediate task is to develop the ores of the Charmitan, Guzhumsay and Promejutochnoye deposits and include them in processing (Fig. 2.9, ***a***). Further, ores from reserve deposits, off-balance sheet and poor ores will be included in processing (Fig. 2.9. ***b***, ***c***).

From the registered potential of uranium deposits in Uzbekistan, approximately 54.7% are economically recoverable reserves in modern conditions. At present, NMMC has six underground leaching mines (UL), producing reserves of thirteen uranium deposits with a depth of ore bodies from 120 to 600 m, characterized by low content, extremely complex mining and hydrogeological conditions of occurrence.

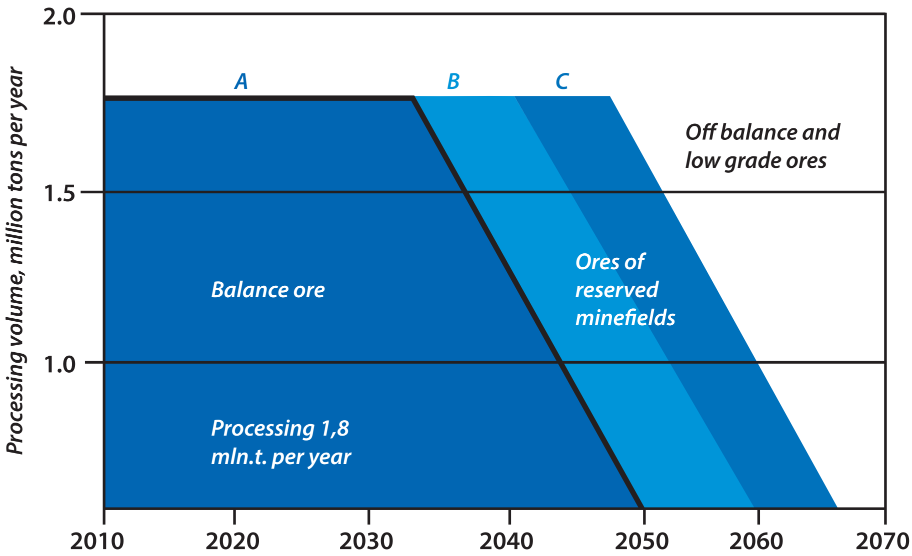

Fig. 2.9. The change over time in the processing volumes of the Charmitan, Guzhumsay and Intermediate deposits: a) the base case scenario; b) with reserve deposits; c) with accumulated waste

The immediate task of NMMC is to develop existing fields and increase uranium production. In the future, solving the problem of providing uranium mines with sulfuric acid and involving into development the reserves of the Meilisay, Yuzhny Sugraly, Kukhnur, Yarkuduk, Aulbek, Northern Mayzak deposits, and the flanks of the Ketmenchi deposit, it is planned to increase production to 4,000 c.u. per year when all mines will ramp up to their design capacity.

The availability of a mineral resource base consisting of 20 deposits, is a favorable factor for the further development of uranium production. Based on an assessment of the estimated resources of mineral raw materials in the depths, experts suggest a forecast of uranium mining for the next 40 years. However, the structure of reserves prepared for development by the criterion of production costs and uranium prices on the world market requires a significant increase in the development of the resource base, due to the additional exploration of the forecast resources, the identification and involvement in the development of new deposits with the introduction of new low-cost technologies.

It should be noted that today the production capacity of mines that provide uranium mining, have a full cycle of technological processing solutions to obtain uranyl sulfate. A system for processing solutions directly at the site of production using local sorption units (LSU) has been implemented. The analysis showed that it is advisable to restructure the concept of uranium production from the system: “energy supply - LSU - construction of new mines” to the system “energy supply - LSU - modernization of existing mines”. The proposed scheme reduces the time of designing the UL sections and capital expenditures for construction. The existing processing capacities of the mines, subject to their modernization and expansion, are capable of providing the planned processing volumes.

Achievement of key production indicators is possible only under the condition of the innovative development of NMMC on the basis of the latest achievements of science, the creation and introduction of new efficient technologies and processes into production practice.

In accordance with the concept of development of the combine for the period up to 2020, it is planned to increase the volume of production of commodity products by 10-20% compared to the results of 2010, which in the conditions of deteriorating quality of the extracted mineral raw materials requires a significant intensification of innovative activity in the combine, development and implementation of new technologies, technical and technological modernization of production.

The implementation of all areas of the Concept will ensure an increase and strengthening of the position and role of NMMC by 2025, not just in the economy of Uzbekistan, but also in the ranking of the largest mining and metallurgical companies in the world.

2.1.3. The concept of innovative development of NMMC

Today, NMMC employs about 65,000 people, who are employed in various areas of industrial production. The plant has a powerful industrial and social infrastructure, which covers an area of tens of thousands of square kilometers. About 350 thousand people live and work here, whose well-being is connected with the plant in one way or another.

Modern conditions of NMMC‘s activity are characterized by the deterioration of the mineral resource base, increasing the distance of the developed deposits from existing communications, decrease in the gold content in the ores, and worsening the technological properties of gold-containing ores. All those problems are global or world-wide in nature and the solution of such problems, is introduction of modern equipment and technologies, since the further development of the plant is impossible without introduction of innovative ideas.

With this, NMMC has a strong production and personnel potential. The plant enjoys such succesful entities as the Central Research Laboratory (CRL), Central Engineering Bureau (CEB), the Central Design Bureau (CDB), the Central Physico-Chemical Laboratory (CPCL) of Northern Administration, the Central Factory Laboratories (CFL) at HMP-2 and HMP-3. In addition, in pursuance of the Decree of the President of the Republic of Uzbekistan Navoi branch of the Uzbekistan Academy of Sciences was established in 2017, which is headed by the Deputy CEO of NMMC for the science, for the purpose of conducting scientific research, promoting technical and technological development of the industry, the introduction of energy - saving technologies, cost reduction-products.

Today, NMMC employs more than 10,000 people with higher education, including 27 candidates of science and 9 doctors of science.

The Navoi MMC industrial complex for the extraction and processing of gold-containing ores has been operating steadily for many years with high technical and economic indicators. During the years of independence of Uzbekistan, the production output has increased by more than 1.5 times. Those achievements became possible through the complete technical re-equipment of existing enterprises, through the construction of new production facilities, as well as through the introduction of the latest scientific and technical developments that significantly increase production efficiency.

It has implemented a program to increase the production of precious metals for the period 2017-2026, in order to ensure further sustainable growth in the production of precious metals due to the advanced development of new deposits, increasing ore production at existing deposits, further increasing the processing capacity with introduction of modern, energy-saving and world-proven technologies, as well as timely and high-quality implementation of strategically important investment projects for the construction, modernization, technical and technological re-equipment of production of NMMC.

Experience in the design, construction and operation of mining and processing enterprises shows that the economic efficiency of the mining and processing enterprise mainly depends on the correct solution of construction issues, the choice of technology and mode of mining operations, the calendar distribution of overburden and ore volumes, and the type of complex mechanization of production processes.

Addressing all these problems requires new innovative approaches.

In the modern world, innovative development and the ability to innovate are one of the main factors for the long-term success of any enterprise.

Rapid progress in all types of technologies around the world is primarily associated with the effective development of innovation.

Navoi Mining and Metallurgical Combine (NMMC) has developed a program for innovative development of NMMC until 2026.

This program of innovative development of NMMC until 2026 was developed on the basis and in pursuance of:

1. the Message of Mr. Shavkat Mirziyoyev, the President of the Republic of Uzbekistan to the Parliament of the country in 2018.
2. Resolutions of the President of the Republic of Uzbekistan „On the program for increasing the production of precious metals for 2017-2021 for the Navoi MMC, state enterprise, and Almalyk MMC, JSC".
3. Resolution of the President of the Republic of Uzbekistan „On the program of additional measures to increase the production of precious metals at Navoi MMC until 2026".
4. Resolution of the President of the Republic of Uzbekistan „On ad-

ditional measures for expedition of the renewal of physically worn-out and obsolete equipment, as well as for reduction of production costs of industrial enterprises“ (for the period of 2017-2020).

5. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan, No. 24, dated 12.01.2018 and Order No. 60 on NMMC, dated 19.01.2018 „On measures for creation of effective mechanisms for introducing scientific and innovative developments and technologies into production“.

The program contains a set of interrelated activities aimed at developing and implementing new technologies that meet the global standards, as well as creating favorable conditions for implementation of innovative development of the plant.

The main goal of the program is to improve constantly the level of technological and organizational development of the plant in order to fulfil unconditionally the production tasks as set out by the leadership of the Republic, with reduction of the cost of main production.

To implement the main goal and following the results of the analysis of the innovative development of the plant, the below goals of the innovative development of the plant were determined:

- increase in the efficiency of extraction and processing of gold, uranium and phosphorite ores;
- reduction of the cost of extraction and processing of gold, uranium and phosphorite ores;
- complex processing of mineral raw materials;
- cost-effective development of small gold deposits;
- increase in productivity;
- reduction of the negative impact of the plant‘s production on the environment;
- improving safe working conditions;
- improving the reliability and safety of production equipment;
- increasing the level of organizational management of production processes;
- increasing the range of export-oriented products;
- improving the social development of the plant.

The main innovative directions of development have been identified to fulfill the main goals of the plant's innovative development.

Main directions and tasks of innovative development of NMMC.

1.Exploration works (EW).

1.1. Application of modern methods for mineral reserves estimation.

1.2. Advanced development of the mineral resource base to ensure an increase in the growth of commercial mineral reserves.

1.3. Introduction of advanced methods of organization, technical and methodological equipment for exploration and production (uranium production).

2. Mining operations.

2.1. Introduction of modern methods of mining, complex and economically rational extraction of minerals, taking into account environmental protection and safety of work.

2.2. Modernization of mining equipment.

2.3. Reducing the cost of mining operations.

3. Processing and enrichment.

3.1. Gold.

3.1.1. Introduction of modern technologies to increase gold recovery.

3.1.2. Modernization of technological equipment.

3.1.3. Reduction of specific costs of materials and reagents.

3.2. Uranium production.

3.2.1. Reducing the specific consumption of reagents.

3.2.2. Modernization of technological equipment.

3.3. Phosphorites.

3.3.1. Involvement of dust fractions generated by KPC into the processing.

3.3.2. Development of technology for obtaining fertilizers from the silt part of the KPC's tailings storage facility.

3.4. Complex processing of gold and uranium ores.

3.4.1. Complex processing of gold-containing ores.

3.4.2. Introduction of technology for processing of uranium black shale ores.

3.4.3. Introduction of technology for obtaining rare and rare-earth metals.

4. Transport.

4.1. Reduction of specific fuel consumption through the use of modern technologies.

4.2. Reduction of operating costs for maintenance of mining equipment.

4.3. Introduction of a unified logistics system for centralized intercity transportation.

5. Mechanical engineering and metallurgy.

5.1. Introduction of modern technologies for production of equipment and spare parts in NMMC.

5.2. Development of production of new types of materials.

5.3. Localization of process equipment and spare parts.

6. Energy.

6.1. Introduction of energy-saving technologies for energy generation.

6.2. Introduction of modern technologies for drinking water treatment at the plant's production facilities.

6.3. Introduction of photovoltaic plants and solar installations as renewable energy sources (RES).

7. Automation and ICT.

7.1. Comprehensive automation of resource management and main production processes.

7.2. Increasing the productivity of drilling rigs by connecting the sensor to the rotation engine and determining technical parameters.

7.3. Complex automation of housing and communal services of NMMC.

7.4. Automation of labor protection and safety services in NMMC.

7.5. Improving the quality of products through the introduction of innovative management methods in the field of metrological support of NMMC.

7.6. Automation of production processes and control systems using modern technologies in order to combine technological and production levels with business systems.

8. Occupational and industrial safety.

8.1. Improving safe working conditions.

8.2. Ensuring timely analysis and forecasting, timely response to prevent possible accidents and incidents at hazardous production facilities of NMMC.

9. Ecology and Environmental Protection.

9.1. Reduction of the negative impact of the plant's production on the environment.

10. Medicine.

10.1. Creating a DNA Bank for a personalized approach to prevent the health issues of employees of NMMC.

11. Agricultural industry.

11.1. Further introduction of biogas production technology.

11.2. Introduction of hydroponics technology into production of grain feed for livestock.

NMMC has a Research and Technical Council (RTC), which is the main management body for innovation implementation. The RTC consists of more than 54 specialists, including representatives of the Academy of Sciences, universities and specialized institutes of Uzbekistan.

The control system of innovation in NMMC is comprised of three levels.

First level: Science and Engineering Board (SEB) of NMMC, the General Director of NMMC acts the Chairman of SEB NMMC.

SEB NMMC consists of 10 (ten) sections in accordance with the directions (Table 1 to this Program). The responsible person of each direction is the Chairman of the corresponding section.

The main tasks of SEB NMMC are as follows: development of priorities for research and engineering development of the plant, implementation of innovation policy, definition of technical policy for achieving the goals of development of production and economic activities of NMMC.

Second level: Science and Engineering Boards of mining administrations and associations of NMMC (Central Mine Administration, Northern Mine Administration, Southern Mine Administration, Mine Administration of HMP-1, Mine Administration-5, NMBP). The chairmen of the SEB of the mine administrations are their chief engineers. The number of sections in the SEB of the mine administration is based on the number of SEB NMMC sections. The Deputy Chairman of the SEB of the mine administration (division) of each section is the chief engineer (or deputy chief, if there is no chief engineer in the organisational chart) of the profile division.

Third level: Engineering boards of the departments of mine administrations of NMMC. The chief engineers (or deputy heads, if there is no chief engineer in the org chart) of the respective divisions are the chairmen of the third-level Engineering Board. The number of sections in the third level Science and Engineering Board is based on the number of sections of the SEB of the mine administration (division). The Deputy Chairman of the SEB of the third level of each section is the chief engineer (or deputy chief, if there is no chief engineer in the org chart) of the profile division.

In 2018, in order to develop research and innovation activities, the plant established an Innovation Center for introduction of new technologies.

The Innovation Center has three groups:

1. The group the introduction of new technologies, with the main task to integrate science with productio.

2. The group for production of research and technical products, which is engaged in rationalization activities and patents.

3. The editorial group for publication of the research and technical journal „Mountain Bulletin of Uzbekistan“ and publication of books, organization of national and international conferences. To date, the NMMC technical library has been fully digitized, and has more than 17,870 books. By the end of 2019, the employees of NMMC, Navoi State Mining Institute and Tashkent State Technical University have digitized more than 134 thousand books and uploaded them into the electronic library website.

Initiator of innovation - the SEB NMMC of any level any Department of management of the plant, any engineer (employee) of the plant can become the initiator of innovation.

The initiator of the innovation shall submit a written application of free form to the higher-level SEB, which shall review the application in accordance with the prescribed procedure.

Innovative projects are reviewed in accordance with the procedure for reviewing, accepting and financing innovative projects in NMMC.

The basic requirements to the initiators of innovation:

Financing of this Program is carried out at the expense of the plant‘s own funds, if the financing is not addressed prior to inclusion of the innovation in the Program.

An innovation system shall be built by using the components of open innovation model.

This model assumes active involvement of third-party organizations in research and development of innovative products. In the innovative activity of the plant, special attention is paid to the search for the most effective options for implementing projects based on comprehensive analysis of the subject in question, considering possible changes in the future. It is not secret that the introduction of modern innovative technologies is associated with significant financial investments, which is why each innovative project is carefully analyzed, studied and worked out by SEB NMMC, with involving scientists of the Academy of Sciences of Uzbekistan, specialists of leading design organizations, research institutes, universities of the country and foreign companies into this process.

The plant successfully cooperates with leading domestic institutions: Navoi state mining institute, Tashkent State Technical University named after Islam Karimov, UzGEORANGMETLITI, NIIMR, Institute of Microbiology, National University of Uzbekistan, Tashkent Institute of Chemical Technology, Institute of Ionoplasm, Center of Advanced Technologies, Institute of Nuclear Physics, etc., as well as with foreign institutions: VNIPIpromtehnologiya (Moscow Russia), VNIMI (Saint Petersburg Russia), UralEnergoResurs (Magnitogorsk, Russia), OUTOTEC (Finland), RUSREDMET JSC (Saint Petersburg Russia), RIVS JSC, Irgiredmet JSC (Russia), Integra-Group (USA), Integra RU LLC (Russia), ENGINEERING DOBERSEK GmbH (Germany), Blast Movement Technologies (Australia)

The NMMC innovative development program includes 105 projects that cover the main areas until 2026 (Table. 2.3.).

Table 2.3

Schedule of implementation of innovative projects until 2026, UZS billion

Description	Years												In 2018-2026, total
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Number of projects*	48	55	78	81	83	85	87	90	95	97	99	101	
Expenses for R&D and implementation of innovative projects*	17	25	25	37	46	55	63	68	72	75	81	90	587
Expected economic effect of implementation*	44	49	50	77	96	115	134	147	160	167	179	192	1267

** The number of projects, the costs of R&D and project implementation, and the expected economic impact will be determined based on the annual programs, contracts, and statements of completion.*

The introduction of innovative developments will help solve such problems as:

- advanced development of the mineral resource base to ensure an increase in the growth of commercial mineral reserves.
- reducing the cost of mining operations and specific costs of materials and reagents, fuel, energy costs, operating costs for the maintenance of mining equipment;
- completeness of mining, complex and economically rational extraction of minerals, taking into account environmental protection and safety of work;
- complex processing of gold, uranium and black shale ores;
- rare and rare-earth metals recovery.
- localization of process equipment and spare parts.
- improving safe working conditions.
- ensuring timely analysis and forecasting, timely response to prevent possible accidents and incidents at hazardous production facilities of NMMC.
- reduction of the negative impact of the plant‘s production on the environment.
- improving the reliability and safety of production equipment;

• increasing the level of organizational management of production processes;
• increasing the range of export-oriented products;
• forecasting and preventing risks of occupational diseases.

Thus, the total planned expenditures for R&D and implementation of innovative projects until 2026 will amount to UZS 587 billion. The economic effect of the expected implementation of innovative projects will amount to UZS 1,267 billion.

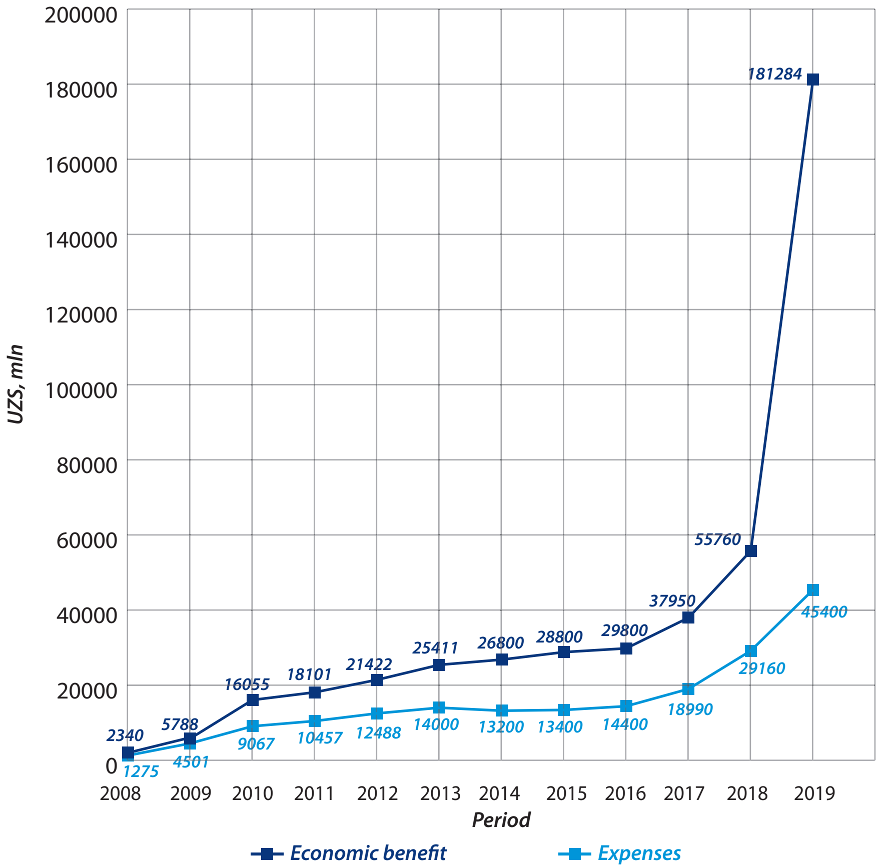

Fig. 2.10. Research, development, engineering and innovation projects and rationalization activity

Currently, the innovative development program for 2019 consists of 58 projects with a total cost of implementation of more than UZS 34.4 billion. The innovative development program consists of the main areas as follows: exploration (4 contracts for UZS 2.5 billion), mining (9 contracts for UZS 5.2 billion), gold and uranium production (9 contracts for UZS 22 billion), complex processing, metallurgy and mechanical engineering, transport, energy and automation (6 contracts for UZS 1.12 billion), environmental protection, ecology and social services. The Fig. 2.10 shows the results for 2019. Today, the innovative development program for 2020 has been developed and approved.

For example, in 2019, following the results of 9 months, 41 research contracts were signed and are in implementation (5 contracts with foreign scientific organizations, 36 with scientific organizations and Universities of Uzbekistan) for a total amount of UZS 8,492 million. The expected economic effect of these projects will be more than UZS 180 billion.

Over the past three years, the economic effect of the introduction of patents has increased from UZS 69 to 107.7 billion, i.e. increased by 164%, Fig. 2.11.

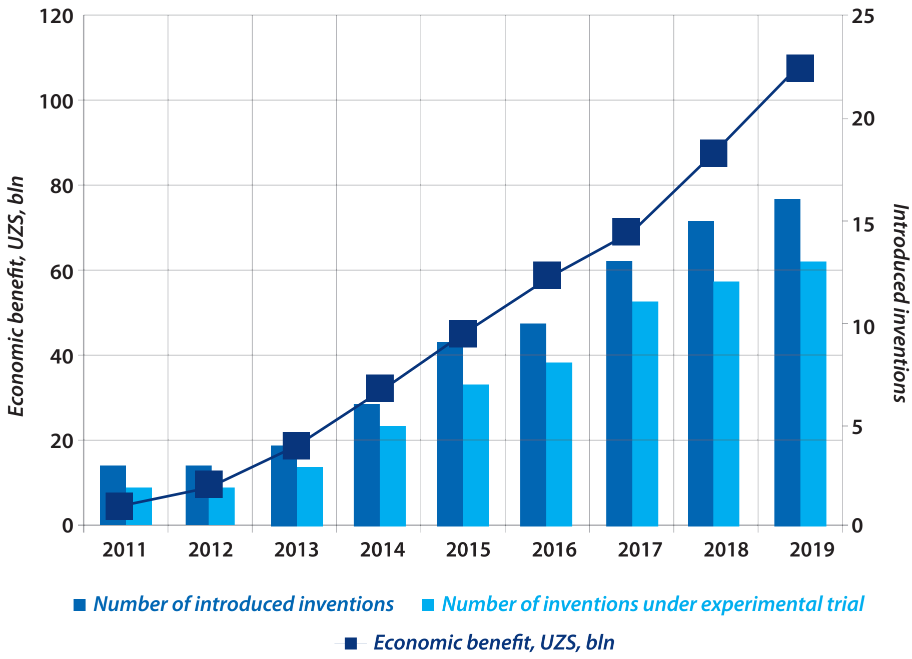

Fig. 2.11. Information about intellectual property

For the first time in the history of the mining and metallurgical industry of Uzbekistan, the employees of NMMC and Navoi Mining Institute received the gold medal „for invention“ by the UN world intellectual property organization (WIPO). The gold medal was awarded for the development and implementation of the „Method for extracting gold from refractory sulfide gold-arsenic ores“ (patent No. IAP 05134, dated 17.11.2015).

For example, the patents have been developed and obtained to resolve the problems of processing gold-containing refractory ores:

- Based on the study of gold behavior patterns during biopulps washing, a technology has been developed and implemented to reduce irrevocable gold losses **(patent No. IAP 04489)**
- The design of the working units of the thickeners of the countercurrent decantation circuit of the bio-oxidation complex has been improved (**patent No. FAP 01012)**
- A combined technology for processing of highly refractory and double-refractory ores containing carbonaceous substances using oxidative firing has been developed (**patent No. IAP 05134**)

Such introductions improved significantly the total recovery and annual gold production with preservation of current ore processing, reduction of cost of the manufactured product and in addition to that, it has received the finished product for the amount of UZS 222,2 billion per year.

NMMC has a regulation on rationalization activities. In March 2019, the program was finalized and the interest rates for innovators remuneration were changed, which contributed to the growth of applications for rationalization, and as a result, the innovators felt additional motivation. Every year, the NMMC rationalizer competition is held, and in 2019, for the first time, a competition was held between young innovators in 7 areas (Mining, Mechanics, Energy, Transport, Gold and Uranium Technology, Automation). In addition to rewards for innovation activities, innovators were given valuable gifts. In 2017, it was accepted 77 proposals with an economic effect of UZS 6.6 billion, while in in the first 9 months of 2019, it was accepted 76 applications with an economic effect of UZS 32 billion, including the application for rationalization „Improving the productivity of the grinding shop at HMP-2 by introducing new technological schemes“. Thanks to the application for rationalization, the processing will increase by an average of 3%. This is 39 million tons in 2018, and 43.7 million tons in 2019.

2.1.4. Socio-technological support of mining production

Technology, in its broad sense, is expedient to define as the sphere of purposeful human activity, organized on the latest achievements of the totality of technical and social sciences. And then with good reason you can talk not only about the technology of production of specific types of material products, but also about the technology of public administration, education, management of certain aspects of public life or the whole society, that is about socio-technological relations and their respective activities. The production and use of constantly updated knowledge is becoming an important factor in the sustainable development of all spheres of public life.

The successful realization of the concept of sustainable development is unthinkable without social and technological support as well as high productivity is impossible without modern technologies.

The role and importance of personnel in the management system of mining production. To date, the combine employs about 65,000 people, of them, 58% are employed in the production of industrial products. Personnel policy of the combine is aimed at staffing departments with young professional workers and employees, reducing the outflow of specialists and their retaning.

Further development of production brings special demands on the issues of training future personnel. The concept of „staffing" production should be considered in several aspects.

In the literal sense, it means a set of workers jointly implementing a certain program. Here staffing is synonymous with the words "collective", "personnel" and is understood as an enterprise's resources. At the same time, staffing is considered not only as a certain set of people, but also as an indispensable condition of their activity and interaction - the process of resource management, which makes possible productive activity. Finally, the organizational aspect of staffing is manifested in the fact that personnel is an indispensable condition for the organization of production, labor and management.

Through the personnel system, an organizational management function is implemented, and staffing is a part (element) of the management system.

Under the system of staffing refers to the personnel management system, operating on the basis of a specific organizational structure to improve production efficiency, meet the material, moral and moral needs of employees. In this sense, staffing is a process of recruitment and placement of personnel, ensuring the achievement of these goals.

By structure, the personnel of the mining enterprise include workers, managers, specialists and employees. Executives either lead functional units (services) or manage the production process directly. In this case, the management staff is called linear. Accounting, analysis of the state, security and quality of personnel is performed at the mining enterprises on the 1st day of each month of the year. Here, records are kept of: the number and use of specialists; turnover of executives for the year by category (director of mines, open-casts, concentrating factories, construction departments; chief engineers; site managers); the composition of executives by education and age; training and education; the number of professionals occupying jobs; the composition of executives in the industry with academic degrees of candidates and doctors of science.

For a quantitative assessment of the staffing of the enterprise, specific indicators have been established: quantity, employment, qualitative composition, stability, turnover, etc.

The stability of executive personnel is determined as a result of analyzing the composition of workers according to work experience and implies a fairly long-term work in one enterprise. It has been established that working personnel for more than three years in one enterprise are considered as a potentially stable production team.

In this connection, it is customary to evaluate stability by the ratio of the number of employees with work experience in a given enterprise for more than three years to the average number of employees. This ratio, as expressed in percentage, is called the coefficient of stability.

Staff turnover occurs through organized and unorganized channels. Organized channels include promotion, election to an elected position, changes in connection with the improvement of the management structure, leaving for studies, recruitment to the Armed Forces, retirement, illness, death, transfer to a similar position, replacement by specialists. Movement through organized channels is a progressive process. The prospect of growth promotion is the ability to express their full knowledge and skills, which is an indispensable condition for the stabilization of personnel. Such a movement indicates a growth of personnel, a constantly improving production management system. The unorganized channels include: release from work for violation of the rules of internal labor regulations, not providing leadership, violation of labor and production discipline, release from work according to their own wish, etc.

Replacement, for reasons of the second group, determines the turnover rate equal to the ratio of the number of changed (dismissed) to the total number of workers in this category. For a proper understanding of the processes of movement of specialists, it is necessary to identify the factors affecting the frequency of movements. Factors can be subjective, related to the personality of the worker, and objective, independent of him. The first include, for example, the features identified in the analysis of the socio-psychological structure of the personality, that is, the factors that indicate the unsatisfactory state of management.

One of the main areas of work with personnel is the formation of a reserve of personnel, which serves as the basis for the advance training of candidates for executive positions. Employees included in the reserve, after purposeful training can be nominated to participate in the competition and elections to senior positions.

Line managers and functional services specialists who meet the requirements and have passed certification, are credited to the reserve. For those included in the reserve, terms for forms and methods of education and training are determined; carry out special training for professional management activities. High-quality training, the passage of all necessary steps in the process of training and internships will provide a high percentage of appointments from among those enrolled in the reserve.

NMMC is a diversified enterprise, so without a focused personnel policy it is impossible to solve the problem of increasing the volume and increasing production efficiency. To date, the plant employs graduates of 394 universities, seven doctors of science, 38 PhD and employs qualified personnel in 780 different specialties.

In accordance with the National Program for Personnel Training, NMMC has developed and is implementing a comprehensive program for the development and effective use of personnel, providing the plant with highly qualified specialists. The plant has a system of continuous monitoring of current and future labor market needs in personnel of various qualifications.

An educational, scientific and industrial complex of proactive personnel training has been formed (Fig. 2.18), with the implementation of the concept of which the main thing is the creation of a permanent system of training, advanced training and its financial support.

As a result, NMMC does not have a problem of personnel shortage, which is one of the most pressing for the mining industry, and closes the need to replace managers and specialists by recruiting staff from among employees.

The well-structured system of training, retraining and advanced training of specialists and workers allows providing for the needs of all parts of the enterprise in personnel. During the year, in training centers, more than ten thousand workers of various categories, from workers to managers, are trained and improve their qualifications. At the plant, a system of continuous education has been created, which allows young people to master a specific specialty, in order to realize themselves, to find a worthy place in society. Training of specialists with higher education for the Navoi Combine is carried out in accordance with the concluded long-term agreements in the universities of Uzbekistan, and highly demanded specialties in the universities of the near and far abroad.

The plant also has its own institution of higher education – the Navoi State Mining Institute (NSMI), where a large amount of research work is carried out, to which students are actively attracted. The relationship between NMMC and NSMI is based on mutually beneficial cooperation in personnel training, where the institute actually resolves issues of intra-company training.

Such training has its own specific features that define the qualitatively new legal relations of the institute and the customer of personnel; ensure the formation of professional competence and the development of personal and general professional qualities in specially created training and production conditions as part of high-tech production.

This integration of educational and industrial relations leads to the emergence of an “education-production” system that corresponds to the interests of the institute and production with a combination of active and personality-oriented approaches to the knowledge gained by students.

However, such a system in modern conditions in some cases is not enough to prepare a specialist to work with modern automated control systems, high-power equipment and high-tech technological processes when they need to be quickly adapted to changing mining and geological and mining conditions. Then it becomes necessary to supplement the system „education - production“ with the element „science“. The peculiarity of the system “education - science - production” is that the professional knowledge and experience obtained in the system “education - production” expand and deepen in the process of studying scientific research by students. In general, obtaining professional knowledge can be considered as components of the educational process, spiritual, educational, and professional education (Fig. 2.19).

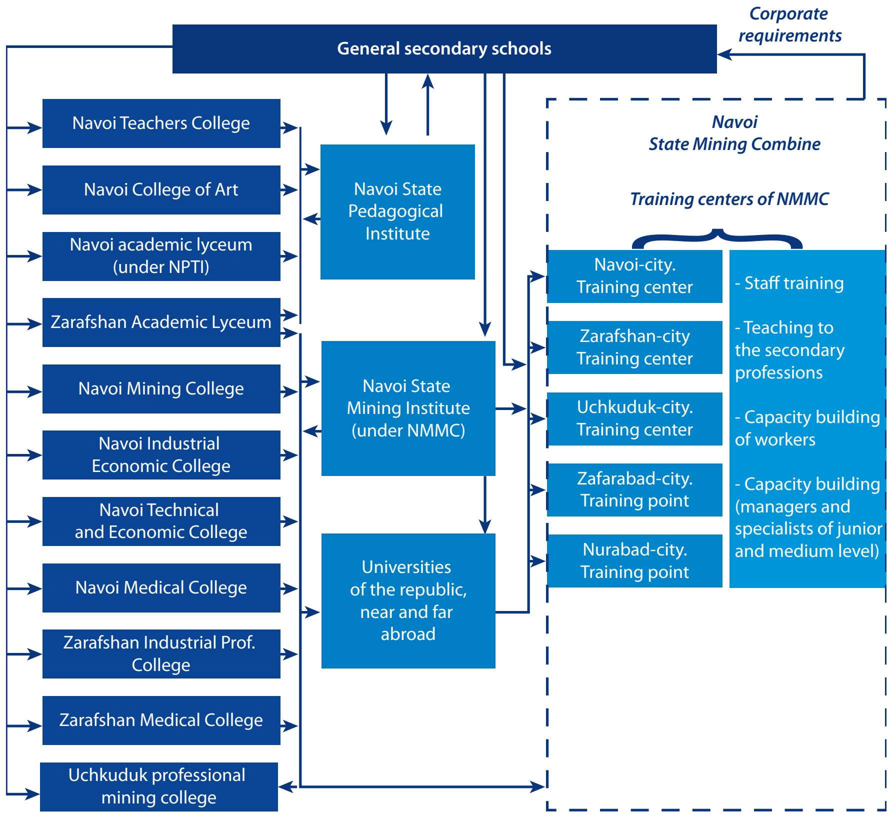

Fig. 2.12. The complex of highly qualified personnel capacity building

2.1.5. Creation of free economic zone (FEZ)

One of the effective mechanisms for stimulating the development of enterprises, primarily small and medium-sized businesses in the region, is the creation of a free industrial-economic zone, which serves as a “window” for investment, technology transfer, improvement of management skills and labor. The conditions that the state creates for the private sector as part of the creation of zones will allow organizations to significantly reduce their costs for infrastructure development and, in the case of special economic zones, take advantage of preferential tax preferences.

The Decree of the President of Uzbekistan No. UP-4059 “On the establishment of a free industrial economic zone in the Navoi region” was signed on February 2, 2008. According to the Decree, the FIEZ was created around the international airport of the city of Navoi, the reconstruction and modernization of which was entrusted to the large construction and installation structures of NMMC. The main activity of economic entities in the territory of the Navoi free industrial zone is the production of a wide range of high-tech, globally competitive products through the introduction of modern foreign high-performance equipment and technology, technology lines and modules, and innovative technologies.

Navoi region of Uzbekistan has become a free economic zone (FEZ). The corresponding decree was signed by Mr. Shavkat Mirziyoyev, the President of the Republic. During 2019-2020, the region is scheduled to implement a program of 511 investment projects with a total cost of more than USD 3 billion, it is planned to use USD 1 billion of foreign direct investment and loans, and create 17.4 thousand new jobs. As reported by EADaily, the Asian Development Bank (ADB) together with the Ministry of Finance of Uzbekistan have developed a program for the development of the mortgage market in Uzbekistan, for which, the ADB will allocate a loan of USD 200 million to Uzbekistan.

The activities and opportunities of the FEZ organized in 2009 were expanded in accordance with the Presidential Decree, dated June 5, 2018. This year alone, the number of residents in this zone has increased by 27 and reached 66. The total cost of the projects exceeded USD 437 million.

National Plast, Limited Liability Company is among the subjects of the economic zone. The company with a total cost of almost USD 16 million produces profiles made of polyvinylchloride. In 2019, more than 10 thousand tons of products were produced here.

The head of Uzbekistan observed the operation of the enterprise and asked about the quality of products. He gave instructions on expanding the production of import-substituting goods, providing the population with affordable and high-quality construction materials.

The President was informed about the second stage of the enterprise, which is planned to be put into operation in the third quarter of 2020. As a result, the production capacity will increase by 40 thousand tons, and the export volume will reach USD 10 million.

During the visit to the FEZ on December 28, 2019, Mr. Shavkat Mirziyoyev visited the sites of the „Green Line Profil" Limited Liability Company.

The company, with a total value of almost USD 40 million, began operations in 2018. 650 jobs were created. This year, 18.6 thousand tons of products were produced with export for USD 10 million. Next year, it is planned to increase production to more than 22 thousand tons and increase exports to USD 14 million.

The head of Uzbekistan got acquainted with the samples of products produced here, asked about their quality and export geography.

„Today, the most important task is to create added value and jobs", Mr. Shavkat Mirziyoyev said. „Every industrial company should form a value chain by using modern technologies and a reasonable approach. We should study foreign markets and expand exports by reducing the cost of production".

The objective prerequisites for the creation of FEZ in the Kyzylkum region are:

- perspective geographic location: distance to the cargo terminal of the Navoi International Airport and the cargo railway station - 1.8 km; E-40 motorway, a nearby electric substation, a nearby water distribution hub and a high-pressure gas pipeline – 800 m;
- necessary industrial, communication infrastructure and qualified labor force: NMMC is one of the largest producers of gold and uranium in the world, JSC Kyzylkum-cement is the largest cement plant in Uzbekistan, JSC Navoiazot, Electrokhimzavod – large chemical plants, Navoi TPP - one of the largest thermal power plants in Uzbekistan;

• significant transport and logistics potential: Navoi International Airport serves international airlines such airlines as Korean Air and Moscovia, the international highway E-40, a direct line connecting Shanghai with Paris, runs in close proximity to the airport, half the volume of transit cargo is served by the railway system, which runs near the airport;

• rich mineral resource base of the region.

• the period of operation of the Navoi free industrial economic zone is 30 years with the possibility of its subsequent extension;

• during the period of operation of the FEZ, special customs, currency and tax regimes, a simplified procedure for entry, stay and departure, as well as obtaining permits for work by citizens – non-residents of the Republic of Uzbekistan;

• the effect of a special legal regime, including tax, currency and customs, applies only to activities carried out by economic entities registered by the Directorate of FEZ, exclusively in the territory of FEZ;

• coordination and operational management of FEZ activities are carried out, respectively, by the Administrative Council, created from representatives of state bodies, and the Directorate of FEZ.

The personal membership of the Administrative Council is approved by the Cabinet of Ministers; the entire territory where the Navoi free industrial economic zone has been created is allocated for use and management of the Administrative Council for the entire period of the existence of the FEZ; FEZ Directorate provides economic entities with land plots on the territory of FEZ for rent without the right to sublet them, transfer their rights and obligations under a lease agreement to another person, pledge lease rights as a contribution to the authorized capital. Sale and other alienation of land on the territory of the FEZ is prohibited. The decree provides for exempting economic entities registered in the Navoi free industrial economic zone from paying land tax, property tax, profits, improvement and development of social infrastructure, single tax payment (for small enterprises), mandatory contributions to the Republican Road Fund and the Republican Fund school education with direct investment: from 3 million euros to 10 million euros – for 7 years; from 10 million euros to 30 million euros – for 10 years. In the next 5 years, the rates of income tax and the single tax payment are set at 50% below the current rates; over 30 million euros – for 15 years.

For the next 10 years, the rates of income tax and the single tax payment are set at 50% below the current rates.

Economic entities registered in the FEZ are exempt from paying customs duties (except for customs clearance fees) on the imported equipment, as well as raw materials, materials and components for the production of products for export for the entire period of FEZ activity. It was determined that for raw materials, materials and components, imported for the production of products sold in the domestic market of Uzbekistan, customs payments are levied at a rate of 50% of the established rates (except for customs clearance fees) with deferment of payment for up to 180 days, if the legislation does not establish a more preferential treatment. In the case of the sale or donation of equipment, raw materials, materials and components imported into the territory of the FIEZ using these benefits, customs payments are charged to the budget in full in the manner prescribed by law.

The document allows business entities registered in the Navoi Free Industrial Economic Zone to: make payments and payments in foreign currency within the FEZ in accordance with the agreements and contracts concluded between them; pay in freely convertible currency the supply of goods, works and services from other business entities - residents of the Republic of Uzbekistan; use conditions and forms of payment convenient for them and payments for exported and imported goods. It has also been established that acts of tax legislation of the Republic of Uzbekistan that worsen the position of taxpayers, with the exception of acts regulating the taxation of excisable goods, are not applied to business entities registered in the Navoi free industrial zone [17].

The creation of the FEZ will make it possible to activate economic and innovation processes in all sectors of the economy and achieve the following results:

- creation of an effective system of planning and managing the processes of creating and operating a zone for the accelerated formation of modern infrastructure of the FEZ;
- creation of a productive system for managing the creation and operation of industrial zones;
- obtaining a large economic effect from the accelerated development of the industrial sector of the economy due to the preferential use of FEZ

as an element of the industrial infrastructure;

- increasing the growth of economic activity in the manufacturing industry and high-tech industries;
- development of industrial business around the city of Navoi and enterprises of the region;
- creation of efficient industries in small and medium business;
- increase employment by creating new jobs;
- raising the living standards of the population of the region and the republic;
- development of export innovation potential of the region;
- an increase in the share of small and medium-sized businesses in the total volume of industrial production;
- increase of industrial and economic activity in the region.

The current line in the investment policy of Uzbekistan is considered to be a further increase in the volume of attracted foreign investments in the Navoi FEZ. First of all, it is planned to implement 19 projects with a volume of about 200 million USD and further pay special attention to attracting investments from highly technological countries such as the Republic of Korea, Japan, Germany, USA, Great Britain, France, Italy, Singapore, China, India, UAE and other countries of the world to the Navoi FEZ. Joint ventures will be established for the production of LCD monitors, computer and telecommunications equipment, economical light bulbs, automotive parts, compressors, gas equipment, medical equipment, medicines, chemicals, building materials, perfumery, furniture, clothing and agricultural products processing.

It seems that the proposed innovative approaches to the creation and development of Navoi FEZ as an effective mechanism to stimulate regional production development will be one of the real mechanisms for the implementation of industrial-innovative state policy, support and development of small and private entrepreneurship in the Kyzylkum region.

Moreover, obviously, the work with investors and foreign companies implies higher need in competent specialists in small and medium-sized businesses. FEZ, which will require modern personnel with knowledge and skills of modern efficient business, is established to develop the economy, employment and raise the standard of living of the population of the region.

2.2. Analysis of mineral resources of the Kyzylkum region

Kyzylkum is an outstanding region of mineral resources of gold, uranium, silver, tungsten, graphite, phosphorites, oil shale and other minerals, the total value of which is more than USD 500 billion.

Based on an assessment of the forecast resources of mineral raw materials in the depths, experts in 2000 assumed a forecast for the development of hydrometallurgical production for the next 30 years. According to their calculations, during the period 2000-2030, when investing in the construction of mining and processing enterprises in the amount of about USD 5 billion and annual mining costs of about USD 2 billion, it seems profitable to obtain the expected products. But the large scale of open-pit mining and the high rates of development of proven deposits, along with price fluctuations in international markets, lead to adjustments to long-term forecasts and the need for their more frequent revisions.

2.2.1. History of geological development of the region

The history of the geological development of the Kyzylkum region covers the period from Precambrian (possibly from Riphean) to Quaternary time. After the consolidation of the Baikal fold system and the transition to the platform stage of development, epirogenic movements have characterize it. Apparently, at this time (PR1), the Central Kyzylkum block is involved in the movements of the positive sign, forming an isometric anteclise. The volcanogenic-sedimentary formations of all stages of development of the Baikalid, which are combined into a metamorphic complex of formations, the so-called “socle” of the middle massif, take part in its structure (Fig.2.13). The total capacity of this complex is estimated at 2500-4000 m.

By the beginning of the Cambrian, the contrast of vertical movements is enhanced by the intensively developing Caledonids of the Northern Tien Shan. The elevated blocks are eroded, in the intermontane depressions and in the surrounding epicontinental basin, terrigenous material accumulates in the form of molasses and a wild flysch-dogosynclinal case of the massif. At the same time, the inception of deep faults, limiting the array. At the beginning of the Ordovician, the region is finally formed as an uplift, due to the erosion of which, in the structures of the negative sign, the I formation of malassoid formations localized in the dogosynclinal basis of the Hercynids (variscide), framing the median massif continues.

By the beginning of the Silurian, the Central Kyzylkum block, bounded by deep faults, is a rigid, stable uplift dividing the Variscian folded system into two branches of the north-west strike.

From the Silurian to the middle of the Carboniferous (the geosynclinal stage of the variscid itself), the middle mass is involved in these movements, occurred in the form of multidirectional block displacements with the formation of superimposed deflections and interblock faults of the depth.

At the early stage of geosynclinal development of the variscid (S, D) in the troughs, the process of formation of flyschid and volcanogenic-terrigenous formations occurs. In general, volcanism occurred weakly and associated with zones of interblock faults of the deep bed.

From the middle of the Devonian and to the middle of the Carboniferous (late geosynclinal stage), carbonate strata accumulate in the areas of the most stable tectonic regime. Their thickness ranges from 2,200 to 4,300 m in geosynclines and 1,000–1,500 m in the array. In the lateral parts of the lateral carbonate formation is replaced by carbonate-terrigenous thickness of more than 1,000 m.

Within the middle massif, the active transgression of the sea basin into lowered blocks (superimposed deflections) is accompanied, as in geosynclinal deflections, by the accumulation of carbonate material. Carbonate and carbonate-terrigenous formations with a thickness of 100 to 1,000 m are formed. As a result, in the geosynclinal stage of development of the Hercynides, simultaneously with the formation of the fold area itself, similar formations are formed within the median massif, forming its singeosynclinal case.

Fig. 2.13. Central Kyzylkum middle massif and its Hercynian framing:

B – Bukantau mountains; T – Tamdytau mountains; Tx – Takhtatau mountains; S – Sangruntau mountains; Ar – Aristantau mountains;

Bl – Beltau mountains, A – Auminzatau mountains; K – Kuljuktau mountains; NN – Northern Nurata mountains; SN – Southern Nurata mountains; Z – Zirabulak-Ziadin mountains; 1 – North Precambrian Block; 2 – South Precambrian Block; 3 – Gulyantash Paleozoic imposed trough; 4 – Edge molasse ditch of the middle massif (Pz); geosynclinal arrays covered by the Late Paleozoic with molasses formations; I – West Bukantau, II – Sever-Bukantau-Nurata, III – Zarafshan-Alay

The geosynclinal formations of the cover of the massif are almost twice as inferior in power to those of the folded system of the variscide, framing the massif. At the end of this stage ($C_{2\text{-}3}$), magmatism occurred widely. Narrow ophiolite belts of peridotite pyroxenite, gabbro-amphibolite and spilite-diabase formations are formed.

A part of the granitoid intrusions of the Kyzylkum complex is apparently associated with this stage.

During the period of the Upper Carboniferous-Permian, which is the orogenic stage of development of the variscide that surrounds the massif, block tectonics within the massif are most intensely occurred. Along with the active volcanic activity in the zones of deep faults, accumulate powerful molasses, represented by the lower volcanogenic and upper red formations.

From the Upper Carboniferous to the middle of the Cretaceous, the median massif represented the demolition region, since neither Triassic, nor Jurassic, or Lower Cretaceous sediments are recorded here.

From the Upper Cretaceous in the sediments of the Meso-Cenozoic cover of the massif, repeated transgressive and regressive accumulation of sedimentary material was noted with overlapping of the latter by continental sediments of eolian, proluvial and alluvial facies.

2.2.2. Tectonic zoning and Structural-formational characteristics

Traditionally, in the geological structure of the Central Kyzylkum, two structural floors were distinguished: the Paleozoic (Upper Homeozoic) fold-metamorphic „foundation“ and the Meso-Kainazois platform cover. “The Foundation” is exposed fragmentary in the raised blocks of the region.

At present, the tectonic zoning of western Uzbekistan is generally accepted, based on the idea that Central Kyzylkum is an integral part of the South Tien-Shan folded system. In accordance with this scheme, six linear structural-formational zones are distinguished, four of which (North-Bukantau, South-Bukantau, Turkestan-Alay and Zarafshan-Turkestan) cross the Central Kyzylkum region in the north-west direction.

An analysis of the distribution of pre-Mesozoic deposits, gravi-magnetic deposits, and the metamorphic complex suggested that the Central Kyzylkum are a rigid block of the earth‘s crust, which is a raised block of the ancient folded structure, which is a residual massif whose boundaries are determined by large deep faults. Such a block is a relatively small fragment of a larger array, is in a clamped form inside a younger folded system and is processed to varying degrees by tectonic processes that occurred in adjacent mobile zones. As a result of such processes, the block is dissected by young intrusions and dykes. It is proposed to call such structures as residual middle arrays. In accordance with this definition, the Central Kyzylkum block is a Varistian middle massif that is framed by geosynclinal formations of the Hercynian tectonic-magmatic cycle. It is characterized by a high position of the basement with a partial exit to the surface, and partially covered with sediment cover. Separate internal superposed bends form on the surface of the basement, made of both singeosynclinal and orogenic formations with sharply reduced power compared to the framing geosyncline.

Metamorphic rocks of Precambrian (possibly pre-Riphean) age, overlapped with structural and stratigraphic disagreement (in imposed troughs) of volcanogenic-sedimentary and molasses formations of geosynclinal and orogenic structural floors of Varisian tects and isogenic iso-tects represent the complex of formations composing the basement of the massif. The sedimentary formations of the platform cover are either absent or have an abbreviated incision.

It should be borne in mind that the most mobile blocks of the Kyzylkum region continue to move relative to each other along the faults delimiting them. Moreover, such movements in adjacent blocks have a different sign. Therefore, for example, if the Bukantau block rises, then the Mingbulak one goes down, and so on. Currently, all the elevations of the Central Kyzylkum massif have a tendency to positive movement. In particular, according to the cosmogeodesic survey, the height of the Aktau mountain in the Tamdyn mountains system is increased by 4 cm per year. These data are presented in order to show that tectonic activity in the Kyzylkum region does not fade.

Many years of studying the geological and structural features of the structure of the Kyzylkum and adjacent territories revealed a number of significant shortcomings and contradictions in the zoning of this region. In particular, the age-related discrepancy between regional stratigraphic schemes with their identical lithology was established, since the age of the suite was often determined not by the presence of faunistic data, but by the mutual position of the strata: the higher in the section, the younger. Therefore, a structural-facial-formational analysis of sedimentary and volcanogenic-sedimentary strata, based on the theory of formations, was used for the lithologic and stratigraphic division of the deeply metamorphosed pre-Mesozoic deposits of the Kyzylkum.

The doctrine of formations attracted special attention of geologists because traditionally associated with it the possibilities of tectonic analysis determine the prospects for the mineragenic study of their components. The most complete study of formations is presented in the works of N.S. Shatsky and N.P. Heraskov. By definition of N.S. Shatsky, sedimentary formations are called natural rock complexes, the separate formations of which (rocks, packs, retinues, sediments, etc.) are paragenetically connected with each other both in lateral directions and in a vertical stratigraphic sequence.

The main importance of the study of geological formations N.S. Shatsky and N.P. Heraskov saw in its use for solving issues of comparative tectonics and forecast of minerals, formational studies provide an opportunity to localize the zone of distribution of formations containing minerals, select their individual parts, characterized by the spread of ore and ore-bearing paragenerations of various types and, finally, select them mineragenically most promising blocks.

The genetic essence of geological formations is determined by several factors, the most important of which are tectonic processes and movements, expressed in relief and volcanism, in the thickness of layered formations, in their composition, structure, etc. Another important factor in the formation of various types of formations is climate, which is indirectly related to tectonics. The properties of formations are also determined by the time of their formation in conjunction with the general development of the earth‘s crust.

The discrepancy between the stratigraphic schemes of individual regions of the Kyzylkum region, which is a consequence of the division of a single geological region into a number of linear independent structures, is particularly pronounced in the age assessment of the metamorphic strata of the region. By a majority of researchers, they belong to the Precambrian formations (up to the Archean). According to these concepts, the volcanogenic-sedimentary formations of all stages of development of baikalid take part in the structure of the lower (metamorphic) structural floor (crystalline basement) of Kyzylkum. These include the spilite-diabase (granulite-amphibolite) formation of the early geosynclinal, siliceous-carbonate, carbonaceous-siliceous and terrigenous-siliceous late geosynclinal and terrigenous-shale orogenic developmental stages. At present, they are represented by quartzites, graphitic schists, marbled limestones and dolomites, carbonaceous mica-quartz schists, siliceous shales, amphibole-chlorite-epidote-albite-quartz schists, and amphibolites. The total capacity of the metamorphic complex of the Kyzylkum region, according to estimates by various researchers, varies from 2,500 to 4,000. This complex is characterized by two components that are dramatically different in the degree of metamorphism. The lower part is composed of metamorphic rocks predominantly in the amphibolite and epi-1 dot-amphibolite facies of regional metamorphism, while the upper part is composed of rocks metamorphosed in the high-temperature subformation of the green-slate facies. According to the aggregate data, the age of the lower part of the complex is Archei - Lower Proterozoic, and the top is Riphean-Vendian. The age of the lower part of the complex, established by the alpha-lead method for zircon, is estimated at 1.6 billion years.

The age of deposits of the upper part of the complex, according to B.Ya. Choreva, should be considered Precambrian. The basis for this is the deep metamorphism of rocks established as a result of research, the exceptional rarity and originality of organic remains (ozogiya, stromatolites) and lithologic and petrographic differences from the faunistically characterized strata of adjacent territories of the Cambrian, Ordovician and Silurian ages. The metamorphic complex of Precambrian deposits is divided into four geological formations.

Spilite-diabase formation was formed at the early stage of the geosynclinal development of the Baikal fold system. In terms of composition, these are metavolcanic rocks of basic composition, amphibolites, amphibole-chlorite-epidote-albite-quartz schists, biotite-plagioclase microgneisses with garnet, black quartzites. Characteristic features of the rocks: widely occurred shingling, fine corrugation, micro ploping, intensive silicification, the presence of a large number of drawing folds, budinazh. The physical-geographical and tectonic setting of the formation is the bed of the marginal seas in the rear of the young ensiatic island arcs. The formation is fragmented throughout the Kyzylkum region. The maximum thickness of the formation exceeds 1,000 m.

Carbonaceous-siliceous (black shale) formation is a lithological formation represented by dark gray to black fillytic schists, carbonaceous shales, black quartzites with lenses of dark bituminous carbonate rocks.

Flysch-like packs of dark gray to black interlayered sandstones and mudstones are noted. Formation in the region as a whole has the same set of sedimentary rocks, in which carbon-siliceous formations prevail. The total thickness of the formation is from 500 to 1,500 m.

Carbonate-siliceous formation with structural and stratigraphic disagreement lies on the spilite-diabase forms. The formation is developed throughout the region, but it has received the greatest distribution in the area of Bukantau and to the south of it. Formation deposits form separate elevations and small ridges (Karashokho, Kaskyrtau, Kokpatas Mountains, etc.) and are represented by carbonate-siliceous sediments. Lithological deposits consist of dark gray-banded quartzite and chert with interlayers and lenses of black bituminous dolomite, light violet, and pink yashmoid chert. The thickness of the formation varies from 600 to 1,200 m.

Siliceous-terrigenous formation lithological represented by dark gray oligomictic sandstones and siltstone, interbedded with seams chlorite and sericite phyllite-eminent shale containing flint lenses and calcareous and argillaceous interbedded sandstone, siltstone, shale greenish-gray and green colors. Silver-gray and gray quartz-mica and mica siliceous schists represent South of Bukantau, in the area of Auminza-Tamdy and Nurata elevations, the formation. Formation capacity is 900-1,000 m.

The metamorphic formations of the Precambrian age that make up the Kyzylkum base are superimposed formations that differ sharply from the previous ones by the degree of metamorphism and the composition of the sediments.

Formation of a wild flysch (ancient molasse) is variable in thickness (150–1500 m) and with a very vague boundary. Characterized by the presence of wide bands with friction, cleavage and milonitization, in places accompanied by iron refining, lightening and silicification. Most of the formation is composed of sandstones, aleurolites and shales, among which chaotically located lenticular blocks of siliceous rocks of black-shale and siliceous-terrigenous formations.

Flyschid formation with structural and stratigraphic disagreement lies on the sediments of the above formations. The lithological formation is represented: in the lower part, gray to dark gray with siliceous shales, interbedded argillites, aleurolites, and sandstones; the upper part is composed of gray, light gray mudstones, siltstones, sandstones, conglomerates, and siliceous rocks, tuffs of the main and middle compositions. The formation thickness is about 1,000 m.

Grauwackian formation (gray-colored) is composed of gray-colored sandstones, conglomerates, less often shale, cherts and lenses of limestone, which are facies of the shallow sea and near the coastal zone of beaches. Within the middle massif of the formation, it performs superposed bends and is part of the geosynclinal cover of the massif. Here its thickness reaches 300 m, and in the geosynclinal frame it is 1,000 m.

Volcanogenic-terrigenous formation goes down to the top of the flysch-like formation with its lower part. The predominant development of the formation was in the southern part of the region, (mountains Kuldzhuktau and south). Here it is represented by deposits of limestone, dolomite, sandstone, and shale, siliceous rocks of gravelites, conglomerates, as well as tuffs of andesite and liporite composition.

Volcanogenic andesite-dacite formation is allocated very conditionally and, basically, according to geophysical data (magnetic and gravity exploration). The main components of the formation are the derivatives of volcanic activity: tuffs, tuff sandstones, tuff-conglomerates (xenotufs), volcomictic sandstones, etc. Formation thickness from 300 to 1,000 m.

Carbonate-terrigenous formation directly lies on the above-described formation. Lithological is represented by dolomites, limestones, conglomerates, siliceous rocks, quartzitic sandstones, shale. The greatest thickness of the formation in the area of Kuldzhuktau Mountains is more than 2,000 m.

Carbonate formation is the most powerful formation in the region (up to 4,000 m). It erodes in a carbonate-terrigenous formation (basal conglomerates at the base), which indicates the transgressive nature of sedimentation. The formation is surprisingly lithologic: it is carbonate rocks in the form of limestone with rare interlayers of terrigenous rocks in areas of local disagreement, as well as terrigenous rocks accumulated in places of local basin regressions.

Formation – lower volcanic molasse. Typical representative of orogenic formations. Formed in the foothills near the volcanic ridges. The main types of it are basalt and diabase porphyrites, almond-shaped basalts, leucobasalts, trachybasalts, andesites, andesite-basalts, dacites, trachidacites, tuffs, flints, jasper, tuffs, flints, jasper, tuffs, flies, flints, jasper, tuffs, silts, jasper, sandstones; limestone. This sequence is fully consistent with the classical definition of the lower volcanic molasse. Formation capacity 1,000-1,500 m.

Formation – the upper red-colored molasse is represented by conglomerates, pebbles, with a large number of boulders, ravelites, sandstones, siltstones, and clays with subordinate limestone. Characterized by large cyclical, improper layering, oblique layering. Thickness - the first thousand meters.

Thus, 13 volcanogenic, volcanogenic-sedimentary and sedimentary formations were distinguished in the pre-Mesozoic sediments. The complex of metamorphic formations (four formations), which we attribute to the Precambrian stage of development of the region, is concentrated in its central part within the local uplifts and is a median residual massif.

2.2.3. Predictive metallogenic features

The patterns of development and occurrence of geological systems are mainly determined by the tectonic conditions of their formation, require the allocation of blocks and zones with a certain tectonic regime, characterizing not only the type but also the structure of geological formations, which is the basis of the predictive part of the metallogenic analysis.

Such systems are structural-metallogenic formation complexes with distinctly expressed prospects for the detection of elements characteristic of the ore province as a whole.

At the same time, the selection of the Central Kyzylkum middle massif predetermined the basic concept and methodology of the forecast-metallogenic analysis, which fundamentally differs from the methodology based on ideas about the linearity of structural-formational-metallogenic zones. As a result, seven characteristic ore elements are distinguished in the Central Kyzylkum region: uranium, gold, silver, tungsten, copper, tin, and polymetals.

Ultimately, this methodology includes an assessment of the prospects of the projected areas based on a comparison of their geological structure with known ore-bearing areas within the study area, or, if prospects of the ore area as a whole are assessed, based on their analogy with the more studied ore areas. Such metallogenic studies are performed in the following sequence:

a) based on the identification of features of the occurrences of mineralization and patterns of its location is determined by the type of ore area;

b) the main ore-controlling factors and their controlling influence on the placement of mineralization within the ore area of this type are determined;

c) the identified ore-controlling factors are ranked based on genetic, temporal and spatial relationships with them of certain occurrence of mineralization;

d) sedimentary geological formations are distinguished that are most favorable for placing mineralization in them according to their geological position (interrelation with magmatic formations, correlation with zones of deep faults, possibilities of syngenetic enrichment by these or other elements);

e) sedimentary and sedimentary-volcanogenic formations are studied from the standpoint of the analogy method in comparison with other areas to which known deposits are confined;

e) based on an assessment of the prospects of various parts of the ore region under study, metallogenic zoning is carried out;

g) a forecast map is drawn up with the designation of promising areas for further exploration.

Below is a forecast-metallogenic assessment of the distribution of the leading ore elements of the Kyzylkum region.

Gold. The most characteristic and industrially important ore objects identified and studied in the Central Kyzylkum, 22 gold deposits are explored in the region. Deposits are ambiguous both in terms of reserves and in industrial importance. Some of them have already been worked out, some are being intensively developed, and some are being prepared for operation. There are deposits that are currently not of industrial importance.

In addition to gold deposits in Kyzylkum, more than 150 occurrences and points of gold mineralization have been identified. Some of them are direct indicators of deposits on deeper horizons, some are indicators of industrial mineralization in a particular ore area, and some are indirect factors for conducting large-scale exploration (scale 1: 50,000 and larger) in promising areas. The typing of gold ore objects was based on well-studied deposits where three types of ores were identified: Muruntau (gold-quartz-low-sulphide), Kokpatas (gold-sulphide) and Altynsay-Karakutan (gold-quartz-vein). Alluvial gold objects are not included here, because known placers are located exclusively in the Meso-Cenozoic sediments.

The Muruntau type is currently represented by the Muruntau, Besapantau, Mutenbay, Eastern (Vostochnoye) deposits and the Sandy (Peschanoe) deposit, which was recently discovered in the Auminzo Mountains. The last deposit has been studied poorly and to a small depth, therefore in the process of further exploration its ore can be attributed to another type. The mineralization of the low-sulphide ore formation (Muruntau type) is confined mainly to the flueshevaya sand-shale **stratum** (Besapanskaya **suite**) of the rocks. A large number of alpine-type quartz veins characterizes the development of the latter and veinlets, as well as lenticular veins, formed due to host rocks and agree with their strike. At the same time, if previously only gold-bearing veins were considered gold bearing, then at the Muruntau deposit, the ore content of quartz veins does not depend on their orientation relative to the host rocks. The confinement of the Muruntau type of deposits to the sand-shale is not accidental and is explained as follows: sand-shale formations were geochemical concentrates of gold, evidenced by an increase in the total concentration of gold and tungsten in quartz veins by about 100 times compared with their clarks and only 10-20 times in relation to the content in host rocks. A.V. Firsov (1963) regards fleishevui „Muruntau thickness as an ancient buried placer.

Despite the fact that gold mineralization is concentrated in the contacts or superintrusive zones of the post-medium carbon instructions, many researchers considered the host sedimentary rocks as the source of ore elements. The most consistent conductors of the idea of syngenetic accumulation of gold of the Muruntau type in the form of ancient alluvial deposits and their subsequent hydrothermal processing were V.G. Garkovets and A.P. Mazurkevich, distinguishing this type of ore as a syngenetic-epigenetic ore formation (Table 2.4).

At the same time, the lithological factor was an important criterion for the detection of gold deposits of this type. Proponents of the primary accumulation of gold associate gold deposits of low-sulphide or syngenetic-epigenetic ore formation with a sandy-shale (flysch) non-Besapan suite, divided into a number of subvolumes: gray, green, variegated besapan. With the accumulation of geological data, a direct link between the Muruntau-type gold ore deposits and the variegated besapan deposits was noted, which many researchers consider to be deposits of "wild flysch", i.e. coarse clastic rocks. This formation is extended in the latitudinal direction (data from drilling and structural geophysics) and its distribution is limited solely by the median array. The formation of the ancient molasse is mapped in the form of narrow bands with a width of 2 to 7 km and a length of up to 80 km, which is associated with its formation in narrow intermountain depressions laid on the Baikal base of the middle massif.

There are seven such structures in the Precambrian basement of the Central Kyzylkum massif. All of them occur under Meso-Cenozoic sediments at a depth of 0 to 600 m, which determines the sequence of their search.

On this basis, for conducting gold prospecting and evaluation work, the areas of distribution of this formation are recommended under the Meso-Cenozoic cover with a capacity of up to 300 m. These recommendations were tested and justified in the Tulyantash site (30 km south of Uchkuduk) cover deposits in the metamorphism of the baths of the sand and shale strata revealed a promising ore occurrence.

The identity of this stratum with the formation of the ancient molasse is still conditional and is based on the data of core drilling performed in 1986-1987, as well as on the similarity of the gravity-magnetic deposits of the Tulantash trough with parts of the formations outcrops on the surface. The priority areas for prospecting at a scale of 1: 50,000 or larger are considered the development sites of the ancient molasse formation in the Auminzatau Mountains west of the High-Voltage silver ore and the Tulantash ore occurrence area.

Kokpatas type. The Kokpatas, Daugyztau, Sarybatyr, Asaukak, Amantay-tau deposits and numerous gold occurrences within these ore fields that have been explored and prepared for exploitation, represent the gold-sulphide ore formation.

In terms of reserves, the mineralization of the Kokpatass type is considerably inferior to the Muruntau type. This type of gold ore to the zones of deep or deep rift formations of the predominantly northwestern strike, with the exception of the Daugiz-Amantaytau area, controlled by faults of the meridional and northeastern strike. The largest of them to the zone of the deep fault, bounding the middle massif from the southwest and pronounced powerful (up to 6 km) zone of tectonic melange, covering the whole system of the Kuldzhuktau Mountains with the Tasskazgan polyelement deposit and several (about 13) gold occurrences, identified as granites and their exocontacts, as well as in the sediments of the lower volcanogenic molasses, which is quite widely developed in this area. To the north-west of the Kulzhuktau mountains, tectonic melange along a bounding deep fault (according to structural geophysics data) is extended over a distance of more than 120 km with an average thickness of 4-5 km. By the nature of the deposits of gravity and magnetic prospecting, the filling of this zone with the hercinid orogenic formations, in particular, the lower volcanogenic molasse, is clearly visible. The Kokpatas zone, which includes the Kokpatas ore field and the Turbai deposit, has been allocated to the category of promising areas in search of gold-sulphide ores. Ore bodies of the Kokpatas ore field are exposed to volcanogenic rocks, which, in our opinion, correspond to the lower volcanogenic formation.

The structural factor for this type of mineralization serves as the main ore-controlling factor, and the structure of the first order for the Kokpatas type of mineralization is the Central Kyzylkum middle massif. To date, no occurrence of this type of gold has been identified beyond its limits. The prospective Kokpatas area, which occupies the Middle Eastern part of the Bukantau mountains, has a large annular structure to the west of the Kokpatas ore field toward the North-Bukantau deep-seated fault.

Table 2.4

Typomorphic characteristics of gold ore formations of the Central Kyzylkum region

Typomorphic characteristics	**Muruntau type. Gold Sulfide Formation**	**Kokpatas type. Gold Sulphide Formation**	**Altyntau-Karakutan type. Gold-quartz-vein formation**
Key factors controlling mineralization	Lithologic only within the median massif	Structural lithology only within the middle massif	Structural - main, lithologic-guestratigraphic-indirect
Stratigraphic level of localization	Upper Proterozoic-Lower Paleozoic	Upper Paleozoic. Hercynian Orgenesis	Hercynian orogenesis. Post construction stage
Morphostructural type of localization	Irregularly shaped trestle lens	Streaky-disseminated, vein	Stinger-veined
Productive mineral geochemical paragenesis	Quartz-rare metal gold	Gold-pyrite-arsenopyrite	Gold polysulfide
Indicator elements:			
a) productive paragenesis	gold, bismuth, tungsten	gold, arsenic, silver	gold, silver, copper, lead
b) above the ore level	arsenic, silver, lead,	silver, antimony, mercury, copper	
c) under the ore level	molybdenum, cobalt	tungsten, molybdenum, cobalt	tungsten, tin, arsenic
Fineness of gold	850-900	700-900	500-600
Geological mining features			
a) raw ores with Au	2-5 cu	2-17 cu	50-200 cu
b) rich ores	Not characteristic	Not characteristic	>200 cu
Secondary elements	Tungsten, molybdenum, tin, tellurium	Silver, arsenic	Silver
Examples of deposits	Muruntau, Myutenbay, East (Vostochny), Sandy (Peschany)	Kokpatas, Daugystau, Sarybatyr, Amantaytau, Asaukak	Aytym, Altynsay, Karakutan, Kapkaly, Beshkuduk, Zarmitan

A large prospective area in search of the described type of ore is also a narrowly extended trough to the northeast of the Muruntau ore field, dissected along the axis by a system of faults, which may be the seams of the deep fault. Mainly volcanogenic rocks of the lower molasse formation make the deflection.

Prospects for the area highlighted on the map, which includes the Daugystau and Amantaytau ore fields, may already be exhausted, although it is possible that prospecting works of a scale of at least 1: 10,000 and larger may reveal new objects of this type of ore here.

As a promising area, the area along the northern slope of the Nuratau Mountains, sandwiched between the southeastern seams of the deep North Bukantau Fault, is also highlighted. Evidence of the prospect of this area for the identification of gold-sulphide mineralization, in addition to the structural and lithological factor (the presence of zones of deep faults, made by the lower-mass formation, is the presence here in the talus gold deposits (Kataich, etc.).

The foregoing leads us to conclude that the spatial Kokpatas type of mineralization is associated with the middle mass of the Central Kyzylkum, namely the structures of the Hercynian orogenesis: long-lived deep faults and narrow grabensynclines along these zones made mainly of orogenic low-mass formation. Characteristic features of the gold-sulfide formation of the Kokpatas type are given in table 2.4.

Altyntau-Karakutan type. The gold-quartz-vein ore formation is represented by ores from the deposits of Karakutan and Altynsay, Aitym, Kapkakly, Beshkuduk, Tilla-Tag, Zarmitan and others. The surrounding medium of this type of occurrence is usually heavily silicified sand-shale deposits of the Lower Paleozoic. Such confinement of quartz-vein occurrences of gold is explained by the fact that intensely silicified host rocks, especially in the zones of deep faults, were the most fragile and during the period of intense orogenic processes, represented the most fractured medium favorable for the penetration of post-magmatic solutions that formed quartz-gold ores and streaks.

The occurrences of this type were revealed directly in granites (mountains of Northern Nurata, Kuldzhuktau). The main factor controlling the placement of gold-bearing quartz veins is structural: the inter-fault zones of intensive crushing and fracturing, tectonic melange zones of deep faults, and the direction of disjunctive disturbances, apparently, does not matter. In Central Kyzylkum, seven re-areas were identified for the search for this type of ore: latitudinal (Ayminza mountain), northwestern, rolling over into latitudinal (Kuldzhuktau, Ziatdin-Zirabulak mountains), northeastern (Aristantau mountain), northwestern (South Nurata, Karatau ridge), latitudinal (North. Nurata) and meridional (central part of Bukantau mountain) directions. At present, from 5 to 10 occurrences of gold mineralization associated with quartz veins and veins have been identified in each promising area.

Quartz-vein gold mineralization is confined to a system of steeply dipping intersecting quartz veins and silicification zones of ore-bearing sand-shale rocks and granodiorite and lamprophyre dikes associated with quartz veins. Elevated concentrations of gold within the ore-bearing zones are often associated with highly fractured limonitized rocks. Near quartz veins, sand and shale rocks are sometimes silicified ricitized, chloritized and pyritized.

Gold-quartz veins contain sulfide mineralization, mainly of pyrite, the content of which ranges from 0.5 to 5%. Gold has a high silver content and is close to electrum.

Quartz, as a rule, of two varieties: milky white and dark gray. Both are gold bearing, but the first is the most enriched in gold.

As prospecting signs of gold ore bodies of this type, quartz veins, quartz, quartz-shale breccias with occurrence of sulphide mineralization can be used; zones of hydrothermally altered rocks, accompanied by silicification and limonitization; arsenic present in the rocks (direct search tags). Zones of late tourmaline can be very favorable for the detection of gold mineralization; quartz-tourmaline breccia; areas of strongly stationed and intensively crushed rocks; rupture faults of the latitudinal, northeastern, northwestern, and to a lesser extent meridional direction; places of conjugation of major faults with small fledging cracks; plots of lamprophyre dykes (indirect search indications).

Characteristic features of the quartz-vein gold ore formation are reflected in table 2.4.

The deposits of this ore formation are distinguished by relatively high gold content and modest reserves of metal. In the overall balance of gold reserves of the Central Kyzylkum, they play a secondary role.

Uranium. In the Central Kyzylkum uranium ore province, in the rocks of the crystalline basement, to date, about eight deposits and more than 50 occurrences of uranium have been identified. All of them are confined to a black-shale formation of late Riphean age, represented by carbon-siliceous siltstone, dark gray sandstones and carbonaceous shale. The only deposit prepared for commercial operation by heap leaching is the Altyntau ore field, whose ores also contain vanadium (0.8-1.0%) and scandium (0.0012). Its reserves have been approved, the project for mining has been completed, but the deposit has been conserved.

It should be noted that uranium in the Central Kyzylkum region is the leading ore element, and its predictive evaluation in the rocks of the crystalline basement is one of the main tasks in the compilation of the forecast metallogenic map.

An analysis of the distribution of uranium mineralization in the global structures of the earth‘s crust elements shows that a large group of uranium deposits within the Phanerozoic folded belts is formed during the Late Paleozoic stage of their development. When! In this case, uranium deposits are located both in the geosyncline of the naskladchaty and in the extra-geophilic mobile zones. Firstly, the median massifs are the most uranium bearing, and secondly, the arch elevations and horst structures formed in the process of activating the ancient platforms.

A special place among the uranium-bearing tectonic structures in the Phanerozoic geosynclinal-folded belts is occupied by the median massifs, which in some cases are “fragments” of ancient platforms (the Kyzylkum massif), and in other areas of earlier consolidation (the French, Czech, North Kazakhstan-central arrays). These structures and their framing are usually saturated with complexes of acidic igneous rocks with which the hydrothermal deposits of the uranium are associated. Exogenous uranium deposits are often formed in the platform cover of the median massifs.

According to the classification of N.P. Laverov occurrences of uranium in the sediments of the basement of the Central Kyzylkum are distinguished into a series of polygon deposits, formed mainly in the oxidation process (surface and groundwater) of primary uranium concentrations of different origin.

In the Hercynian folded region of Western Europe, inside and framed by the Iberian, French and Czech median massifs, this type of uranium occurrences is widely developed. The foundation of the Central Kyzylkum middle massif of 70% is covered by the Meso-Cenozoic deposits of the platform cover, in which, in fact, all the sedimentary deposits of uranium of this region are concentrated. Endogenous and polygenic deposits of uranium in the Proterozoic-Paleozoic sediments were found only in elevated blocks, where these deposits reach the surface. The ore-containing medium of these occurrences is a carbon-siliceous (black shale) formation. Late, apparently, was the medium of syngenetic accumulation of scattered uranium in the lagoon-coastal facies. This formation is always enriched in uranium by 1-2 orders of magnitude higher than the background Clarke concentrations. The revealed occurrences of uranium in the basement sediments have an exit (all without exception) on the day surface and, as a rule, are located in the zones of greatest tectonic activity.

The Czech Median Massif (Ore Mountains) is the most similar to the Central Kyzylkum Median Massif. Its search and knowledge is much higher than that of the Kyzylkum massif. Both are framed by the Variscian folded system, and metamorphized Precambrian strata represent the foundation of the arrays.

In the Central Kyzylkum middle massif, uranium-enriched sedimentary rocks are found at several stratigraphic levels. Its high content is typical for the Late Riphean and especially Early Paleozoic carbonaceous black shale, in which, besides uranium, there are high concentrations of vanadium, phosphorus, molybdenum, selenium, copper, zinc, lead.

Granites and acid volcanics of the Hercynian folded cycle are distinguished by a distinct radio-geochemical specialization, and among them are formed at the orogenic stage of development. Along with elevated and abnormally high contents of uranium (up to 20×10^{-4}%) and thorium (up to 70×10^{-4} %), potassium leucocratic granites and liparites are present in significant amounts: tin, tungsten, molybdenum, beryllium, lithium, rubidium, cesium, boron and fluorine. Granites are the most enriched in uranium in ore-bearing geo anticlinal blocks, which cause large faults.

On polygenic uranium deposits in black shales of Kyzylkum established repeated re-deposition of uranium minerals. Here relics of early metasomatites of hydrothermal uranium ores are noted. The processes of redeposition of ores and their enrichment in the cementation zone coincided in time with the formation of stratiform exogenous deposits at a depth from the first tens to the first hundreds of meters from the surface.

In uranium deposits in black shales, occurring in poorly metamorphosed, but intensely disturbed and permeable rocks, post-ore processes penetrated to a great depth. Linear oxidation zones developed to a depth of 200 m. The secondary enrichment zones are located below the oxidation zones. When imposing new concentrations of uranium minerals on | primary uranium ores and sulphides form polygenic ore bodies. At the deposits, occurring in the structures covered with the cover, the hypergene processes are weak or not occurred at all.

From all the above, it follows that the uranium provinces of the Late Paleozoic indentation in large geosynclinal-folded massifs and their framing are “fragments” of Precitbrian cricons granitized earlier, whose rocks are enriched in scattered radioactive elements. Late Paleozoic provinces are characterized by the development of polychronic uranium mineralization.

When forecasting new uranium ore regions in the geosyncline-folding belts of the Late Paleozoic consolidation, a set of favorable criteria should be taken into account. The leading place I among them belongs to the confinement of the known uranium-bearing territories to the median massifs. The zones of deep faults and the nodes of their intersections, as well as the presence of granite-gneiss domes, are of particular ore controlling value.

According to these criteria, three promising areas in Bukantau are distinguished within the Central Kyzylkum middle massif; one is in the western part of Tamdytau and one is the latitudinal-oriented zone in Auminzo and Aristantau elevations. All of these areas, in addition to the structural factor, are located in the outlines of the carbon-siliceous formation.

Silver is widespread in Kyzylkum and is mainly a concomitant component in deposits of polymetals, tungsten, tin, and mainly gold.

Currently, three silver deposits (Okzhetpes, “Vysokovoltnoye”, Kosmanachi) and more than 15 ore occurrences have been discovered in Central Kyzylkum. In all these occurrences, the presence of gold mineralization is noted. The “Vysokovoltnoe” deposit is under development since 2005.

On the presented forecast-metallogenic map, the promising areas for silver-containing ores are not highlighted, since they completely coincide with the areas that are promising for gold.

Silver-containing ores are localized mainly in the rocks of the variegated besapana (the formation of the ancient molasse), and the large capacities of the ore bodies are characteristic of the variegated besapana with other formations (the Kosmanachi deposit).

The Daugiz-Tamdytau region in the central part of the middle massif and the area of the Turbay ore cluster in the central part of the Bukantau Mountains are the most prospective for the discovery of silver deposits.

Polymetallic deposits of the Uch-Kulach ore field are also promising for silver, with the carbonate-volcanogenic rocks of the middle-upper Devonian ore-hosting medium.

Outside the Central Kyzylkum region, silver deposits in the Aktepe ore field in the northeast of the Kurama Mountains have been discovered. The deposits are associated with the intrusion of gabbro and gabbro-diorites.

This type of ore is not yet known in the Central Kyzylkum region, yet the presence of a large number of intrusions of the main composition, identified under the Mesozoic Cenozoic cover of positive gravity deposits, suggests in the future the identification of this type of silver ores within the Central Kyzylkum massif.

Copper. Currently, in the Kyzylkum region, prospecting and exploration for copper is not carried out due to the prevailing opinion that the area is not prospective for the detection of industrial copper ore facilities. Exploration work carried out in the 1960-1970s revealed two non-industrial copper-polysulfide deposits: Karamurun (north-west Bukantau) and Koktau-

Central (south-west Tamdytau), as well as more than forty ore occurrences concentrated in the north of Bukantau (east of the Karamurun deposit) in the central part of the middle massif, where they form a transverse metallogenic zone of the northeast strike, including the Central Koktau deposit. In the extreme southeastern part of the middle massif on the northern slopes of the Nurata ridge, a group of copper ore occurrences has been identified.

All occurrences of copper in the median massif are associated with quartz-sulfide veins, where the ore mineral is chalcopyrite.

Two ore occurrences of the copper-nickel type were found at the Taskazgan graphite deposit in the north-west of the Kuldzhuktau Mountains. Ore occurrences are confined to small gabbroid intrusive bodies. Their prospects are not fully understood.

In our opinion, the northern and northwestern parts of Bukantau with numerous copper ore occurrences and the Karamurun deposit are the most prospective to identify the commercial copper ores. By themselves, these occurrences of copper are not of practical interest, but may be indicators of large concentrations of copper ore at depth. This idea is suggested by the presence of two intensive gravitational anomalies along the deep ring fault.

To determine the nature of these anomalies, you need to know their source and depth of its occurrence. The discovery of a large copper-nickel deposit is not excluded here.

Based on the foregoing, the prospects for discovery within the Central Kyzylkum median array of copper ore deposits, in our opinion, are quite high.

Tungsten. It should be noted that Western Uzbekistan is still the only region of Uzbekistan where industrial deposits and associated tungsten ore occurrences are concentrated. In total, there are five deposits and more than forty occurrences. Currently, only the Ingichka deposit in the Zirabulak Mountains is being developed, the rest are either already developed (Lyangar), or are being prepared for exploitation (the Sarytau and Sautbay fields in the Bukantau Mountains).

The tungsten ore objects of the Kyzylkum region correspond to three genetic (volcanogenic-sedimentary-metamorphogenic, magmatic, hydrothermal) and eleven ore-formation types. The main part of the tungsten deposits is more or less clearly associated with Hercynian granitic magmatism. The exception is the quartz-carbon-shale and argillized types, for which this relationship has not yet been identified.

The industrial and genetic classification of mineralization serves as the basis for determining not only the ore-formational affiliation of an object, but also for the expected scale, ore quality and leading morph types of ore bodies, taking into account the relationship of objects with a complex of diverse geological conditions, i.e. to give access to the forecast of tungsten mineralization.

The quartz-carbon-shale rare-metal ore-formation type is represented by the Kaskyrtau ore occurrence, which is confined to a carbonate-siliceous formation. Tungsten mineralization is located in seams or tectonic scales of modified tuffaceous rocks among siliceous shales. For ore occurrence, two types of ores with a different set of impurity elements are distinguished: limonite, hydroxide-tungsten (vanadium, molybdenum, copper) and carbonate-barium-scheelite (silver, antimony, arsenic), which develops mainly from the converted lenses of carbonate rocks of siliceous thickness. Industrial value is not yet clear. With a large extent and thickness of tungsten-containing bodies, the concentration of tungsten trioxide as a whole does not exceed 0.1%. The forms of finding tungsten and ore control factors have not been clarified sufficiently. This ore-formational type has a great future, since with relatively low tungsten contents the deposits can have significant scales and reserves.

The formation of copper-bearing skarns is spatially and genetically related to the ranges of early orogenic soda granitoids.

Tungsten is the main ore element of these skarns, but its concentration is insignificant and today has no industrial value.

The industrial and genetic type of tungsten-bearing skarns includes three ore-formational types: calc-skarn, skarnoid, and magnesian-skarn.

The first ore-formational type is represented by deposits of Koytash, Lyangar, Yakhton, Ingichka. Ore bodies are localized by the contact of granitoid massifs with limestone, less often in intensely fractured dolomite limestones of exocontact.

The main and secondary elements in skarns can be molybdenum, copper, gold, tin and bismuth, except tungsten.

The vertical scale of mineralization is more than 1,300 m.

The skarnoid ore-formation type usually accompanies limestone-skarn. Differs from it lithologic-structural characteristics, morphology and material composition. Interlayer bodies of this type are confined to carbonate-containing terrigenous and volcanic-terrigenous formations in exocontacts of granitoid massifs at a distance of 200-250 m from the contact. Industrial ore bodies of this type are installed at a distance of up to 150 m from the contact, if the carbonate-containing horizons cross the ore-controlling faults (deposits Yakhton, Ingichka). The most productive skarnoids are formed near the granitoids (10-15 m), where, merging with the contact bodies of the skarns, they form powerful combined bodies of complex morphology (Koytash, Lyangar).

Magnesian-skarn ore-formational type is relatively new for Western Uzbekistan. Currently it is one of the most promising industrial types of tungsten mineralization.

Scheelite-containig magnesian-skarn objects are localized in dolomite rocks in the exocontacts of intrusions of almost all granitoid complexes, as well as within the granite-gneiss domes.

Dolomites, productive for the formation of magnesian skarns, are part of the carbonate and carbonate-volcanogenic formations of the Hercynian geosynclinal stage, and are noted in the form of lenses and layers in the carbonate-siliceous formation of the Precambrian formation complex. The clear stratigraphic (formational) confinement of dolomites largely determines the stratified layer morphology of magnesian-skarn objects. At the same time, the fragility of these rocks leads to the formation of a wide network of small fractures, which, with a high chemical activity of penetrating post-magmatic solutions, contributes to the formation of stockwork. As a result, the stock-type type of mineralization occurs: the birth of the Yachton-areal, linear Tym-Kalta and inter-formational bodies with full replacement of the dolomite horizons with skarns (Fazilmon, Cholcharatau).

In practice, the tungsten ore objects are polyformational. Tungsten-containing greisens are widely developed on typical skarn deposits (Ingichke, Yachton, Koytash), and skarns (Sarytau, Sautbay, Cholcharatau) are well developed on the stockwork ones. The most striking example of combining several types of mineralization is the Sarytau deposit, where fluorite-mica greisenes are superimposed on the feldspar-pyroxene-skarn and quartz-Kalishpat-gumbiite formations; this significantly increases the concentration of tungsten in the ores. Such deposits in world practice are of great industrial importance.

In the forecast-metallogenic forecast in the Kyzylkum region, in addition to the well-known ore sites of Turbay (South Bukantau) and Zirabulak (Ziatdin-Zirabulak Mountains), seven new perspective areas are identified for the search for tungsten ores. Four of them are located east of the Muruntau gold field. They form a meridional elongated metallogenic zone, possibly associated with a hidden deep fault of the meridional strike. Each area is associated with an array of granitoids, breaking through rocks of carbonate-siliceous, siliceous-terrigenous formations of the metamorphic complex of the Precambrian age. These formations include interlayers and lenses of carbonate rocks favorable for the formation of skarnoids.

Three more prospective areas were identified in the southeast corner of the middle massif, where they form a transverse northeast metallogenic zone, also associated with a complex of granitoid intrusions of the Hercynian orogenic stage, piercing the formations of the Precambrian basement. In addition, the two extreme areas of the deep fault zones, limiting the middle massif from the south and north-west.

Tin. The tin-ore occurrences of Kyzylkum are located in the geosynclinal structures of the framing of the Central Kyzylkum middle massif (Ziatdin-Zirabulak mountains). Here, five non-industrial deposits have been identified: Karmana, Karnab, Semizkuduk, Lapas, Changali, and several ore occurrences. They are located both directly in intrusions and in their exocontacts in carbonate-terrigenous strata.

Polymetals. **Lead**, **Zinc**. In the Kyzylkum region, four deposits represent polymetals: Central, Far, West and South, united in one Uch-Kulach ore field. In terms of reserves, this is a large polymetallic object, which is currently being mined. The ore field is located in the southeastern corner of the middle massif in the junction zone of the northeastern and northwestern strike limiting its deep faults.

The ores of the Uch-Kulach group of deposits belong to the barite-pyrite-galena-sphalerite formation and are localized in the volcanogenic-carbonate-terrigenous rocks of the Devonian. This lithological complex at the base of the section is represented by interbedded limestones, dolomites, often with admixture of pyroclastic material, tuffs, tuffites, sandstones, siltstones, mudstones in the middle part, essentially carbonate rocks (organogenic limestones, dolomites) at the top.

The volcanogenic-sedimentary concept is most fully justified by P.V. Pankratyev and Yu.V. Mikhailov. In their opinion, the ore formation at the deposits of the Uch-Kulach ore field occurred in two stages. The first hydrothermal-sedimentary, including hydrothermal introduction, sedimentary deposition of substances, diagenesis and hydrothermal-metasomatic formation of ores combined in them in root systems. This long process - from living to frans - took place against the backdrop of a damped volcanic activity. The second, metamorphic stage, associated with the general folding of the region and subsequent tectonic processes, led to a profound transformation of ores (recrystallization of minerals, changes in the primary composition and partial redistribution of the substance with the formation of new sulfide concentrations) in the zones of intersecting faults.

Despite the distinct stratification of mineralization and synchronicity of ore deposition with sedimentation, from the position of purely sedimentary genesis it is difficult to explain such facts as the alternation in the section of homogeneous carbonate strata of oxide goethite-hematite and sulfide mineralization.

According to Shatsky (1955), Naboko (1959), Strakhov (1966), and others, the source of the ore substance in the sea basin was a magma chamber that generated ore-forming solutions from the final phases of active volcanism to the latent non-effusive. The occurrence of the latter is evidenced by the presence of layers of siliceous and silicified rocks in clay-carbonate sediments.

The close connection of ore formation processes with volcanic activity is indicated by the occurrence of deposits to the zone of development of acidic volcanic formations, the alternation of polymetallic ores and volcanogenic-sedimentary rocks in the section, the decrease in the intensity of mineralization as the volume of terrigenous impurity in ore-bearing sections decreases, the presence of pyroclastic admixture ore-bearing cuts, the presence of hydrothermal change zones in the under-cave volcanogenic rocks, tracer one hundred penetration of ore-bearing solutions in the marine basin. At the same time, there is a lag in the time of ore sedimentation processes from the maximum activity of volcanism. Such a separation of the processes of mineralization from the maximum of volcanic activity in time indicates that polymetals are apparently associated with deep-lying magmatic foci, the thermal field of which served as a powerful ore-forming factor even after the cessation of volcanism. This suggests that the ore components could be introduced into the sedimentation basin by hydrotherms, somehow connected with volcanic foci (Pankratiev, Mikhailova, 1981).

A detailed study and development of the Uch-Kulach ore region yielded new data on the geotectonic position, ore zonality, conditions for the formation of mineralization, the specifics of the geological conditions of ore deposits and other features of this object, which is a kind of „uchkulach" type among stratiform lead-zinc deposits. The obtained data allowed us to reveal additional criteria for forecasting and searching for stratiform polymetallic ores. As a result, an area on the southeastern margin of the median massif was identified as promising, which included the Uch-Kulach ore field, as well as the area in the eastern part of the median massif between the deep faults of the northwestern direction.

Thus, the selection of the median massif predetermined the metallogenic zoning of the Central Kyzylkum. As a result of the differentiated metallogenic analysis of Precambrian metamorphic and geosynclinal formations, as well as formations of the syngosynclinal cover of the massif and molasse formations of the epigeosynclinal cover of the massif, they are justified: their predictive metallogenic significance for gold, uranium, silver, copper, tungsten, tin and polymetals. The polygenicity of the processes of gold and uranium-rare metal mineralization has been established. Perspective areas were identified for the elements under consideration for more targeted production of prospecting and evaluation work.

The results of these studies represent an alternative point of view on the geological, structural, and forecast-metallogenic specialization of the Central Kyzylkum.

2.2.4. The state of study of complex Uranium-rare metal Kyzylkum ores

By the end of the thirties, first in Europe, and then in the USA, interest in the structure of the atomic nucleus and the possibilities of its transformation increased sharply. As a result, uranium acquired the value of strategic raw materials, and Central Kyzylkum became one of the first regions where its mining was organized on the basis of the Uchkuduk deposit, discovered in 1952. This discovery was the beginning of a new direction in the study of the uranium-bearing capacity not only of the territory of Uzbekistan, but also of the adjacent regions.

During exploration of the Uchkuduk deposit, it was found that uranium mineralization is confined to permeable aquifers and almost always to the boundary of the reservoir oxidation zone represented by yellow (oxidized) and gray (not oxidized) rocks, which is its specific feature. The ore controlling value of the redox border was so effective that its tracking was the basis for prospecting and exploration.

In 1956, the Ketmenchi deposit was discovered in the south of the Central Kyzylkum also confined to the pinching out of zones of reservoir oxidation of aquifers and Uchkuduk ceased to be the only object with specific features of mineralization.

Radiohydrochemical studies at the Uchkuduk field have shown that near the closure of the zone of reservoir oxidation there is a sharp decrease in the electrochemical potential of groundwater, accompanied by a rapid decrease in the content of uranium dissolved in them. The high (up to $n * 10^{-4}$ %) uranium content in the waters of the aquifer feeding area and its exact ($n * 10^{-6}$ %) amount in the stratum waters outside the mineralization made it possible to conclude that The formation water filtration process not only oxidizes permeable rocks with a concentration of new portions of useful components on the geochemical barrier, but also promotes the oxidation zone with mineralization moving along the aquifer. As a result, a specific feature of the formation of ore deposits has become a reasonable pattern of localization of deposits. A new genetic concept has emerged, and uranium deposits located on the line of pinching out of reservoir oxidation zones (ROZ) have become known as Uchkuduk deposits.

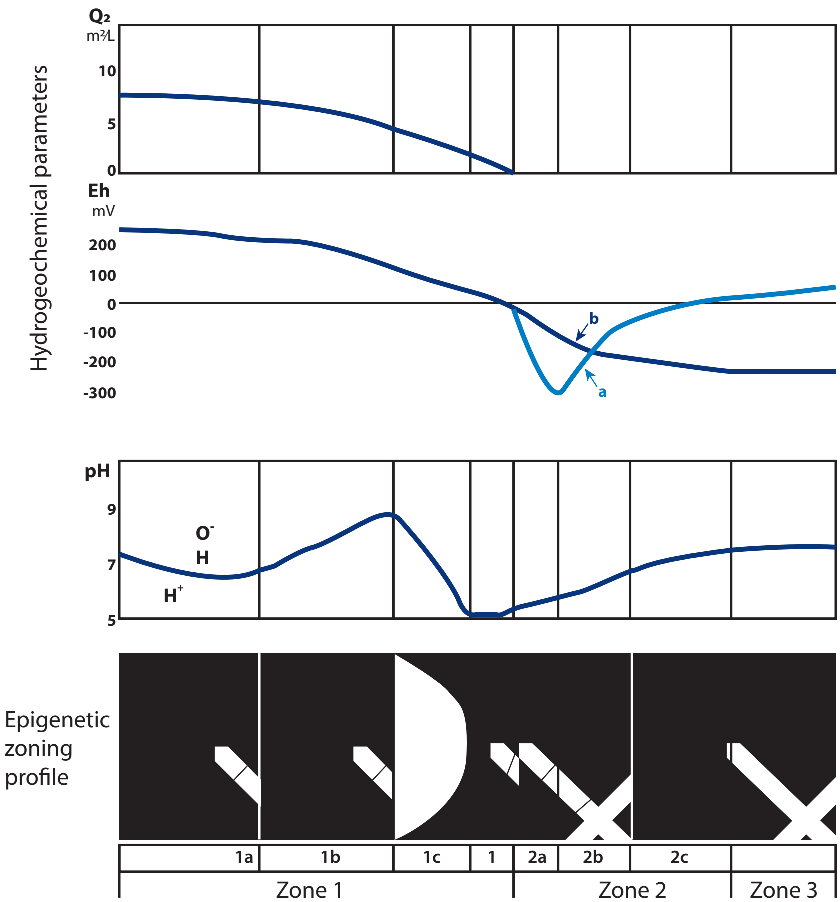

Fig. 2.14. Schematic diagram of the ore-controlling reservoir oxidative–epigenetic zoning with generalized graphs of the change in Eh and pH of the lithohydrogeochemical environment:
Zone 1 – zone of formation oxidation; Zone 2 – zone of uranium mineralization; Zone 3 – the zone of non-oxidized barren rocks

Based on the revealed patterns of the connection of mineralization with zones of reservoir oxidation, large deposits of uranium were discovered in the Kyzylkum region in a short time (Bukinai in 1959, Sabyrsay in 1960, South Bukinai, Sugraly, and Lyavkan in 1961, etc.). The accumulated material was enough to create a theory of exogenous layer-epigenetic (layer-infiltration) ore formation, the main provisions of which are reduced to the following.

Deposits of uranium ore and related elements in the fields of the Uchkuduk type are formed from reservoir oxygen-containing waters in aquifers, represented by gray-colored permeable rocks of sedimentary origin.

Such deposits have a characteristic zonal structure (Fig. 2.14), and the selection of zones is based on the behavior of iron, which is part of the rocks and causes a change in their color during the geochemical transformations, and uranium, the amount of which is easily determined by the change in the radioactivity of the rocks.

A prerequisite for the process of ore formation is the presence of iron sulfides and carbonates in the rocks of the aquifers.

The uranium mineralization zone is characterized by a gradual decrease in the uranium content from the border with oxidized rocks in the direction of the movement of formation waters. At the same time, in the subzone of rich ore, the rocks acquire a dark gray color due to the deposition of tetravalent uranium oxides in them. In the subzone of low-grade ore, the rocks practically do not differ in color from the non-oxidized part of the formation and are characterized by some enrichment of tetravalent uranium with minerals. The subzone of the aureole includes gray-colored unaltered rocks, the content of uranium in which slightly exceeds its background concentration in the initial layer.

The width of the selected zones of ore deposits varies considerably depending on the characteristics of the lithological composition of the aquifer and the intensity of the formation-oxidation process.

The redox potential (Eh) of the reservoir water regularly decreases as the free oxygen content decreases from the full oxidation subzone (Eh = + 600/400 mV) to the partial oxidation subzone (Eh = + 100/0 mV). The further nature of the change in the redox potential depends on the mineralogical and geochemical features of the non-oxidized rocks.

For example, in an anaerobic microbiologically active medium (rocks with carbonaceous organic matter with a low degree of carbonation in the presence of sulphate-reducing, hydrogen- and methane-generating microflora), the "failure" of the electrochemical potential is observed up to values of Eh = -100 / -300 mV (graph a) in Fig. 2.21), and then its increase to values of Eh = -50 / + 100 mV. If there are epigenetic reducing agents in the rocks (iron and other metals disulfides, hydrogen sulfide and hydrogen from tectonic faults), the electrochemical potential gradually decreases, reaching the lowest negative values far from the zone of layer oxidation (graph “b” in Fig. 2.14).

The nature of the change in the alkaline-acid index of the pH-medium during the course of the layer-oxidative transformations of the rocks of aquifers is more complex than the nature of the change in the electrochemical potential Eh.

The oxygen-containing water entering the aquifers has a pH of 7.0 / 8.0. It has been established that in the inner part of the oxidized rock zone, the alkalinity of water rises to pH = 8.5 and decreases in the advanced parts of the formation oxidation zone to pH = 7.0 / 6.0 and gradually increases to pH = 7.0 / 8.0. as the distance from the reservoir oxidation. The reason for these changes is that the oxidation reaction of iron sulfides (pyrite, marcasite and siderite) and organic matter occurs with the release of H + ions, which can lead to acidification of the medium.

This effect has been studied quite well at sulphide mineral deposits, where due to the generation of sulfuric acid, acidic pH of groundwater may drop to ~ 2.0 or less. It is also known that minerals containing primarily calcium and magnesium carbonates hinder the acidification of the environment, which explains the increase in pH with distance from the boundary of the reservoir oxidation zone. Therefore, carbonates play the role of a hydrogeochemical buffer in the way of reducing the pH environment, and when] the presence of oxidizing agents (in particular, sulfuric acid), the carbonate equilibrium shifts towards the predominance of CO_2 in the formation waters.

The severity of the acid geochemical barrier is determined by the ratio in the rocks of the aquifer of the amounts of potential acidifiers (iron sulfides, organic matter, etc.) and neutralizers (alkaline minerals) of the medium, as well as the carbonate content of the formation waters and the initial value of their pH.

Thus, because of exogenous-epigenetic processes in permeable rocks of the sedimentary cover of the Kyzylkum province, a reducing geochemical barrier appears on the border of reservoir oxidation zones, consisting of an alkaline (neutralization) and adjacent acid areas in the rear part, which causes the formation of Uchkuduk type deposits.

In addition to the main useful component (uranium), Uchkuduk deposits contain selenium, rhenium, molybdenum, vanadium, scandium, yttrium and lanthanides in various concentrations. In the mountain massif, they usually form a system of compact, nested roll-front or paleoplacer ore bodies nested in each other. In this case, polyvalent elements (U, Mo, Se, Re, V) are localized on the reduction and monovalent elements (Sc, Y, lanthanides) - on the neutralization geochemical barriers.

Uranium migrates in the oxygen produced water mainly in the form of uranyl carbonate anions $UO_2\ (CO_3)^{2-}$ and $UO_2\ (CO_3)_3^{4-}$ with a gross concentration of carbon dioxide ≈10-2.5 mole/kg of water. The first of these anions prevails at pH = 6.0 – 8.2, the second - pH > 8.2. Such waters, possessing a high positive redox potential, actively leach uranium from any rocks on the way of filtration of oxygen reservoir solutions.

Selenium is a constant and regular satellite of uranium in the reservoir-oxidation process in almost all deposits of this type. The Se zone of epigenetic accumulation is shifted relative to the uranium accumulation zone towards limonitized rocks, encompassing the advanced part of the layer-oxidized zone (mainly the suboxidation of partial oxidation and wound removal) and sometimes the rear part of the uranium mineralization zone. In his case, its content reaches hundredths and first tenths of a % with a Clarke of Se in sandy rocks of 0.05 cu. Thus, the selenium roll is usually enclosed in uranium.

Molybdenum in the Kyzylkum region (Sugraly, etc.) deposits is deposited in the presence of epigenetic reducing agents, and its accumulation area is shifted to the advanced part of the reservoir, covering the subzone of poor uranium ores, halo and part of the zone of unoxidized rocks. Characterized by molybdenum mineralization to rocks, almost devoid of carbonate substance. The process of reducing the precipitation of molybdenum, which migrates in the oxygen-produced water in the form of molybdate ion MoO_4^{2-}, takes place in an acidic and neutral environment.

Rhenium concentrates on many deposits of the Uchkuduk type, being localized in the form of roll-front or reservoir bodies, generally coinciding with uranium deposits, but with the domination of epigenetic reductants somewhat displaced in the forward part of the reservoir profile. In this case, rhenium occupies an intermediate position between uranium and molybdenum. Rhenium mineralization often has more thickness than uranium.

A universal form of rhenium migration in oxygenated groundwater is perrhenate-rhenium ion ReO_4^-.

Vanadium. Exogenous-epigenetic vanadium mineralization accompanies uranium minerals only when the oxidized rocks of the productive horizons (Northern Kanimekh) have a reddish-pink color, which is a consequence of the oxidative reaction of the pH-raising formation waters. Under these conditions, corresponding to the appearance of an internal alkaline wave (Fig. 2.21), it becomes possible to actively extract vanadium from the host rocks (polymict sands, dolomite sandstones, etc.) and subsequent sedimentation in permeable sedimentary rocks.

In the North Kanimekh deposit, vanadium ores with V_2O_5 content in hundredth fractions of a percent form roll-front and lens-shaped bodies localized near the pinching out of the zone of reservoir oxidation both in pyrite-bearing non-oxidized and limonitized rocks.

Scandium. Epigenetic accumulations of scandium are established at the deposits of Bukinay-Kanimekh ore field. In all cases, they are associated with rocks rich in pyrite, but poor in carbonate (Northern Kanimekh), or relatively poor in pyrite, but practically free of carbonates (Beshkak).

The contour of elevated concentrations of scandium fits into the nose of the uranium roll, sometimes with a slight shift towards the zone of unoxidized rocks. At the North Kanimekh deposit, the content of scandium in uranium-bearing sands averages 3 – 5 cu.

Yttrium and lanthanides as components accompanying uranium are installed in the ores of the reservoir-infiltration deposits and ore-bearing horizons, which contain epigenetic scandium.

Let us consider in more detail the geological and hydrogeological conditions of the main deposits of the Kyzylkum uranium province.

The Uchkuduk deposit is located in the north of the Central Kyzylkum uranium-ore province in the marginal part of the Beshbulak artesian basin.

Industrial reserves of uranium (99%) are concentrated in deposits located at a depth of more than 10 m. The presence of eight ore-bearing aquifers determined the multi-tiered structure of the deposit, and the infiltration processes form a peculiar ufology of ore bodies, the basis of which is the so-called roll of various modifications with two main morphological elements: nose (central) and limb (tail or end). Different combinations of these two elements determine the morphological diversity of the ore bodies found on the Uchkuduk deposit (as in all other deposits of this genetic type).

At the Uchkuduk deposit, 93 ore deposits with a total area of 24 km2 and a length of 100 to 6 km and a width of 25/2000 m have been explored. In terms of ore bodies, they have an elongated horseshoe shape. The depth of ore occurrence at the Uchkuduk deposit ranges from 8-10 to 110 m in the north and up to 280 m in the south. Ores are poor or common (0.03%), rarely with a uranium content of up to 0.2 - 0.4%. The texture of their finely interspersed and fine.

The following uranium minerals and uranium carriers are found in ores occurring at depth: nasturan, uranium oxides, coffinite, uranium-containing phosphate bone residues, carbonaceous substances, in oxidized ores, uranophane, betauranotil, autenite, tyuyamunite.

Selenium and molybdenum are found among the secondary elements in the deposit, their content does not usually exceed a thousandth of a percent.

The Sugraly deposit is confined to the northwestern wing of the Tamdytau massif, in the sedimentary cover of which two hydraulically connected aquifers are distinguished.

The ore of the Sugraly deposit is mainly represented by sand and calcareous sandstones. Typical composition of ore: quartz particles 50/60%, feldspathic rocks 5 - 15%, rock fragments 10%, iron sulfides up to 2.5%, glauconite up to 2%, goethite-hydro goethite – up to 2-5%, uranium oxide – up to 10%, nasturan-single grains, uranophane – up to 10%, native selenium – up to 1%, jordisite – up to 1%.

The depth of occurrence of ore bodies varies from 260 m to 675 m. In terms of ore deposits are winding strips and ribbons, less often have a sickle shape. Their length varies from a few hundred meters to 17-20 km, and its width varies from 100 to 500 m. In the section, ore deposits and ore bodies, generally having a roll-front with a nose and limb, are not always sustained. Their thickness varies from 0.2 to 4 - 6 m.

The ores of this mine are complex. The uranium content varies from 0.034 to 0.267%, selenium varies from 0.05 to 0.112%, molybdenum from 0.004 to 0.26%, rhenium reaches 10-15 cu. The main ore minerals are uranium oxides and jordizite - are concentrated in the form of thin impregnation in the clay and clay-carbonate material of sandy rocks or in the form of thin films on the surface of detrital grains. The bulk of molybdenum mineralization is spatially separated from uranium ore by several tens of meters. Selenium mineralization in the form of intermittent spots is common in the inner part of uranium ore bodies and copies their shape in space.

The Bukinai deposit is located near the southwestern end of the Nurata Range.

Uranium mineralization is confined to sandy sediments of the Upper Cretaceous, the outcrops of which border the northwestern spurs of the Nurata Range, composed of Paleozoic rocks.

At the Bukinai deposit, the lower rhythm of the Karasagyr horizon is located, which contains about 87% of its reserves. Industrial mineralization is noted in various lithological types of rocks (gravels, sands of various sizes, I siltstones and clays), but fine-grained sands dominate, to which about 90% of proven reserves are confined. The terrigenous component prevails in the material composition of these sands (70-98% of the rock mass). The main minerals in the sand composition are quartz (50-75%), feldspar (15-40%), clay minerals (5-15%) and rock fragments (1-15%). By chemical composition, ore-containing silicate rocks, with an insignificant content of CO_2 (up to 0.30%), P_2O_5 (up to 0.2%), total sulfur (0.2-0.4%) and organic carbon content (0.1-0, 2%).

All ore deposits are localized at a depth of 150-200 m in permeable sands at the pinching out of the zone of reservoir oxidation formed by the pressure oxygen uranium-bearing waters of the Karasagyr horizon.

In terms of the chemical composition, the ores are silicate with a CO_2 content of up to 0.5%. Carbonized siltstones and sandstones with a CO_2 content of up to 20% sometimes occur in the roof of ore-containing sands. The amount of uranium in ores varies from 0.028 to 0.08% with an average thickness of the layers of 1.0-3.2 m. The native selenium is found among the secondary elements (no more than 20% of the uranium content).

The Beshkak deposit was discovered in 1969. It is located on the eastern wing of the Karakata Depression and is represented by noisy sub-horizons, separated by an intermediate aquitard with a capacity of 5-6 m. The filtration properties of the rocks of these two subsurfaces vary in the sands from 1,5 to 6,0 m/day, in sandstones from 0,2 to 1,0 m/day.

In the zone of layer-oxidized rocks of the horizon, the electrochemical potential of water (Eh) reaches +220 mV, in the ore zone decreases to +43 mV, at the place of development of gray-colored unchanged rocks decreases to - 57 mV. In the deposit of food and transit, the uranium content in water is $n * 10^{-5}$-$n * 10^{-4}$%, radium - $n * 10^{-11}$%, in the ore zone it increases noticeably: uranium - up to $6 * 10^{-3}$%, radium – up to $4 * 10^{-10}$%; outside the mineralization in the water washing gray-colored rocks, drops sharply: uranium – to $n * 10^{-6} / 10^{-7}$%, radium – to $n * 10^{-12}/ 10^{-18}$%.

The ores have the form of winding ribbons in plan as elongated by 4-6 km in the sub latitudinal direction. There are two deposits in the deposit, one of which contains 87% of the deposit's reserves. Its length reaches 6 km, width – 500 m. The depth of occurrence of ores varies from 30 to 300 m, power varies from 1 to 4 m. The content of uranium in ores is 0,015-0,2%. In the section, the ore deposits have a typical roll-front form with well-developed central parts and two end parts.

The ores are silicate. The carbon dioxide content does not exceed 0.5% and is on average 0.05-0.10%. The content of phosphoric anhydride is also insignificant: from 0.05 to 0.15%. Along with uranium mineralization, selenium is present in the ore zone, the elevated levels (up to 0.03%) of which are established in rocks at the junction of the roll limb with the nose.

The Sabyrsay deposit is confined to Mesozoic-Cenozoic sediments, in which one of the four aquifers (Sabyrsai) with a filtration rate of rocks from 1 to 11 m / day is ore-displacing.

In a plan view, the major commercial areas of Sabyrsay deposit look like in the form of two separated parallel strips: Northern continuously traced ~ 20 km, and a central, elongated from west to east on ~ 11 km.

In terms of complexity of the morphological structure, ore bodies at the deposit are divided into reservoir, simple roll-front and complex roll deposits. In terms of simple roll-front deposits provide a kind of tape with a width of 100-350 m, elongated along the line of pinching formation oxidation at 400-3,000 m. The reservoir and complex roll-front deposits have a width of 450-700 m and a length of 1,000-3,000 m.

Selenium concentrating near the main uranium ore zone can be interesting as the secondary element. Selenium ore bodies are small. The content of selenium in them reaches the hundredth and even the first tenths of a percent. The bulk of it is in the native form. The confinement of the smallest needles of native selenium to clusters of iron hydroxides is characteristic.

The Ketmenchi deposit was discovered in 1956, but due to the difficult mining and technical conditions, its development was first postponed and then renewed in 1967 because of the commercial leaching started, which led to a reassessment of its prospects and the conversion of reserves to industrial.

The deposit has explored 30 deposits, which are confined to the horizons of fine and medium-grained sands, sandy-clay and gravel rocks on clay and lime cement, enriched with carbonaceous organic matter.

The form of ore deposits is the most diverse - from winding ribbons to isometric trapezium. The length of the deposits varies from 300-800 m to 1.5-2.0 km with a width of 50-150 m. The depth of the reservoir varies from 100 to 460 m. Inside the deposits, the distribution of industrial concentrations of the useful component is intermittent, presented in the form of small blocks, grouped in separate areas, separated by barren rocks, 5 km or more.

In terms of the chemical composition, the ore deposit belongs to aluminosilicate with a low content of carbonates. The CO_2 content is on average close to 1-2%. High carbonate interlayers (up to 8-10% of CO_2) are sporadic and do not exceed 5-10% in the total volume.

Thus, the analysis of geological and hydrogeological conditions shows that exogenous-epigenetic deposits of the Uchkuduk type have specific conditions for the localization of mineralization due to:

- features of exogenous-epigenetic ore formation, which consist in the fact that oxygen-containing water first extracts useful components from the rocks of feeding areas, and then, when changing geochemical conditions during filtration by permeable rocks, concentrate them, depositing in a certain sequence on the restoration or neutralization geochemical barrier;
- compact arrangement in a single aquifer of pigenetic concentrations of uranium and associated useful components;
- confinement of industrial concentrations of uranium and related useful components to highly permeable heavily watered aquifers;

- heterogeneity of the lithological composition and filtration properties of rocks of productive horizons.

The study of the hydrogeochemical conditions of the migration of uranium and ore formation showed that in the process of filtration of productive solutions in the zone of the moving geochemical barrier, epigenetic ore formation occurs continuously, the process of which can be conventionally represented as repeating cycles, each of which includes:

- admission of new portions of uranium in the form of carbonate complexes with the reservoir oxygen-containing waters;
- decomposition of carbonate complexes of uranium, accompanied by its reducing precipitation and increasing concentration in the zone of ore mineralization;
- oxidative dissolution of precipitated uranium with the formation of secondary carbonate complexes;
- decomposition of secondary carbonate complexes and replanting of uranium on the displaced geochemical barrier.

Aulbek deposit is located in the North-West side of Karakatin depression, on the southern backdrop of the mountains of Aristata.

The mineralogical composition of ore sands is similar to each other. The deposit‘s ores contain quartz, feldspar, mica (muscovite, chlorite, biotite), carbonaceous detritus, and clay minerals. The average quartz content is 52-69%, feldspar – 15-27%, and rock fragments – 4-10%. The content of the debris material is 84-90%, on average, i.e. the main component of the composition are debris materials, which is a favorable factor for in-situ leaching.

Pyrite is occurred in non-oxidized gray-colored ore-free and ore sands, sandstones and siltstones, in the form of interspersed small crystals and fine-grained aggregates with a size of 0.05-0.25 mm. The pyrite content in the sands is 0.08-0.9%, on average, and up to 0.8% in siltstones. The average pyrite content in limonitized sands is 0.02-0.08%.

The content of carbonates in ore-containing sands is 1.54-13.57%, or 6.44%, on average. The maximum values depend on presence of carbonate peas and nodules in significant quantities. Carbonates are represented by calcite, with average content of 0.2-1.0% in the sand, and 1.2-114.4% in dolomite (predominant). They occur in the form of grains with a size of 0.01-0.1 mm in the intergranular space, and with cementing the debris grains, they form peas and bindings up to 0.5-1.0 cm in diameter.

Phosphorite average content is 0.5% in the sands, it is occurred in the form of bone fragments and teeth of fish of white, light pink, brown and black color.

Mineralization is distributed more or less evenly in the sands and presented in the form of the uranium oxide (uraninite). Uranium mineralization occurs in the form of black powdery and sooty films and pugs on the surface of clastic grains. Part of uranium is present in the sorbed form in clay, phosphorite, and other minerals.

The dominated form of uranium is hexavalent. The oxygen average coefficient for uranium ores is 2.91%, which is favorable if ores are stripped with solutions during in-situ leaching.

In addition to uranium, the ores contain rhenium, molybdenum, selenium, and rare-earth elements. Selenium was determined by x-ray spectral, rhenium spectral, scandium and rare-earth neutron activation methods.

Native selenium is represented by small (up to 0.03-0.2 mm) needle crystals and their accretions in association with disulfides and iron hydroxides in the intergranular space.

Molybdenum mineralization is occurred in the form of powdery and sooty films and black pugs on the surface of clastic grains.

The mineral form of rhenium has not been established.

Kuhnur deposit is located in the southeastern part of Central Kyzylkum.

The deposit‘s ores contain quartz, feldspar, mica (muscovite, chlorite, biotite), carbonaceous detritus, and clay minerals. Mineralogically, the detritus material is composed mainly of quartz (50-80%), feldspar (20-35%), mica minerals (10%), and fragments of siliceous rocks (10-15%). A relatively high percentage of feldspar is typical for the santonian tier rocks, and a high content of siliceous rock fragments is typical for cognac rocks. The clay component is represented by hydromica and kaolinite, and carbonate substance – by calcite. Accessory minerals make up about 1% and are represented by pyrite (up to 2%), marcasite, phosphorites, and iron hydroxides. Pyrite is common in all areas of development of gray-colored deposits. Sand rocks are relatively poor in organic matter (0.2%), which is found in the basal layer of the section and in clay layers, where it is represented by decarburized plant detritus. The carbonate content in rocks is insignificant, the CO_2 content ranges from 0 to 1%, rarely more, reaching 4.3% in sands, and 9-10% in carbonate-clay sandstones. On average, the CO_2 content in the sands is 1.43%.

Uranium ores are mainly represented by rocks of gray, light gray, and rarely dark gray color, differing from non-ore ones by the presence of ore minerals. According to the lithological composition, mineralized sands, carbonate sandstones and siltstones are distinguished, but the conditioned ore intersections are discovered only in loose sands. According to the granulometric composition, sand ores are medium-fine-grained, there is no cementation, sometimes they are slightly compacted. The texture of ores is determined by the lithological and textural features of mineralized rocks. Ores of massive texture predominate, as uranium minerals are distributed evenly in fine-grained riverbed and multi-grained steams sediments.

The predominant ore component of uranium ores is regenerated uranium black. It is released from underground water solutions in a reducing environment as a result of the reduction of hexavalent uranium that migrated from the oxidation zone. The uranium black forms powdery-earthy sooty clusters of microscopic small particles (hundredths and thousandths of a mm or less) of irregular shape. Highly dispersed powdery-loose and sometimes more or less dense crusts and thinnest films of uranium black are located on the surface of quartz grains and other clastic rock-forming minerals. The mineral is opaque, dark gray, and has a hardness of 1-2. It dissolves well in acids. In well-sorted sands, the uranium black is distributed evenly and is associated with a dust-clay component.

In sands with lenticular layers of clays and siltstones, uranium black forms a border around them. In the wings, mineralization is often „pressed“ into clay and silt-clay differences of roof and sole rocks. It is rare to find uraninite in the richest areas. There is no definite pattern in its distribution in different parts of the ore deposit. Uraninite is occurred in ores with a high ($>$ 0.1%) concentration of uranium only. Since rich uranium ores are more typical for the upper wing and bag part of the ore deposit, they contain more uraninite than the other parts of the deposit. They are represented by the smallest rounded or somewhat angular secretions that are in close fusion with pyrite, uranium black, amorphous silica and other minerals. The sizes of individual rounded uraninite secretions vary from thousandths to tenths of a millimeter. The chemical composition of uraninite corresponds to the formula $3UO_2$, $8UO_3$. Uraninite contains a mixture of well-formed epigenetic pyrite crystals.

Coffinite was found in mineralized Sands according to x-ray diffraction analysis.

The main volume of ores has a uranium content in the range of 0.018-0.120%, making an average of 0.030% content for the deposit.

In addition to uranium, the ores contain rhenium (from 0.20 to 0.98 g/ton).

Istiqlol (Tohumbet) deposit is located spatially on the Western dip of the Aktu and Karatau mountains, which are branches of the South Nurata range.

The deposit‘s ores contain quartz, feldspar, mica (muscovite, chlorite, biotite), carbonaceous detritus, and clay minerals. Mineralogically, the detritus material is composed mainly of quartz (50-80%), feldspar (20-35%), mica minerals (10%) and fragments of siliceous rocks (10-15%). At the Istiklol deposit, the carbonates are represented by calcite, which makes up an average of 0.11-1.93% in the sands, and dolomite+siderite-0.68-5.81% unevenly distributed in the deposits of the ore-containing horizon – from complete absence in some areas, reaching the maximum values in others. There are carbonates in the form of white grains in the intergranular space, and cementing clastic grains, they form pugs and bindings up to 0.5-2.0 cm in diameter, less often they form layers of carbonate sandstones. The average CO_2 content of the Istiklol deposit is 1.6%.

The Istiklol deposit is dominated by uranium in hexavalent form, the state of uranium mineralization is fine-aggregate, and uranium is present in sorbed form. The oxygen average coefficient in uranium ores is 2.82%, which is favorable when stripping ores with in-situ leaching. Ore mineralization in uranium ores is represented by uraninite and rarely coffinite

Uraninite, which forms the same type of discharge forms in all ore zones, occurs in the form of singer-collomorphic formations, individual globules and their clusters ranging in size from fractions of a micron to several microns on quartz grains, feldspars, and in clay matter. The chemical composition of uraninite corresponds to the formula $3UO_2$, $8UO_3$. Uraninite contains a mixture of well-formed epigenetic pyrite crystals. The oxygen ratio in the uraninite varies from 2.00 - 2.21 to 2.75. Uraninite was established according to x-ray diffraction analysis, the study of ores in an electron microscope (at an increase of 10 thousand).

Coffinite is very rare and occurred in the form of spindle-shaped crystals that associate with the same minerals as uraninite. It is isolated as grains up to 0.01 mm in size in the clay mass of mineralized sands and sandstones. It has a sharp dot illumination on radiographs. The presence of coffinite is confirmed.

Part of the uranium in the sorbed state is present in phosphorites (up to 0.07%), glauconite (up to 0.07%), vegetable detritus (up to 0.04%), and other minerals.

Selenium mineralization is represented by native gamma-selenium, which forms the smallest (9 hundredths of a mm) needle crystals of black color, less often their splices on the surface of clastic grains, in the intergranular space in association with uraninite, pyrite, iron hydroxides, and other minerals. Part of selenium is present in phosphorites, glauconites, and plant detritus. The size of native selenium coincides with the size of silt particles (less than 0.05 mm), rarely reaching 0.1 - 0.15 mm. Therefore, native selenium is mainly concentrated in silt-clay mass. Part of the selenium is in scattered form.

Patterns or rhenium localization are common with the uranium. Rhenium ores border uranium deposits on their periphery, both in plan and in section, from the gray-colored rocks and are partially combined with uranium ore bodies, generally repeating their morphology. In the plan, the contours of rhenium bodies (according to the onboard content of 0.5 g/t) are usually combined with uranium deposits by an amount of about 70-75%, the remaining reserves are localized outside of them in the area of uranium scattering in gray colors. As a rule, the rhenium bodies represent simple and well-expressed rolls with all elements in the section. The content of rhenium in the contours of uranium ores ranges from ≤ 0.2 g/ton to 1.0-2.0 g/ton, rarely increasing to 10-15 g/ton, due to low concentrations of rhenium. It was not possible to determine its mineral form with even electron microscopy and x-ray diffraction analysis. However, significant recovery volume of rhenium with water (up to 70%) may indicate its presence in an easily soluble semivalent form. Part of the rhenium is probably available in the sorption state in the clay substance, as well as in the sulfide form. The rhenium content increases with decreasing particle size, which indirectly indicates a very thin size of rhenium secretions.

Terekuduk deposit is located in the Eastern part Karakatin depression, South-West wing of periclinal dip of the North-Nurata horst-anticline.

The host rocks and ores from Maastricht deposits are composed mainly of detritus minerals (quartz, feldspar, and rock fragments) that are resistant to leaching solutions, which is favorable for recovery useful components from ores.

The CO_2 content of the sands varies from 1.54% to 13.57%, averaging 6.44%. And from 5.94% to 21.28% in loosely compacted sandstones, with 9.14%, an average. The composition of carbonates contains dolomite 0.73-6.97%, on average and calcite – 0.03-0.57%. Carbonates are found in the form of isometric-irregular, rhomboid and rhomboid-irregular grains with a size of 0.01-0.05 mm and their accretions up to 0.1-0.2 mm in the intergranular space together with the clay substance. Calcite very rarely develops from organic residues. The sharp predominance of dolomite in the composition is a favorable factor for in-situ leaching of useful components from ores.

Ore mineralization, distributed in the sands more or less evenly, represented by uranium oxide (uraninite), selenium-native selenium and molybdenum-molybdenum sulfide (jordisite) in uranium ores. Uranium oxide is observed in uranium ores in the amount of 0.01-0.09%, native selenium in selenium ores – 0.01-0.02%, molybdenum sulfide in molybdenum ores – 0.02%.

The mineralized rocks of the deposit are represented by gray-colored fine-grained sands and sandstones. The composition of the detritus material, the cementing substance and the autistic mineralization do not differ from those without ore.

In some cases, the presence of uranium minerals causes a relatively darker color of the mineralized sections of the rock.

The texture of ores is dot-spotted, uranium mineralization is represented by dispersed uranium oxides, which are released in the form of loose and slightly compacted films and clusters on clastic grains and in sandstone cement. Uranium oxides are classified as uranium blacks, since x-ray diffraction analysis (similar to the Varajan deposit) showed the structure of mineral impurities only. This may be due to the fine dispersion of uranium mineralization. It is released from underground water solutions in a reducing environment as a result of the reduction of hexavalent uranium that migrated from the oxidation zone.

In uranium ores, regardless of the type of ore, uranium prevails in hexavalent form, with gross content varying from 80% to 96%, or 93%, on average. The oxygen average ratio for uranium ores is 2.93.

Molybdenum mineralization is represented by jordisite. Molybdenum sulfide (jordisite) occurs in the form of powdery and sooty deposits and black pugs on the surface of clastic grains likewise uranium oxide. It is identified by using microchemical reactions to molybdenum and the results of x-ray spectral analysis. X-ray diffraction analysis showed a colloidal form of molybdenum mineralization. Jordisite easily passes into ilzemanite, since the analysis of the solubility of molybdenum mineralization showed that 70% (of the molybdenum content in the initial sample) of molybdenum is dissolved in water at room temperature (18 ºC) and is represented by ilzemanite (colloidal water-soluble mineral of molybdenum). The insoluble part of molybdenum is jordisite (colloidal molybdenum sulfide). Founding of jordisite is confirmed by the following: the mineral is x-ray amorphous and easily converts to ilzemanite, which is soluble in water.

Selenium minerals in the Terekuduk deposit were not found, but, by analogy with other deposits of the upper Cretaceous, they are obviously represented by native gamma-selenium. forming the smallest (hundredths of a mm), needle-like crystals of black color, less often their accretions on the surface of clastic grains, in the intergranular space in association with uraninite, pyrite, iron hydroxides, and other minerals. Part of selenium is present in phosphorites, glauconites, and plant detritus. The size of native selenium coincides with the size of silt particles (less than 0.05 mm), rarely reaching 0.1 - 0.15 mm. Therefore, native selenium is mainly concentrated in silt-clay mass. Part of selenium is dispersed in iron hydroxides. According to mineralogical data, sand ores are silicate (the total average content of detritus minerals is 90.56% with low average content of gross sulfur of 0.12%, CO_2 – 1.84%, Sorg – 0.10% and P_2O_5 – 0.05%.

The rhenium content in the ore sand is generally < 0.2 g/ton. The average content in the sands of the ore zone is < 0.2-0.4 g/ton. The rhenium content in sandstones is < 0.2-0.6 g/ton. Vanadium is present in sand – 34.9-64.5 g/ton on average, and sandstones – 36.1-130.7 g/ton. Yttrium in barren sands, and the Sands of the ore zone, averaging 2.8-7.8, thorium – 1.9-3.1, strontium – 68.7-91.2 and arsenic – 2.3-6.0.

Yogdu deposit (North Mayzak) is located on the Northern slopes of the Zyatdin mountains with typical accumulative relief

Uranium mineralization is localized mainly in sand rocks, less often in siltstones and clays. The ores and host rocks are mainly varied the presence of uranium mineralization.

Sand ores are characterized by a clay content from 3 to 24% and a carbonate content from 0.55 to 1.00%, on average. Their permeability to water and acid solutions is determined by a filtration coefficient of 1.0-4.7 m/day. In the balance of reserves, those „sand“ ores make up about 93% and are a technological grade for in-situ leaching.

In terms of the content of four- and six-component uranium, the sand ores of different ore-containing horizons do not differ from each other. They are, as a rule, dominated by uranium in the hexavalent form.

Uranium black is the main ore mineral of the deposit. It is observed in the dispersed state only (the first hundredths of a mm), and is concentrated in thin classes of ores.

Accessory minerals – tourmaline, stavrolite, ilmenite, garnet, and others, make up a maximum of 1-2% of the total rock composition.

Authigenic mineral in the deposit‘s ores include uranium black, native selenium, pyrite, marcasite, dolomite, calcite, celestine, and other minerals. The presence of glauconite and phosphorite grains is typical in the Campan and, to a lesser extent, to Maastricht deposits.

Phosphorites are a characteristic authigenic mineral of the Maastricht and Campan deposits. Their content varies from 3-5% in the Maastricht sediments to 5-8% in the Campan sediments. It occurs in the form of rounded, oval formations of whitish, cream and brown color, with a size of 0.1-0.3 mm. According to spectral analysis, phosphorites contain lanthanum, yttrium, and ytterbium in their composition as impurities.

The CO_2 content in the sands varies from 0.11 to 5-6%, reaching 9.0-15.9% in some cases. At the same time, there is an increase in the carbonate content from the lower to the upper horizons: in the Santonian tier, the average CO_2 content in the sands is 0.73%, in the lower pack of the Campanian tier – 1.1%, in the upper – 1.69% and in Maastricht – 3.77%. In siltstones and clays, the CO_2 content is 0.16 - 9.2%. The maximum amount of CO_2 is typical for carbonate sandstones, which is 10-25%, on average, reaching 35.2%. The average content of CO_2 for the deposit #1 – 1.0%, deposits # 2 – 0.55%, deposits # 3 – 0.56%.

In terms of uranium content, the ore deposits are poor, with high levels of selenium, rhenium and vanadium pentoxide from associated components. In addition to being present in uranium ores, which is a small percentage of the total reserves, selenium forms independent ores. Native selenium is represented by needle-like crystals of steel-gray color, sometimes fused in parallel. Selenium forms small clusters on the surface of clastic grains and in the intergranular space.

Rare-earth element.

Rare-earth elements (rare-earth metals) are chemical elements of the secondary subgroup of group III of the periodic table: these are scandium, yttrium, lanthanum, and lanthanides. They are relevantly rare in the earth's crust, and form insoluble oxides (obsolete expression – earth) - hence their name is derived. Silvery-white metals that fade in the air due to the formation of an oxide film. Chemically active. In nature, they occur together. More than 120 minerals containing Sc are known. The most important native Sc minerals are: bazzite $Sc_2Be_3Si_6O_{18}$ and ergonic $ScPO_4 \bullet 2H_2O$. Yttrium, along with other rare-earth elements, is found in minerals: xenotime, fergusonite, euxenite, gadolinite, thalenite, iteroparity and others. In nature, Lanthanum, together with other rare-earth elements, is a part of minerals: monazite, bustinza, loparite and apatite. Yttrium and lanthanides have predominantly the same valence as scandium (III) and their behavior in aqueous solutions and accumulation at the blowout of ISOZ is similar in general. The contours of epigenetic ore deposits of yttrium and ytterbium, in general, follow the contours of conditioned uranium ores. At the same time, high levels of yttrium and lanthanides were recorded in sand samples with both rich and poor uranium mineralization, which indicates the absence of a complete spatial combination of geochemical barriers that determined the formation of uranium ore and rare earth accumulations in the area of the formation-oxidizing zone. It is worth to note that all ore-bearing areas with epigenetic accumulations of rare earth elements are composed of gray-colored rocks with relatively high pyrite concentrations (0.2 - 5%) and low carbonate content (usually less than 0.5 - 0.2%). Detailed studies of the results of sample analyses have shown that rare-earth elements in the ore-containing horizon are characterized by a relative constancy of the percentage ratio between them.

Associated components, having different content and degree of extraction, are accumulated in conjunction with Uranium on the border of blowout of ISOZ.

2.2.5. Material composition and metal content of the Kyzylkum combustible shale

The oil shale of the region has been studied periodically over the last century, which made it possible to draw the following conclusions.

1. Oil shale is radioactive, contains elevated concentrations of vanadium, molybdenum and a number of other metals; in industrial installations can be used as energy raw materials with thermal capacity up to 3300 kcal/kg.
2. From slate it is possible to obtain high-sulfur fuel oils used for lubrication of engines, but unsuitable as a raw material for liquid fuels due to high sulfur contents (4 - 6%).
3. The largest Baysun field possesses prospective reserves of 55 million tons, with a deposit length of up to 50.5 km, a depth of 600 m, and a calculated reservoir thickness of 0.52 m (with fluctuations from 0.1 to 0.9 m).

In 1962, after the regional prevalence of oil shale was proven far to the west and north-west beyond the Tajik Depression, a qualitatively new period began in their study.

It is proven as well, that the areas distant from the Tajik Depression are also radioactive and have the rare metal content of combustible shale, and the almost continuous extent of the stratum was traced in the direction of the South Kazakhstan manifestations of the lower reaches of the Syrdarya river (Bayhodja, Bukhar-Mazar, etc.). Upon the initiative of A.S. Fedorenko, who showed the continuous regional nature of the spread of metal-bearing oil shale and the possibility of their utilization as products of chemistry, non-ferrous metallurgy and agriculture began a comprehensive study of the oil shale of Uzbekistan. In the period 1965-1967, the team he headed performed a wide scope of work, the results of which led to the following conclusions:

1. Oil shale is confined to the stratigraphic level of the lower Eocene strata belonging to the zone of the development of planktonic foraminifera Globoratalia aecua; above and below the zone, black pyrite-containing clays with minimal carbonate and terrigenous impurities are characterized by the development of benthic forms of foraminifera.

2. Two isolated basins, Kyzylkum and Amudarya-Hisor (they are called as Syrdarya and Amudarya in subsequent publications) in which the original humus-sapropel substance was later transformed into combustible layers, were accumulated and outlined by core-drilling core drilling and paleo geographic reconstruction. At the same time, paleo geographic constructions are developed for an extremely narrow time interval of “accumulation” of a layer of combustible shale with a capacity of up to 1.0 m and more.

3. Oil shale is classified as a limestone-type coal-carbon-type graphite and composed of three main components: a clayey substance of a hydromica composition, a structureless gel-like substance consisting of colloalginite (80 - 89%) and vitrinite (15 - 20%), and cutinized elements (spores, higher pollen plants).

For the first time in the flat areas of Uzbekistan (Urtabulak, Uchkyr-Kulbeshkak) or for the first time outlined by a combination of paleo geographic and structural factors (Sangruntau, Aktau), deposits of combustible shale of Uzbekistan were made, but the authors calculated their reserves.

4. In 1963-1966, the Kashkadarya exploration expedition has confirmed the reserves of the Baisun deposit of combustible shale to a depth of 600 m, which, according to drilling and short adits, were divided into A + B + C and C2 categories.

5. Resin content from 8–10 to 11–12%, respectively, previously known only at the Baysun deposit (10–12%) was found in the oil shale of Sangruntau and Urtabulak.

6. Oil shale is everywhere enriched with molybdenum, vanadium, uranium, tungsten, rhenium and other metals that are directly dependent on the organic carbon content.

7. The reserves of combustible shale and metals are calculated, and the content of the latter, in terms of dry shale, shale ash and pyrite are up to 5-10% of the mass of shale.

8. Discussing by the elemental and material composition of the fuel shale, as well as by the inclusions of the teeth and bones of sharks, fish scales, the presence of ichthyol, OM of combustible shale consists of components of plant and animal origin.

It is assumed that the metals in combustible shales are in the organometallic form of the compounds, since only sulfide forms in the form of molybdenite, ferrimolybdite, and povelitite are established for molybdenum.

9. Material composition. Oil shales are considered as thin mineral „mixtures“ of organic and inorganic constituents. Organic matter is separated into bitumen and kerogen (main part). The latter consists of polycyclic subgroups interconnected by alkanes and long-chain isoprenoid. Inorganic matter includes: clay hydromica and montmorillonite composition, carbonates (calcite and dolomite), grains of quartz, feldspar, pyrite grains, colonies of foraminifera shells with carbonate, phosphate or silicate shells, scales and bone fish fauna remnants, coprolites of digging organisms, made of phosphate collophanite. The quality of oil shale is determined by its main components, which are separated during the technological redistribution. In the process of semi-coking, fuel and chemical products are obtained: resin and pyrogenic sunflower water; gas containing volatile components, including sulfur and nitrogen; coke and flue gas; ash.

The mineral components of the inorganic part of the shale, distinguished under a microscope, besides pyrite, contain clay (about 20%), grains of quartz and calcite (more than 5%), kaolinite (about 4%) is clearly released.

The material composition of the bitumoids of oil shale of some objects of Uzbekistan is studied unequally. The geochemical features of bitumoids of a number of the most studied deposits are illustrated in table 2.5.

This table shows that the organic matter of combustible shales of Uzbekistan is distinguished by a high content of bitumoids by far greater their content in the kerogen of most of the world‘s known deposits.

The oil shale of the Syrdarya basin with the Sangruntau deposit is somewhat different from the Amudarya deposits with higher degrees of catagenetic transformation. It should be noted that the Urtabulak, Pamuk, East Chandyr, Kultak-Zevardy, Ulus-Dzham, Uchkyr-Kulbeshkak, Karadarya, Maymanaktau deposits in the Amudarya basin are geographically located in the arches of the structures of the same name in the Bukhara-Karshi oil and gas region.

Vanadium, molybdenum and rhenium, partly scandium, selenium, tungsten, nickel, rare earths, platinum group metals, silver, gold, aluminum and titanium (tab. 2.6) can be of the greatest practical value in combustible shales of Uzbekistan.

Separately, uranium is considered, the hydrogenic deposits of which are localized in the surface rocks of the Cretaceous-Paleogene, having reservoir properties at geochemical barriers, and can be spatially combined with the position of the shale formation in specific structures. In this case, the oil shale will be ore for uranium. Along with uranium leaching, the migration of molybdenum, selenium and other metal elements to geochemical barriers is noted in the hypergenesis zone of similar lithologic and structural positions (Uchkuduk type deposits – Uchkuduk, Bukinai, Lyavkan and others).

Table 2.5

Specification of oil shale and resin in a number of fields in Uzbekistan

	Deposit		
	Baisun	Urtabulak	Sangruntau
Moisture, %	4.39	7.2	8.7
Mineral carbon dioxide CO_2	5.53	8.6	1.3
Burning ash A	57.6	60.3	74.8
Cond. org. weight 100(CO_2+A)	30.0	31.1	23.9
Sulfur common, S_{com}	4.71	4.56	4.57
Heat of combustion, $Q_б$, kcal/kg	3,085	2,520	2,072
Distillation of slate in an aluminum retort (load 20 g), %			
Resin	11.7	9.4	6.1
Decomposition water	4.0	4.8	4.4
Charbox	78.6	73.7	84.9
	5.7	12.1	4.6
The output of the resin from the services. org. masses, %	39.0	30.1	25.5
Ash chemical composition, %			
SiO_2	45.5	34.7	55.0
R_2O_3	23.2	19.6	22.0

Continuation of table 2.5

K_2O+Na_2O based on K_2O	2.2	7.1	1.6
MgO	3.6	3.1	3.2
CaO	19.2	23.6	12.4
SO_3	8.3	11.8	6.2
Total	102.0	99.9	100.4
Resin yeild, %			
Based on dry slate	10.2	6.4	3.7
From the exit in the aluminum retort	87.7	67.7	60.7
From the conv. org. masses	34.0	1.5	1.43
Density at 20°C, g/cm^3	0.968	0.973	0.989
Viscosity at 75°C, °E	1.47	1.5	1.43
Flash point, °C	64	96	88
Mechanical impurities, %	0.33	0.05	0.12
Ash content, %	0.09	0.01	0.06
Start boiling, °C	93	179	90
Boils up to 200°C	7	3	4
250°C	19	19	17
300°C	36	40	40
350°C	62	63	70
Phenol content, weight, %	2.5	3.4	3.1
Birefringence	1.495	1.548	1.549
Heat of combustion QCб, kcal/kg	9,830	9,720	9,590
Mole weight	256	258	255
The content of 3,4-benzopyrene, 10-4	40	28	25
Elemental composition, %			
C^c	84.9	81.5	79.8
H^c	10.3	10.0	9.8
S^c	4.2	4.7	6.4
O^C+N^C (by diff.)	0.6	3.8	4.0
C:H	8.23	8.15	7.78

Table 2.6

The average content of metals and a number of non-metals in oil shale deposits Sangruntau and East Karakat (% – data spectral analysis, cu - data chemical analysis)

Element	Content	Element	Content
Be	0.001 % (0,2 cu)	Ru	0.03 cu
B	0.01 %	Rh	0.05 cu
Mq	1-2%	Pd	0.014 cu
Al	3%	Jr	0.03 cu
P	0.4% (до 40000 cu)	Aq	0.001% (2.4-3.2 cu)
Sc	5.6 cu	Cd	0.002% (30-40 cu)
Ti	0.01% (1000-5000 cu)	Jl	77 cu
V	0.12% (900-1670 cu)	Sn	6-8 cu
Cr	0.01% (200-420 cu)	Sb	13.9 cu
Mn	0.006% (600 cu)	TR	170-685 cu
Fe	1-2% (37000 cu)	La	57 cu
Co	20-71 cu	Ce	73-230 cu
Ni	300 cu	Eu	2-10 cu
Cu	0.05% (300-400 cu)	Sm	50-160 cu
Zn	0.01% (100-225 cu)	Yb	2.6 cu
Ga	0.001% (3-8 cu)	Lu	23 cu
Ge	5-6 cu	Hf	9.6 cu
As	1.5-2.0 cu	Ta	0.28 cu
Se	0.002(10-100 cu)	W	130-300 cu
Pb	26 cu	Re	0.3-0.8 cu
Sr	2,360 cu	Au	0.02-0.2 cu
Y	20 cu	Tl	10-15 cu
Zr	2,660 cu	Pb	0.006% (10-20 cu)
Nb	3-5 cu	Bi	30 cu
Mo	0.04-0.075% (400-750 cu)	Th	8-12 cu
U	16-85 cu		

Uranium. The occurrence of uranium in combustible shales is recorded during gamma logging of wells by a sharp increase in the curve in the Gamma ray (GR) log (from 2 to 10 times higher than the normal background). Chemical analyzes indicate that its main clusters are associated with inclusions of a phosphate substance that is unevenly distributed in the bulk of the rock.

This fact allowed G.I. Trostyansky (PA Kyzyltepa Geology) attributed uranium mineralization to the uranophosphate ore formation. Indeed, anomalous peaks of the Gamma ray (GR) log also characterize phosphate rock interlayers located in the Paleogene section stratigraphic above the oil shale. Previously A.P. Vinogradov drew attention to the importance of the PO4-3 ion for fixing uranium in the soils and rocks of the weathering crust profile. It is also likely that uranium is associated with the actual organic matter (data provided by V. Shcherbiny), where uranium-vanadate ore accumulations are common. In the spectrum of chemical elements of black shale formations (including combustible shale), known in the stratigraphic range of the Phanerozoic, vanadium (by content) is usually one of the first places. Its position in the spectrum of metals led to the birth of the term "vanadium-shales", which is popular in geological literature. Radiometric measurements of combustible shale samples taken from the core of wells in remote regions of Uzbekistan showed significant fluctuations in the uranium and radium contents, regardless of the depth of extraction and the degree of oxidation of shale.

Vanadium. In the oil shale, there is an elevated content of vanadium in comparison with the Clarke in the lithosphere — 0.015% (both in the ash of shale and in the organic component). The average values of it in the combustible shales of Central Asia in the form of a pentoxide are 0.3%, which, in terms of vanadium, with a coefficient of 1.78, corresponds to 0.17%.

Sustained vanadium content in combustible shales, a direct connection with kerogen (correlation coefficient 0.51; correlation ratio 0.43) suggests its organophilic character. However, its correlation with phosphorus and sulfur indicate the possible (not yet established) existence of mineral forms. The absence of the latter indicates the presence of vanadium in the form of organometallic compounds. The close association with uranium, molybdenum, and nickel, as well as well-known examples of increased vanadium contents in oils, indicate the possibility of its being found in the form of porphyrins. The most widespread distribution of vanadium is associated with organic matter of marine origin (plankton, benthos), less - with peat formation. From literary sources, it is known that vanadium is predominantly concentrated in black shales in the stratigraphic range from Archean to Precambrian (USA, Canada, Karelia, Baltic) to the youngest sediments. The deposits of the Taskazgan Formation of the Central Kyzylkum are enriched with vanadium (the Rudnoye deposit and other uranium-vanadium schists of the region).

Molybdenum. In contrast vanadium and uranium, molybdenum in shale is more prone to sulphides (mainly to pyrite) and much less to the organic mass. The data of one differentiated sample showed that pyrite contains 0.034% Mo, while the relatively bespirito mass of slate contains only 0.009%. In early diagenetic pyrites (melnikovites) minerals were detected (%): molybdenite – 49.9; ferromolybdite – 27.4; powellite – 23.2. But since molybdenum and kerogen shale have direct correlations, it can be assumed that molybdenum-containing pyrite does not play a significant role in the overall molybdenum balance in shale, otherwise the dependence of molybdenum and kerogen would be disturbed. However, Mo has properties and organophilicity and chalcophilicity. Its content in sedimentary rocks is $2.0 \times 10^{-4}\%$, and in bituminous shales rich in organic matter – $1.0 \times 10^{-2}\%$ and more.

Table 2.7

Data on Mo content in combustible shales of Central Asia

Object	Ash content, A	Mo, %
Urtabulak (an. 26)	57.3	0.14
Karadarya (an. 17)	63.2	0.166
Baisun (22 an.)	72.0	0.18
Uchkyr (8 an.)	68.5	0.047
Sangruntau (17 an.)	74.23	0.63
Aktau (7 an.)	72.9	0.057

Table 2.7. presents data on the content of Mo in combustible shale of Central Asia. As it is evident, the average content of molybdenum is 0.1% with a maximum of 0.27%.

Rhenium. High values of rhenium in combustible shales (from 0.2 to 21.4 cu), relative simplicity of its enrichment and extraction, an unusually abnormal concentration coefficient relative to the Clarke (up to 4000-5000) push it into the range of the most promising metals in combustible shales of Central Asia. In the literature, there is even a new definition of "gold shale"). The content of rhenium in combustible shales is extremely weak; however, a weak positive relationship is established between it and kerogen, with a correlation coefficient of +0.11. There is a complex dependence in rhenium with sulfide sulfur of early diagenetic pyrite (melnikovite).

Excess rhenium in relation to molybdenum in this type of formations indicates its aggression to copper. However, in the combustible shale its high contents are not observed (100-300 cu). The extremely limited number of rhenium tests allows only preliminary conclusions on its prevalence to be made. So, in Baisun shales, 1.3 cu is set, in Jam shales about 1, in Sangruntau shales - from 0.3 to 0.8 cu. The association of rhenium, molybdenum, vanadium, and nickel is regarded as organophilic.

Tungsten. Industrial contents of tungsten in ores of sedimentary genesis are almost always an exception. Such accumulations are known in the brine of modern Lake Sears in the California Valley of the United States, in selected coastal placers of Russia. High tungsten content in combustible shales of Central Asia is rare. The form of the compounds most of all it is close to molybdenum and less to rhenium. Although tungsten in combustible shales forms positive correlations with kerogen and a sulfide ion, its mineral forms have not yet been established. With relative stability and uniform distribution in combustible shales, this element (along with the others) is of particular interest as a new mineral type in the structureless primary sedimentary carbonaceous formations of the region. It should be noted the presence of scheelite a carbon-quartz metaso-matite, the major gold ore Muruntau and establishing industrial tungsten contents in carbonaceous metasandstones and shales some objects Central Kyzylkum (Sarytau, Zholdas et al.), Which indicates paragenetic unity Paleozoic black shale and Paleogene combustible metal-bearing formations of the region. Taking into account that up to 60% of tungsten is leached in the zones of surface oxidation, its accumulations in other environments of modern sedimentation pools can be considered quite probable, i.e. tungsten minerals are found not only in placers or evaporites, but also in hydrogenic infiltration ores. The average tungsten content in Central Asia combustible shales is 0.047%, maximum 0.14%. In recent years, the demand for tungsten mined from complex ores with its low grade has fallen.

Other metal elements. In addition to the metal elements described above in combustible shales, individual analyzes have established chemical elements that have attracted the attention of technologists on the contents. These include, above all, nickel, rare earths, platinoids, yttrium, selenium, sporadically - scandium. Cadmium, silver, titanium, copper, gold, cobalt, lead, germanium are of secondary importance. Of particular importance in the balance of metals extracted from oil shale, along with rhenium, molybdenum, vanadium, selenium, yttrium, rare earths, platinoids can acquire, the study of which is just beginning. The discovery of platinum group metals in the Mansfield shale (albeit significantly enriched in copper and silver) was the impetus for more thorough study of all the black shale formations of Central Asia at the PGM, among which we include the Paleogene combustible shale of Uzbekistan and, in particular, the Karakata depression. The estimated resources of combustible shale of the Syrdarya and Amudarya basins are estimated to a depth of 600 m from the day surface and amount to 93 billion tons in Central Asia, including 47 billion tons in Uzbekistan (Table 2.8).

Table 2.8

Oil shale reserves in Uzbekistan's fields

Mine field	Reserve category	Counting depth in m	True area in ths.m^2	Counting thickness in m	Stocks of natural shale in thous. tons	Stocks of absolute dry shale in thous. tons
Baisun	B	200	200	0.6	216	206
Baisun	C1	300	1,416	0.56	1,421	1,358
	B+C1		1,616	0.57	1,637	1,564
	C2	500	55,360	0.54	53,822	51,453
	B+Ci+C2		56,976	0.55	55,459	53,017
Sanruntau	C2	100	100,000	1.0	180,000	172,100
Aktau	«-»	«-»	70,000	«-»	126,000	120,500
Uchkyr-Kulbashkak	«-»	«-»	340,000	0.52	318,240	304,240

Continuation of table 2.8

Urtabulak	«-»	200	230,000	0.6	248,400	237,500
Total	B+Ci+C		796,976	0.65	928,100	887,257

Estimated resources of combustible shale to the entire depth of the basins were practically not estimated. Within the limits of the basins, the calculated inventories at five fields amounted to 1 billion tons, including: at Baisun (up to 600 m from the surface) – 55 million tons; Urtabulak (up to 200 m) – 248 million tons; Uchkyr-Kulbeshkak (up to 100 m) – 318 million tons; Sangruntau and Aktau (up to 100 m) - 180 and 126 million tons, respectively. Uzbekistan‘s oil shale, characterized in the geological literature of the CIS countries as highly promising, but poorly studied, has no analogues in terms of the set and content of metallic chemical elements sorbed by bitumoids, kerogen, clay minerals and sulfides.

2.2.6. Phosphorite deposits in the Kyzylkum region

In the Central Kyzylkum region, granular phosphorites are distributed almost everywhere where deposits of Eocene age occur, to which they are confined. However, industrially significant reserves are concentrated mainly in two gentle depressions - Dzheroy and Sardara, which is reflected in the name of the deposits. One of such deposits (Tashkura) is a benchmark for other granular phosphate deposits in Central Kyzylkum.

The Tashkura deposit is located 50 km to the SE from the city of Zarafshan. It is confined to the eastern side of the Tashkura hollow and is adjacent from the north to the mountains Amantaytau and Aristantau.

Occurrence of rocks in the field is gentle, complicated by neotectonic of a plicative nature (undulating topography) and discontinuous disturbances of the post-Paleogene age.

Productive mineralization is confined to the mid-Eocene marl-clayey pack and is represented by two hollow falling (3 ° -5 °) northeast layers of industrial phosphate ores (reservoir and reservoir 2), which are penetrated by wells to a depth of 280-300 m over an area of 2,500 km^2.

The average content of P_2O_5 in reservoir 1 is 16.2%, in the reservoir 2-20.8%. The distribution of the useful component in the reservoirs is relatively uniform.

The main ore mineral is francolite, which is apatite-like calcium phosphate containing about 33% P_2O_5. Other minerals in ores contain calcite (26-43%), gypsum (1.0-3.5%), clay (3-8%), quartz (1.0-5.0%).

Along with widespread rock-forming elements in phosphate rocks, a rather large spectrum of rare (beryllium, lithium, zirconium, tin, molybdenum, bismuth, antimony, arsenic, strontium, fluorine, niobium, vanadium), scattered (gallium, germanium, scandium), rare earth (lanthanum, cerium, neodymium, samarium, europium, terbium, dysprosium, ytterbium, cesium) and radioactive (uranium, thorium) elements. Most of these elements do not give elevated concentrations and therefore are of only mineralogical interest.

At the same time, in the phosphorites under study, some elements (F, U, Yb, Dy and less often Tb, Nd and Ce) give concentrations that are 5-10 times higher than the Clarke content, which is of practical interest for the associated extraction during the production of fertilizers. An example is the development of phosphate deposits in the United States, where in passing receive a small amount of uranium, fluorine, vanadium and selenium.

Analysis of the mineralogical composition of phosphorites shows that they show a direct relationship between phosphorus pentoxide and elements such as La, Ce, Nb, and U. As for the concentration of Sm, Eu, Dy, and Yb, their maximum contents correspond to phosphorites with low P_2O_5 content. i.e. here the relationship is inverse.

The main source of radioactivity is uranium, the content of which in the phosphorites of the Tashkura-Jeroy deposit is significantly lower than in the phosphorites of a similar type from the main deposits of the world (Table 2.9.).

Table 2.9

The average content of radionuclides in granular phosphorites of various

Country	Uranium, cu	Thorium, cu
Uzbekistan (Tashkura)	40.0	5.5
Morocco	141.0	8.2
Egypt	123.0	6.4
USA (Florida)	156.0	14.7
Brazil	274.0	40.0

The specific alpha activity of the ore in question is 3500-4500 Bq/kg, which does not exceed the value regulated by radiation safety standards and sanitary rules for working with natural substances at industrial enterprises (7400 Bq/kg).

The cracks of a sedimentation nature are found in all lithological differences of rocks of the phosphate-bearing strata, their distinctive feature is a small length (up to 1.5-2.0 m) and gentle angles of incidence (up to 12-15°). Tectonic disturbances in the field are practically absent.

The physicochemical properties of the ore, supra- and sub-ore rock are given in Table 2.10.

Table 2.10

Physical and mechanical properties of ore-bearing rocks

Description	Overproductive stratum (clay marl)		Subproductive stratum (marl)
Density, g/cm^3	2.80	2.94	2.79
Bulk density, g/cm^3	1.46	1.76	1.70
Porosity, %	35.1	44.2	32.3
Compressive strength, MPa • in natural state • in water-saturated condition	9.5	44.5 17.3	10.2
Water absorption, %		6.4	
Filtration coefficient, m/day	0.2-1.2	0.5-2.0	0.1-0.8

Overproductive strata rocks belong to sediments of average compaction; their coefficient of water saturation varies from 0.78 to 1.51. Permeability is weak. Filtration factor from 0.2 to 1.2 m/day.

Phosphate rock strata have increased porosity (up to 51%) with a filtration coefficient of up to 2.0 m/day.

Rocks of the sub-productive stratum belong to highly compacted rocks, the filtration coefficient of which ranges from 0.1 to 0.8 m/day.

Studies of the granulometric composition of the phosphorus-bearing rocks showed that, according to the grain size and weight content of the terrigenous components, only phosphate rocks can be classified as fine-grained rocks, and all other rocks – to clayey formations.

Indeed, marls containing productive strata consist of finely dispersed material, 50-70% of which has a size less than 0.005 mm, and 16-28% a size of 0.05-0.01 mm. Phosphorites are well grained and relatively uniformly granular. The bulk of the grain (up to 77%) concentrates on two adjacent screens of 0.01 and 0.05 mm. According to the existing classification, phosphorites should be attributed to aleurite-clay formations. In the direction from the roof to the sole of phosphorites, some aggregation of detrital material is observed. The host rocks also differ from productive strata by a high water holding capacity (17 ÷ 19 versus 11 ÷ 14 in phosphorites).

Hydrogeological conditions Jeroy-Sardara field are same for all stations. At the same time, groundwater, found at a depth of more than 100 m, has a pressure of 50–160 m over a large part of the field. By chemical composition, they are sulphate-sodium chloride and sodium-calcium chloride with salinity 3-5 g/l. The total (mainly carbonate) water hardness is 10.5-15.6 mg/eq/l.

Groundwater is isolated from phosphate rock by clays and carbonate-clay sediments, which are a regional confluence.

2.2.7 Characteristics of phosphorus minerals and their occurrence in nature

Deposits of phosphorites belong to sedimentary rocks and are deposited in layers or in the form of separate pieces of various shades, ranging from gray to brown and black shades, which are found in the form of placers, cemented with clay compounds and limestone. The phosphorus clarke content in the earth's crust is about 0.08% of the useful substance. To date, more than 200 minerals have been described in which phosphorus is found, however, the main part of it is concentrated in the composition of minerals such as phosphorites [$Ca_3(PO_4)_2$] and apatites [$Ca_5(PO_4)_2 CaX_2 (X = P, Cl, OH)$]. In quantitative content, the proportion of phosphorus is greater than the proportion of nitrogen, sulfur, and chlorine, and unlike them, phosphorus occurs as compounds, even being part of protein compounds. A lot of phosphorus is found in the tissues of the bone system of vertebrates (calcium phosphate). The main minerals containing phosphorus are as follows: fluorapatites – $Ca_{10}(PO_4)_6F_2$, hydroxylapatites – $Ca_{10}(PO_4)_6(OH)_2$, chlorapatites – $Ca_{10}(PO_4)_6Cl_2$, carbonatapatites – $Ca_{10}P_5CO_{23}(OH)_3$ and fluorocarbonatapatites – $Ca_{10}P_5CO_{23}(F,OH)_3$. Part of the calcium is replaced in minerals by other elements: strontium, barium, magnesium, lanthanum, iron and manganese. Mineral phosphorus compounds are divided into two groups: primary and secondary. The primary ones are apatites of volcanic origin, which were formed from rocks of igneous origin. They were formed at the time of formation of the earth's crust. Secondary are phosphorite ores of sedimentary type formed as a result of the death of living organisms. The main raw materials for obtaining phosphorus fertilizers and phosphorus compounds are apatite and phosphorite ores. Both types of raw materials contain a mineral that contains a lot of phosphorus – fluorine-apatite $Ca_5(PO_4)_3F$. World reserves of phosphorite and apatite ores according to the data are shown in table. 2.11.

Table 2.11

World reserves of phosphorite and apatite ores

Country	**The average content in the ore, %**		**Reserves, million tons**	
	P	P_2O_5	Ores	P_2O_5
Morocco	14	32	60,100	8,400
USA	10	23	61,000	6,100
CIS	9	20.5	26,800	2,400
Tunisia	13	30	6,200	800
Algeria	12	27.5	3,400	400
Other countries	11	25	8,200	900
Total:			**165,700**	**19,000**

The territory of the CIS countries has large reserves of ore, which are distributed unevenly. The main producers of phosphorus fertilizers are Ukraine, the Baltic States, the North-Western, Central and Ural regions of Russia, as well as Kazakhstan and Uzbekistan. According to forecasts, the CIS countries occupy the 3rd place in the world in terms of reserves of phosphorite ores, after to the United States and Morocco only. The proven reserves are represented by about 2 billion tons in terms of useful substance – P_2O_5. Proven and forecast reserves of phosphorite ores in the CIS are estimated at more than 8.1 billion tons of P_2O_5. In Kazakhstan, the forecast reserves of phosphorites in the Karatau basin amount to more than 635 million tons of P_2O_5, which can be attributed to 450 million tons of possible and, the rest to the prospective deposits. Such deposits are mostly concentrated at the depth (up to 1,000 m) of the surface horizons. The average P_2O_5 content in these ores is about 20-25 %.

The average amount of total phosphorus in treated soils ranges from 0.01 to 0.2%. Phosphorus compounds that are of organic origin are often represented by nucleic acids, phosphatides and phytins, and mineral compounds consist of phosphorous-containing minerals – phosphorite and apatite, which contain various phosphate compounds (oxides of phosphates containing calcium, magnesium, potassium, sodium, etc.). On neutral and alkaline soils, calcium phosphates are mostly predominant, while in acidic soils, aluminum and iron phosphates are more common. The organic and mineral components found in the soil in phosphorus compounds are usually insoluble in water, which makes them inaccessible to plants. The amount of water-soluble phosphorus compounds in the soil is quite small and is about 0.02-2 mg of P_2O_5 per 1 liter of soil solution.

Mineral compounds in the composition of phosphorite and apatites are practically insoluble in water and their introduction into the soil in this untreated form is impractical, because in this form they are difficult to access and poorly absorbed by cultivated plants. Treatment of phosphorites with sulfuric acid leads to the formation of various phosphoric acid salts, the degree of solubility of which is quite high. It is the water-soluble part of phosphoric acid salts after sulfuric acid treatment that are the main part of phosphoric fertilizers, which are necessary for the intensification of agricultural production, since such macronutrients as phosphorus, nitrogen and potassium are the most important elements of nutrition of the main agricultural crops. The main phosphorus-containing raw materials for the production of phosphorus fertilizers are deposits of natural phosphorite ores: apatite and phosphorite. In the composition of these ores, phosphorus can be in an insoluble form and mainly in the composition of a complex compound as fluorapatite – $Ca_5F(PO_4)_3$ or as tricalcium phosphate – $Ca_3(PO_4)_2$.

Apatites are mainly rocks of volcanic origin, having a granular structure and, in addition to fluoroapatite, may contain other minerals of igneous origin. For the production of phosphorus-containing fertilizers from apatite ores with such a complex composition, products can be used after their pre-enrichment to obtain apatite concentrate containing up to 40% P_2O_5, the yield of which is quite high and is about 21% of the weight of apatite ore. The largest apatite Deposit in Russia is located on the Kola Peninsula near Kirovsk-city (Khibiny). In this field, apatites are most often deposited together with nepheline – $(Na,K)_2O{\bullet}Al_2O_3{\bullet}2SiO_2{\bullet}2H_2O$ and other related minerals. Nepheline rock from can be separated apatite by using the flotation method of enrichment and recovery of apatite concentrate containing 39-41% of the total P_2O_5, and nepheline fraction containing up to 30% of aluminum oxides (bauxites) – Al_2O_3, which is a raw material for the aluminum industry. The ore bodies in the deposit are represented by lenticular or sheetlike forms, with a capacity of occurrence (layer thickness) up to 200 m.

Phosphorites are rocks of sedimentary origin containing phosphorus, which is a part of fluorapatite and other francolite with various impurities. The volume of P_2O_5 is quite low and upon enrichment, its content in phosphorites ranges from 20-30%. In order to get easily digestible phosphorus fertilizers suitable for use on any type of soil, it is necessary to convert the insoluble phosphorus salts of natural phosphorites into water-soluble and easily digestible salts. This is what the main task of the production technology of mineral phosphorous fertilizers is intended for. Phosphoric acid salts are mainly produced by using mineral acids and increasing their acidity. Two main salts in the form of water-soluble calcium phosphates – $Ca_3(PO_4)_2$, and $CaHPO_4$ are produced by acid treatment. In this case, it is necessary to transfer most of the phosphorus compounds to the solution as monocalcium phosphate – $Ca_3(PO_4)_2$. In order to convert insoluble natural phosphorus salts into soluble forms, it is necessary to decompose them using acids, alkalis, and heating to high temperatures (thermal sublimation of phosphorus). At the same time, when soluble salts are recovered, the main goal is to obtain phosphorus fertilizers with the highest possible concentration of phosphorus.

2.2.8. Deposits and occurrences of metallurgical, mining, mining chemical, gemstone raw materials and building materials

All industrial minerals of various geological ages are traditionally divided into ore or metal, non-metallic or non-metallic, combustible or caustobioliths and hydro-mineral or mineralized waters (groundwater and self-inflating on the surface) by their industrial use. The current intensive development of mining and mineral science has led to some transformation of previously recognized concepts.

Thus, the combustible slates and phosphorites considered by us, attributable to non-metallic mining and chemical raw materials are classified as metal-bearing minerals with modern technologies.

The bulk of non-metallic minerals is of sedimentary origin. They have a great industrial value. Some of them are considered as "remnants" after they have identified two large homogeneous groups - a group of combustible minerals and a group of metals.

Due to the high heterogeneity of nonmetallic (non-metallic) raw materials, it is impossible to formulate any unified requirement, taking into account the profitability of its production, the cost of the products obtained and the possibility of replacing it with some other material. As an example, for our region, let us take limestone.

Limestone. Sedimentary, clastic rock of organic, or, less often of chemogenic origin, mainly consisting of calcium carbonate ($CaCO_3$) in the form of calcite crystals of various sizes. Limestone, which is mainly consisting of shells of marine animals and their debris, is called a shell rock. In addition, there are nummulite, bryozoan and marble-like limestones, massive-layered and thin-layered. This mineral is developed in all stratigraphic ranges of the lithosphere. In the Kyzylkum region, rock exposures of the Devonian - Carboniferous are the most widespread. First of all, the chemical formula as $CaCO_3$ of limestone can be considered as a chemical feedstock, which is a source of calcium salts and carbon dioxide for soda production. Limestone is the most important component of cement and other binding cement. The use of limestone for the liming of acid soils, that is, as a fertilizer popular in agriculture, is widely known.

Crushed limestone or its variety – chalk are pigments in glue and other whites. Chalk is a filler of many industrial products - plastics, rubber, etc. Occurrences of pure limestone in nature are limited.

Limestones are interbedded with dolomites, clays, gypsum. In Central Asia, widely used clay-gypsum, called „ganch", where it is advisable to use dolomite.

In the south of Kyzylkum, in the mountains of Auminzatau, displays of brucite marbles are known. Brucite $Mg(OH)_2$ - a mineral with the highest possible MgO content (about 70%) is used for the production of refractories, for the manufacture of highly pure chemically active magnesia products used in mineralogical and technological spheres of production.

Limestones and their mineral varieties: marls, shell rocks, calcareous and calcareous clays in the Kyzylkum region have unlimited reserves and are also concentrated in sedimentary strata of the Jurassic, Cretaceous and Paleogene. Limestone is widely used on construction sites as crushed stone, rubble and saw stone. Its metamorphosed variety (usually of pre-Mesozoic age) - marble - the most valuable sculptural and decorative material in urban planning, is worthy of separate consideration.

Marbles. Marble (from ancient Greek **μάρμαρος** "white or shining stone") is a metamorphic rock consisting only of calcite $CaCO_3$. After recrystallization of $CaMg(CO_3)_2$, dolomite marbles are formed. Formation of marble is a result of the so-called process of metamorphism, when the structure of limestone (sedimentary rock of organic origin) changes significantly under the influence of certain physical and chemical conditions. Facing marble is considered an eternal material. The history of marble mined in Uzbekistan is connected with the sights of Amir Temur's time – this is the Bibi-Khanum mosque (1399-1404), and later Gur-Emir, Registan ensemble: Ulughbek madrasah (1417-1420), Sher-dor (1619-1636), Tilla-Kari (1647-1660) in Samarkand, Aksaray Mosque and Temur Crypt in Shakhrisabz, monumental architectural masterpieces of Bukhara and Khiva. Until now, the Amankutan marble deposit has preserved old mines in which semi-processed marble columns and arches have been found.

The "second breath" to the marble of Uzbekistan was given by the metro builders of Moscow, who had chosen it since 1934-1935. During the construction of the first stage of the Moscow Metro (Komsomol station), warm tones marble from the Gazgan deposit was used. The powerful deposits of marble, marbled limestone of the Zarafshan, Sultanuizdag, Nurata and other ridges are widely used in urban planning. At 60 km north of the city of Navoi, the Gazgan marble deposit, unique in its reserves, with its color and physicomechanical properties, is located. Marble fine-grained, multicolored (more than 35 colors). It is conventionally divided into two types: - warm (color) and cold (gray).

In addition to the Gazgan marble deposit, well-known Amankutan deposit, which located 60 km south of the city of Samarkand, where marble blocks were mined back in the XIV-XV centuries. In the immediate vicinity of Gazgan there is the Nurata marble deposit (3 km from the district center of Nurata). And 5 km from Nurata is known Aktau mine of banded marble. Black marble of the Tepalik deposit is developed 20 km south of the city of Navoi.

The development of marble employed North and South Mine Administration of NMMC. For the development of the stone processing industry of the Kyzylkum region for the future, it is necessary to equip the quarries with modern mining equipment with extensive use of stone-cutting machines with a flexible working body carrying diamond-bearing cutting elements, drilling pit machines, pneumatic pillows and hydraulic jacks. Further improvement of the block mining technology should be based on the use of wire saws, on the unification of methods for determining quarry parameters in accordance with the mining and geological conditions of deposits and the properties of rock massifs that determine the labor intensity of block mining.

Graphite. Graphite (from anvient Greek **γϱάφω** “to write”) is a mineral belonging to the category of native elements, one of the allotropic modifications of carbon. The structure is layered. The layers of the crystal lattice can be arranged differently relative to each other, with forming a wide range of polytypes, with symmetry from hexagonal syngony (dihexagonal dipyramidal) to trigonal (ditrigonal-scalenohedral). The Taskazgan graphite deposit, located in the Kyzylkum region, is the only one in Uzbekistan where small mining operations are carried out by small teams of the Bukhara region. About a hundred of graphite deposits located on the contact of marbles and marbled limestone with gabbroids are only partially explored.

Graphite of the Taskazgan deposit is suitable for producing a concentrate with a carbon content of 63-86%, with chemical refinement up to 97%. The resulting concentrates can be used in the manufacture of electric brushes (including aviation ones), graphitoplastics, antifriction products, galvanic cells, alkaline batteries, and nonstick coats. Graphite is used in the nuclear industry, rocket technology, in the manufacture of explosives, in medicine, in the chemical industry.

Development of the Taskazgan field in certain areas was carried out by open pit. On the basis of this field it is possible to create a modern mining enterprise.

Mesozoic-Cenozoic minerals. In the Kyzylkum region, as well as throughout the territory of Uzbekistan, at the Paleozoic and Mesozoic border, eluvial processes were widely developed, because of weathering of eruptive magmatic, metamorphic, and volcanogenic-sedimentary rocks of pre-Mesozoic age. The widespread development of kaolinites formed in the process of weathering of feldspar and mica of the Paleozoic and Precambrian parent rocks, determines the general profile of the kaolin weathering crust and affects the industrial properties of industrial kaolin. In connection with the use of kaolin from the Angren coal deposit in the industry, in the Kyzylkum territory, in-depth studies of kaolin as a weathering product for various types of rocks were conducted to an insufficient degree. More attention was paid to placers of heavy minerals concentrated in the weathering profile and poor-quality bauxites. The most common among the Mesozoic-Cenozoic top sediments are clays of various compositions that are widely used in many sectors of the national economy.

Clay. Industry, using clay, very clearly takes into account the properties of clay components of minerals. In the largest quantities, the red-burning - brick-tiled and expanded clay clays, containing a lot of iron alkali, and therefore very fusible, are used. It is believed that among the clay minerals that make up these clays, ferruginous smectite predominates, but it is rather difficult to prove precisely, since there is usually quite a lot of fine-grained ferriferous minerals in these clays. Clay is a fine-grained sedimentary rock, dusty in dry state, plastic and when moistened. Clay consists of one or more minerals of the kaolinite group (derived from the name of Kaolin area in China), montmorillonite or other layered aluminosilicates (clay minerals), but can also contain sand and carbonate particles.

The kaolin minerals are next in terms of importance. Kaolinite, which forms the basis of all kaolin minerals, is relatively weakly plastic, but its most important feature is that iron cannot enter its lattice. This is of great geochemical and technological importance, since the accumulation of kaolinite creates very high concentrations of alumina, free from iron oxides that are chemically very close to alumina. This also makes it possible to use kaolin as a refractory, and, finally, the absence of iron makes kaolinite white, and this, in turn, makes it possible to obtain white technical products from it, including paper, porcelain, earthenware, paints, plastic and much more.

Purely kaolin clays belong to two genetic types: first, these are primary kaolin — various, mainly feldspathic rocks, which have passed into a clay-quartz rock that has preserved the structure of the parent rock, and, second, secondary kaolin — the same kaolinite material, but redeposited without recrystallization in freshwater. In the process of redeposition, kaolin can be completely freed from quartz or, conversely, redeposited together with this last, giving sandy clay or even kaolin sand; they are all easily enriched.

The kaolin material that has undergone sufficiently high purification during the re-deposition process may also undergo recrystallization with release of aqueous forms of free alumina, thus forming clays with a total alumina content of 30% or higher, which are technically called refractory clays. The redeposition of kaolin clays under alkaline (somewhat saline) reservoirs leads to the emergence of kaolinite-montmorillonite, disordered, mixed-layer structures, which have both high alumina content and very high plasticity, which is typical of plastic clay ball-clay type.

The next group of clays is smectite clays, among which bentonite clays and fuller‘s lands are distinguished. On the territory of the Kyzylkum, kaolin and bentonite clays, to a lesser extent, flask-shaped, are widely manifested. The most widely used clay in the manufacture of refractory products, porcelain, earthenware, building ceramics, as adsorbents, drilling fluids, in the aluminum, paper, rubber industry, for cleaning wines and oils. The largest clay deposits in the region are Kamysbulak (25 km north-east of the village of Tamdykuduk) and Takyrkuduk (30 km north-east of the village of Tamdykuduk). The deposits are of the same type and are associated with deposits of the middle - upper Eocene - Oligocene. Minor occurrences of bentonite clays are also known - Dautbay 12 km north of the village. Mullaly, Suleiman - 15 km north-east of the same village, Dzhetymtau - north 19 km north-west from the village. Jean-Sharva, Dzhetymtau - south 14 km to the north-west and Beshbulak 4 km to the northeast of the same village. Jean-Sharva. Stocks of clay were not read. They are practically unlimited.

NMMC divisions studied the deposits of bentonite clays from the Zarafshan and Prikaryernye deposits (Table 2.11), as well as the Kyzylkuduk deposit of red-colored clays for the production of bricks, tiles, tiles and other products (Table 2.12).

Kyzylkuduk deposit of red clay. Clays meet the standards of rational safety according to RSS-76. In the case of semi-industrial tests carried out with a charge mixture of 75% clay and 25% sand, samples of bricks with a compressive strength of 100–110 kg/cm^2 and a residual moisture content of bricks of 4–5% were obtained.

Clay is a fine-grained sedimentary rock, dusty in dry state, plastic and when moistened. Clay consists of one or more minerals of the kaolinite group (derived from the name of Kaolin area in China), montmorillonite or other layered aluminosilicates (clay minerals), but can also contain sand and carbonate particles.

The firing temperature is 1050 + 20 °. Brick brand „100“ GOST standard 530 80, frost resistance F-15. Clay size distribution:

sand particles - 0.2-10.8%;
dust particles - 21.3-50.2%;
clay particles - 4.7-33.8%;
plasticity number 3.6-21.2 (on average 13.9).

The chemical composition of clays: the volume mass of reddish clays is 1.679 kg/cm^3, the content of SO_3 is 0.10-1.0%, and the CO_2 is 3.6-10.8%.

Table 2.12

Chemical composition of bentonite clays of Zarafshan and Prikaryernoe deposits

Chemical composition in %	Zarafshan deposit of bentonitic greenish-yellow clay	Prikaryernoe deposit of bentonite greenish-gray clay
SiO_2	58.9-63.2	53.2
$Al_2O_3 + TiO_2$	13.1 – 18.6	10.7
Fe_2O_3	5.2-5.9	8.1
CaO	2.5- 4.2	2.2
MgO	1.6 - 2.3	1.9
K_2O	1.7 - 2.1	-
Na_2O	1.4 – 2.0	-
As	-	0.03
CO_2	0.04 - 0.41	-
S	-	0.002
SO_3	0.8 - 4.1	-
Mo	-	0.007
Size of fractions in mm		
> 0.25%	0.1 – 0.5	0.2-0.6
0.25 0.01 %	7.7 - 13.9	8.8 - 14.0
<0.01 %	85.9 - 92.1	85.0 - 93.0
Plasticity number	27.4 - 35.6	30.0

Table 2.13

The chemical composition of the red clay of Kyzylkuduk deposit

Chemical composition, %	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	Na_2O	K_2O	CO_2	SO_3
75% clay, 25% sand	46.9-50.2	12.5-13.3	4.5-6.3	10.3-14.3	2.4-3.2	0.4-0.6	0.78-0.96	2.02-3.2	3.61-10.8	0.1-1.0

Clay deposits are non-cutting, reserves are practically unlimited. The content of harmful impurities in clays meets the requirements of the industry for brick raw materials. A very small admixture of sodium bentonite to water easily creates a porous structure, and such water “gelles”. Sodium bentonite is widely used in the preparation of drilling fluids. However, the strength of the structure created by such bentonite is very low, therefore, in order for the clay to hold the impurity (sand) more firmly, which is necessary in the manufacture of pellets and molds, preference is not given to pure sodium montmorillonite, but sodium calcium. Calcium montmorillonite - Fuller‘s earth - serves as the best sorbent, therefore such clays are used as a filter for the purification of oils and juices. Calcium as an exchange cation is relatively easy to exchange with other cations, and this feature is widely used in engineering for the production of so-called modified clays. Currently, almost all montmorillonite clays are used in activated form.

Currently, clay as sorbents are used to clean wine, juice, beer and other beverages, as well as vegetable oils. In the oil industry, mineral oils are refined with clay, and it can be used to regenerate used oils. Montmorillonite clay is also used as a catalyst in the cracking of petroleum. However, the total amount of these clays used by industry is relatively small.

Montmorillonite clays began to be used in the foundry industry in the beginning of the 20th century already. Molds are made from sand with a small amount of clay; Clay is strongly dispersed and distributed in the intervals between the contacting grains and firmly binds them. The higher the quality of the clay, the less it is needed for a bundle of a mold. The role of clay in the casting mold is somewhat controversial: on the one hand, clay, gluing sand between them, creates form strength, and on the other, it is harmful because it sticks the gaps between sandy lands fully or partially and thus reduces the porosity of the mold, which is highly undesirable. , because when pouring metal into the mold, all the air that filled the mold must escape from it through the pores. The greater the porosity of the form (with equal strength), the better. Approximately the same role as in casting molds, clay plays in one more intermediate technological process - obtaining ore pellets.

It is necessary to emphasize another feature of clay, which was not previously mentioned, and which distinguishes clay from other minerals. The properties of clays can be somewhat changed by chemical exposure. Clays with sodium as an exchange base are very easily dispersed, they give a gel-like suspension in water with a very small amount of clay, but the bonds created by these clays are very weak. If the exchange cation is calcium, the clay has good sorption properties (it cleans well oil, vegetable oils, juices, wine, beer), but is poorly dispersed, etc. Artificially, it is produced clay with sorbed silver, lithium and other elements; they are also used in industry. Brand new, exceptionally profitable building material – ***expanded clay***. Providing a raw material base for the production of expanded clay is an urgent task, since expanded clay concrete is the basis of the future construction industry. At present, for the production of expanded clay, raw materials of previously explored Paleogene (Kattakurgan) and Cretaceous (Beshtyube, Kungurtau) rocks are used for additional testing and additional assessment simultaneously on large deposits of Bandykhan (Surkhandarya region). The raw materials for the production of expanded clay in Uzbekistan are mainly low-melting clay rocks of the Meso-Cenozoic of various chemical and mineralogical composition and origin, as well as clay schists and quartz-alunite rocks of the Paleozoic.

The rates of industrial development of claydite deposits are lagging behind the requirements of the construction industry in the republic. Of the nine deposits of claydite raw materials, Azkamar (Bukhara) and Kungurtau (Karshi) are exploited. Other claydite enterprises (Tashkent, Jizzakh, Samarkand) are supplied with raw materials mainly from neighboring republics (Kazakhstan, Turkmenistan).

Marls. Marl is sedimentary lithoid rock of mixed clay-carbonate composition: 50-75% carbonate (calcite, less often dolomite), 25-50% insoluble residue (SiO_2 + R_2O_3). Depending on the composition of the rock-forming carbonate minerals, marls are divided into calcareous and dolomite. The silica content in common marls exceeds the amount of one and a half oxides in an insoluble precipitate by 4 times maximum.

Marl is mainly used for cement production. Predicted resources in the Kyzylkum region are unlimited. The most significant deposit is Dzharykbass, located 30 km north of the city of Tamdy. Marl reserves at this site in category C 2 - 4.5 million m3. Moreover, 9 million tons suitable for the preparation of cement. On the Kosbugen field, located 27 km north of the village. Mullaly, reserves are determined by category C, at 8 million m3, of which it is possible to manufacture 17.6 million tons of portland cement.

Sands. The largest deposit of quartz sands is Aydaraly, located 25 km north-east of the Tamdy town. Estimated reserves - 15 million m^3. The sands are white, fine-grained. In its natural form, it can be used for the production of silicate products, plastering solutions, and after processing it can be used in glass production and molding metallurgy. The sands of the Dzheroy deposit, located 3 km south-east of the settlement. Tamdy, have a slight admixture of feldspar and can be used as raw materials for various building materials. The mineral resources of the Paleogene sands are practically unlimited.

2.2.9. Underground thermal mineralized water

Highly mineralized water – brines (B) are common near the surface of the earth in arid areas and mainly are the product of intense concentration during evaporation of continental and seawaters. The relationship between the distribution of brines and the development of salinity and salt deposits has been empirically established. The depth does not determine water mineralization and the hydrogeological closeness associated with it, but by the presence or absence of sediments of increased salinity in the section of the pools. Two types of brine are associated with salt deposits. Those are either the uterine B saltwater pools that once existed here (sedimentation B), or B, formed due to the penetration of "alien", for example, surface water and solutions, to the salinity deposits, as well as the leaching of salt deposits (B leaching).

Groundwater is used in the national economy of the republic for various purposes. Weak salty water (dense residue up to 3 g/l) is used in the desert for irrigation of pastures and small-oasis artesian irrigation, and in oases irrigated with river water, they are used as an irregular additional source of irrigation (collector-drainage network). Medium brackish waters (dense residue 3-5 g/l) are suitable for watering sheep and are an important source of irrigated desert pastures.

A special group consists of groundwater with specific properties or containing valuable components. These include mineral waters used for medicinal purposes, thermal waters used as heat sources, industrial waters, from which iodine, bromine and other valuable components are extracted.

Central Kyzylkum are distinguished in a special hydrogeological region of a mountain-folded region, in which small intermountain artesian basins are combined with low-mountain hydrogeological massifs. The interbedded waters of the Cretaceous sediments in these basins in many cases have a relatively low degree of mineralization (2-5 g/l), serve as the main source of pasture irrigation and are used for gravity artesian irrigation in separate arrays. Freshwater used for water supply of mining enterprises is much less common.

Low mountain massifs of the Central Kyzylkum hydrogeological region. The mountain ranges of the Central Kyzylkum have a desert climate with an annual precipitation of less than 250 mm. Due to the extremely poor supply, groundwater is mostly located below the thalwegs of the local hydrographic network, and in the watershed parts of the mountain ranges, the zone of regional fracture of the Paleozoic and Pre-Paleozoic rocks is completely drained. Sources are very rare, their production is extremely insignificant, in the whole region is no more than 100 l/sec. The highest flow rates are 0.5-20 l/sec, in isolated cases - up to 20 l/sec. The estimated groundwater resources estimated by the possible absorption of precipitation are 1.85 m^3/sec.

The fractured-karst waters of limestone have a dense residue up to 1, less often up to 2 g/l, fracture waters of other rocks have a higher mineralization: granites - 0.5-2.5 g/l; shale - 1.4-6.

Deposits of weak salty stratal waters in the Upper Cretaceous deposits of the Karagata and Minbulak artesian basin of the Central Kyzylkum. The small artesian basins of the Central Kyzylkum desert represent a desert where fresh groundwater is found only in eolian sands in the form of very rare lenses floating on saline waters. They are used mainly by wells with a small flow rate. Therefore, weak saline inter-layer waters, discovered by hydrogeologists in the Upper Cretaceous sandstones of the Karagata and Minbulak basins, have played an important role in the economic development of the desert. In the remaining six basins of this hydrogeological region there are no waters of such quality, and mostly medium and highly saline waters are used, which are used for watering sheep. The Minbulak and Karagata artesian basins are the largest in Central Kyzylkum (up to 50-60 km in diameter). The main water-containing complex in them is the Upper Cretaceous sediments (sands and sandstones with clay interlayers) with a thickness of several hundred meters, filling the deflections between the elevations and outcrops of the Paleozoic basement. The resources of the artesian waters of the Karagata basin are estimated at 1.7 m^3 / s, of Minbulak - at 3. This amount also includes medium-saltish waters, which could not be distinguished in the estimated calculations. The main prospects for the use of resources are associated with fine oasis artesian irrigation of land in order to create insurance reserves of feed for free range Karakul sheep breeding.

Mineral and medical, industrial, thermal, table waters and salt-mud lakes. Mineral, thermal waters and salt-mud lakes, also referred to as "hydromineral raw materials" or "hydro mineral resources", are valuable complex mineral resources. Diverse in chemical composition - the value of total mineralization, the presence of various trace elements, as well as the gases contained in them and the temperature - mineral and thermal waters are widely and successfully used as therapeutic - balneological resources, as table drinking water, as industrial chemical raw materials, and finally as sources of natural heat for household and household purposes.

Among the mineral medicinal waters, there are different: strong sulfur-hydrogen types of the Sycimecestine, radioactive or radon, carbonated cold and hot, ferrous, iodine and bromine-containing, arsenic, waters containing various micro elements (boron, strontium, nickel, cobalt, etc.), also thermal, i.e. natural warm and hot waters with temperatures from 25-30 to 95-100° and above and from slightly or slightly mineralized to brine. Iodine, bromine, boron, rubidium, cesium, tungsten, radium, sulfur (from hydrogen sulphide), ammonium products, various salts such as sodium chloride and sulphate, magnesium sulphate and sulphate potassium chloride, etc. are extracted or can be extracted from industrial mineral water. Mineral medicinal and industrial waters can also be thermal.

In recent years, in Karakalpakstan it was found through deep drilling the high-yield spouting mineral warm and hot (30-37°) waters of chloride-sulphate-sodium composition with a total mineralization of 2-3.5 g/l, i.e. slightly mineralized waters. They are confined to the layers of sandstones of the Upper Cretaceous age of the Aral Sea artesian pool (in the western part of the Syrdarya artesian pool). They deserve comprehensive quality testing in order to establish the possibility of using them for industrial bottling as mineral table waters. Given the considerable remoteness of Karakalpakstan and the Khorezm region from other regions of Uzbekistan, a positive solution to this issue will be of significant economic and economic importance.

The waters of the Kyzylkum gas and oil fields - Gazli, Tashkent, and others deserve attention.

The salt-mud lakes of Mullaly, Agitma, Tuzkan, Balykly, Aksykon and brines Karakon, Sultansandzhar, Kaparas, Karaumbet, Barsakelmes and the Sarykamysh group of lakes should be considered as the most prospective.

Valuable mineral industrial iodine bearing and iodine-bromine waters have been identified, awaiting detailed exploration and practical use of the new for Uzbekistan branch of the chemical industry-iodine-bromine.

The territory of the Republic of Uzbekistan is subdivided into two large areas - the mountain-foothill area, which occupies its eastern and southern parts, and the flat-lowland areas - in the west and north. The mountain-piedmont region is an alternation of mountain ranges, intermountain valleys and depressions, flat and lowland, large, occupies the deltaic parts of large rivers (Amu Darya, Zarafshan), dry steppes, sandy desert Kyzylkum and Ustyurt plateau.

Artesian pools located in the desert zone contain interstitial waters in sandy packs of several aquifer complexes (from Neogene to Jurassic). According to quality indicators, this groundwater are used for irrigation of pastures and oasis irrigation. It should be emphasized that most aquifer systems contain high-pressure waters, the piezo metric levels of which naturally exceeded the earth's surface by 20-50 m. Because of many years of operation and, unfortunately, useless self-draining wells in many artesian basins, the piezo metric levels decreased almost surface. Groundwater is poorly mineralized (with a residue of 1.5-5.0 g/l) and may be of considerable interest for household and drinking use after preliminary water treatment in desalination plants. Similar experience is available in the Southern Aral Sea region, where about 100 such installations have been installed, desalinating the groundwater of Upper Cretaceous sediments for drinking water supply to certain rural settlements remote from the centralized water supply systems.

The relict deposits of fresh groundwater in the Golodnaya Steppe and eastern Kyzylkum, which occupy large areas and are confined to the Neogene sediments of the buried alluvium of the Syrdarya river. At present, they receive insignificant food due to precipitation only in eastern Kyzylkum.

The following balneological groups of mineral waters have been identified on the territory of the republic: without specific properties and components, hydrogen sulphide, iodine, bromine, radon and carbonic. The most valuable mineral waters without specific properties and components (nitrogen-alkaline terms, sulphate and chloride-sulphate sodium types of Izhevsk and New-Izhevsk) are distributed in the Tashkent region, Kyzylkum, Zarafshan and Central Kyzylkum pools, as well as in the upper hydrogeological floor.

Within the Central Kyzylkum artesian pools, mineral water (MW) groups in the Cretaceous and partially Paleogene sediments are widely spread. According to their mineralization, they can be considered as medicinal table. Radon MWs can be formed in emanating reservoirs enriched with radioactive elements within the Central Kyzylkum group of artesian pools — waters of the Upper Cretaceous sediments of the Uchkuduk regions (Mingbulak artesian pool), Artak collector (Tubelek artesian pool). The thermal waters of tectonic fault zones have been studied to a lesser extent.

For the first time in Uzbekistan, explored with the calculation of operating reserves by industrial categories Altynsay field of thermal water for the heating of greenhouses. It is located on the northern side of the Zarafshan intermountain pool, on the southern slopes of the Aktau Mountains, and administratively in the territory of the Altynsay state farm, Khatirchi district, Navoi region. Thermal waters are confined to the fractured zone of the Upper Paleozoic granodiorites, which are complicated by tectonic disturbances of thrown and thrust nature and covered by rocks of the Quaternary, Neogene and Paleogene ages with a waterproof layer of Paleogene formations up to 200 m. Granodiorites are developed to the depth 104-612 m and expose to the daylight area in 10-15 km to the northeast. Thermal water is derived from intervals from 129-145 to 280-305 m. The static water level is set from 38.9 m below, to 0.52 m above the ground surface. The flow rate of water in wells 5.62-21 l/s, specific flow rates – 0.2-2.6 l/s. Water is brakish (1.6-1.8 g/l) from neutral to slightly alkaline (pH – 7.0-8.1), oxygen-nitrogen (N-83.8, O_2– 15.44% by volume of dissolved gas), sulphate-sodium chloride (SO_4 – 24-28, CI – 66-69, Na – 83-85 mg eq) is high-thermal (very hot) with a temperature on the spout of 59-65°C. Operating reserves by category B - 2972.2, C1 – 656.6 m^3/day (34.4 and 7.7 l/s). Thermal power capacity of the field in terms of the operational reserves of thermal waters in category "B" is 6.49 thousand Gcal/year. Thermal water is a complex hydro mineral raw material that can be used as a healing mineral water, for bottling, and used after heating for technical purposes.

Thus, groundwater is a valuable mineral resource that can provide prerequisites for the production of iodine, bromine, caustic salt, and rare elements in Uzbekistan.

2.3. State and prospects for the use of energy and water resources in the region

2.3.1. Energy and water supply of enterprises and social facilities

The energy base of the plant developed in three stages. At the first stage (1959-1964), in the shortest possible time, four power units were built at the Navoi Power Plant (NPP) in Navoi, a diesel power station and a thermal power plant in the city of Uchkuduk, a 220 km power transmission line Navoi-Uchkuduk with a length of 300 km, hundreds 35 kilometer transmission lines of 6 kV with distribution substations, trunk and distribution pipelines for heat and water networks were laid, the first sources of heat and water supply systems for cities were erected. The crucial role in this period in the development of energy supply was the NPP, the construction and the combine carried out operation of which until 1966. NPP contributed to the creation of a powerful industrial complex of a number of large industrial enterprises in the Kyzylkum region. The commissioning of the first power units at NPP allowed the plant to commission uranium mines and quarries in Uchkuduk in the shortest possible time, ensure sustainable operation of energy-intensive mining equipment, build modern cities - Navoi, Uchkuduk, Zarafshan - with all the infrastructure, as well as ensure the electrification of nearby settlements, cities of Bukhara and Karshi.

At the second stage (1966-1973), the first two stages of the gold extraction complex in Zarafshan were built and put into operation, which contributed to an even more intensive energy supply of the plant. During this period, 220 kV transmission lines were commissioned: Kyzylkuduk-Zarafshan-Besapan, 54 km long, Amudarya-Zarafshan, 215 km long, Navoi-Besapan, 185 km long; The 220 kV power transmission line at Muruntau open pit and the 220/35/6 kV substation is a hub in Zarafshan and a technological station at Hydrometallurgical Plant No. 2. During this period, the Amudarya-Zarafshan conduit with a diameter of 1220 mm and a length of 208 km a cascade of pumping stations and 220/35/6 kV technological substations.

At the third stage, the expansion of energy capacities was continued, associated with the construction of a gold extraction complex in the city of Uchkuduk, the expansion and reconstruction of hydrometallurgical production in Zarafshan. During this period, there were built and commissioned the second 220 kV transmission line Navoi-Besapan, 184 km long, 220 kV transmission line, Besapan-Uchkuduk, 132 km long, one of the main hubs in the region under the 220/110/35 kV "Feruza" station with two autotransformers 2x125 MVA in Uchkuduk, which connected the 220 kV network of the NPP - Besapan-Zarafshan-Uchkuduk-Takhiatash Power plant, a number of 220/35/6 kV technological substations into a single ring.

Now, the energy sector of the plant is a complex set of facilities and structures for electricity, water, gas and heat supply. Tens of thousands of kilometers of air and cable networks of all voltage levels, drinking and technical water supply lines, powerful pumping stations and installations, heat supply sources and systems of cities and industrial facilities are on the balance of enterprises and in operation.

The complexity of the operation of this economy is associated primarily with the scale and remoteness for many hundreds of kilometers from each other of enterprises – large industrial and city-forming centers. For uninterrupted power supply of the population of the cities of Zarafshan, Uchkuduk, Navoi, Zafarabad, Nurabad and Krasnogorsk, located on the balance of the plant, the energy service annually performs a large amount of work on preparing networks and systems of heat and water supply for operation in winter conditions.

Power supply. The consumed electric power is currently 420 MW with annual energy consumption of 3,730 million kW / h. The plant operates 1100 km of 220 kV transmission line, 1,450 km of 35-110 kV transmission line, 15 220 kV substations with an installed capacity of 1,150 MW-A, 67 35-110 kV substations, 989 km of cable and air networks 6-10 kV, 1093 6-10 / 0.4 kV transformer substations, several tens of thousands of kilometers of low-voltage networks. The power supply of the Zarafshan-Uchkuduk region is provided by three 220 kV transmission lines, all networks are looped back and reserved through the junction transit substations of 220 kV. In connection with the growth of electrical loads, the construction of the fourth 220 kV transmission line Navoi-Besapan is planned.

According to the Decree of the President of the Republic of Uzbekistan, No. PP-3465 "On the program of measures for guaranteed supply of electric power to the newly created production facilities of the Navoi MMC till 2026", dated January 9, 2018, the construction and installation operations are underway at NMMC to commission the facilities under investment projects. In total, it is expected to be commissioned of 4 units of 220kV substations with a total transformer capacity of 662 MVA, 5 units of 110kV substations with a total transformer capacity of 340 MVA, 9 units of 220 kV transmission lines with a total length of 356 km, 8 units of 110 kW transmission lines with a total length of 180 km. The operation of power equipment and networks of all voltage levels is carried out by the personnel of the power shops included in the structure of enterprises.

Introduction of a steam turbine into sulfuric acid production.

The NMMC's project „Improving the energy efficiency of the sulfuric acid production of Northern mine administration by means of generating electricity with using secondary energy resources" was implementation with participation of the International Development Bank. The main goal of the project is to increase the energy efficiency of sulfuric acid production by generating electric energy with using secondary heat of the Sulfuric Acid Production Shop (SAPS). The process of producing sulfuric acid stipulates burning sulfur, with release of a large amount of heat. Heat is used to produce steam consumed in the process and for heating. When the produced steam was consumed, some of the heat was irretrievably lost. Heat losses were about

43,000 Gcal per year. In order to avoid heat losses, in 2016, the construction of a steam Turbine Generator Unit (TGU) for generating electric energy was completed.

Every year, the steam turbine unit generates 38 million kWh of electricity, which covers 80% of the demand by sulfuric acid production in electric energy. During the period of operation, the steam turbine unit generated more than 57.5 million kWh of electricity (since June 2016).

The implementation of the project enabled to eliminate the inevitable losses and use the lost heat to generate electricity, as well as create an additional 22 jobs. The unit is operated by graduates of local educational institutions.

The heat supply of industrial enterprises, facilities, five cities and three workers' settlements is carried out mainly from their own industrial heating boilers and thermal power plant in Navoi. On the balance and in operation there are 26 heat supply sources, on which boilers with a total capacity of 854.4 Gcal/h are installed. Consumption of thermal energy annually amounts to 1,300-1,400 thousand Gcal, of which from own sources – 600-700 thousand Gcal. The boiler plants of the enterprises mainly work on liquid fuel, while the boiler houses of the cities of Zarafshan, Uchkuduk, Mardjanbulak and settlements of Zafarabad, Sarimay use gaseous fuel.

Annual fuel consumption for heat generation is 90.0 mln m3 of natural gas and 4,000 tons of furnace oil.

One of the current areas of energy supply of the plant today is gas supply - gasification of cities and workers' settlements, the transfer of industrial fuel using installations to natural gas. The use of natural gas instead of liquefied for domestic purposes; the transfer of boilers from fuel oil to gas will ensure the stability and continuity of the energy supply of the population and industrial enterprises.

Currently, the cities of Navoi, Zarafshan, Zafarabad, Nurabad and Zarmitan are fully gasified. High-pressure gas pipeline branches have been built for gold-processing plants in the cities of Zarafshan and Uchkuduk. with a length of 95 km and for the gold extraction complex in Zarafshan. Gasification of the industrial zone of the Zarmitan mine of the Zarmitan gold ore zone was completed. A high-pressure gas pipeline branch to geotechnical mines in the Navoi region was commissioned.

In average, consumption of natural gas at the plant is 180.0 million m^3/year.

The economy of natural gas was 34.0 million m^3/year for the period 2010-2019, for amount of UZS 5.72 billion.

Water supply.

Domestic-drinking and technical water supply of cities and industrial enterprises of the NMMC is mainly carried out from the surface sources of the Amudarya and Zarafshan rivers. The installed capacity of pumping stations at the water intakes of the plant is 992 thous. m^3/day. The length of the main conduits and distribution networks is 1,906 km.

The water supply systems of regions are characterized by the parameters as follows.

Zarafshan-Uchkuduk region. The sources of water supply for the cities of Zarafshan and Uchkuduk, HMP-2 (Hydrometallurgical plant) and HMP-3 (Hydrometallurgical plant), deposits, quarries, and other industrial facilities are the r. Amu-Darya and low-powered underground sources Mingbulak, Beshbulak, Karakata with a productivity of 5,000 and 26,000 and 7,200 m^3/day, respectively. The underground water sources are used to provide household and drinking needs (Mingbulak) for people of Uchkuduk-city, and technical needs (Beshbulak) for HMP-3. Auminzo-Amantai mine is supplied with water from Karata deposit and water duck ADZ.

Due to their low productivity and rapid development, and the development of the region for uranium in the city of Uchkuduk and gold in the city of Zarafshan in 1965, a decision was made on the construction of the Amudarya-Zarafshan water pipeline complex, which has no analogues in Europe, with a diameter of 1220 mm, a length of 208 km, a capacity of 256,800 m^3/day. This complex energy complex includes seven main booster pumping stations operating in a single mode and ensuring the rise of water from the level of 140 m to the river. Amu Darya to the mark of 692 m. The water pipeline complex includes a 220 kV transmission line with a length of 210 km with four 220/35/6 kV transit substations and three 35/6 kV substations.

The uniqueness of the complex lies in the fact that it was built and put into operation in the extreme conditions of the Kyzylkum desert with complete lack of roads and lack of water through the dunes up to 30 m high, under the scorching sun in summer and the outdoor temperature above 60°C.

The first kilometers of the pipeline were laid in the autumn of 1966, and in the early spring of 1969, a proud inscription **was written on the last whip of the pipe: "Desert, I am the Human and I brought you the life"**.

A water pipeline with water intake and a complex of pumping and filtering stations was put into operation on May 27, 1969. In order to increase the capacity of the conduit in subsequent years, the second line of the conduit with a diameter of 1220 mm.

To ensure water supply of the city of Uchkuduk, from the city of Zarafshan was constructed a drinking water conduit with a diameter of 1,000 mm and industrial water conduit with a diameter of 700 mm, each conduit has 95 km length. The second unit of the filter station was constructed and commissioned in the city of Zarafshan.

In accordance with the resolution of the President of the Republic of Uzbekistan, PP-2806 "Program of additional measures to increase the production of precious metals until 2026", dated 01.03.2017, stipulates expansion of existing and construction of new capacities HMP-2, GHLP, HMP-3, Auminzo-Amantai (HMP-5).

To ensure water supply of additional facilities, as well as taking into account the population growth in the Zarafshan-Uchkuduk region, this program stipulates implementation of the project "Construction of the third train of the Amudarya-Zarafshan water main, with reconstruction of pumping stations" for the period from 2018 to 2025. With this, 157.3 km long water main will be constructed, with reconstruction of pumping stations. Capital investments envisaged for the construction are amounting to UZD 127 million. The maximum capacity of the ADZ water conduit will иу more than 120 million m^3/year (14 thousand m^3/day) in 2026.

Navoi industrial area. The source of drinking and technical water supply of industrial enterprises (Navoi TPP, Navoiazot JSC, Elektrokhimzavod JSC, Kyzylkumcement JSC, HMP-1, NMBP), as well as the residential zone of the city of Navoi is the Zarafshan river. The design capacity of water treatment facilities as operated by the plant is 640 thousand m^3/day, including 240 thousand m^3 of drinking water and 400 thousand m^3 of technical water. The actual capacity of the complex is 100 thousand m^3/day of drinking water and 120 thousand m^3/day of technical water.

The consumers of quality drinking water and technical water are supplied in a stable manner and in the required amount.

The plant's energy efficiency improvement strategy is an important aspect to increase the competitiveness of the enterprise's economy.

In the economy of Uzbekistan, the mining industry is one of the leading ones and is based on a strong mineral resource base.

The priority area of activity of NMMC is the industrial development of mineral resources, and the main products are gold and uranium. This is the basis for the entire life of the mining and metallurgical complex with a complete production cycle: starting from prospecting and exploration, ore mining and processing, till production of pure gold (99.99) and uranium oxide.

The mining and processing industry is one of the most energy-intensive sectors of the national economy of Uzbekistan. The average cost of energy in the industry is about 20% of the total cost of mining and processing of ore.

In connection with the transition to a market economy, the importance of economy and rationalization of the use of fuel and energy resources (FER) sharply increases. At the existing mining and processing industries developed and implemented quite effective measures aimed at energy and resource conservation.

However, these activities are local. Analysis of domestic and foreign experience shows that the reserves of fuel and energy resources savings exist in almost all parts of the technological process of the mining and processing industry.

Annual consumption of fuel and energy resources in NMMC is close to 800 thousand tons of oil equivalent (t.o.e). The presented graphs of changes in unit costs (Fig. 2.15) for the purchase of fuel and energy resources separately for each resource and as a whole from 2009 to 2019, taking into account the growth of tariffs and the increase in production, show that with an increase in the planned production volumes, the unit costs for FER.

The basis of the energy and resource saving strategy at NMMC is the creation of an energy-saving production structure for the extraction, transportation and processing of ore based on a comprehensive solution to the issues of saving and energy saving.

One of the priorities of the strategy of transition to energy-efficient production is to carry out systematic work on the implementation of a system of resource and energy saving.

Rationalization of fuel and energy consumption, strengthening the economy of fuel and energy resources are inextricably linked with the formation and implementation of the plan of organizational and technical measures (OTM). The main objectives of the OTM plan are to save all types of fuel, heat and electric energy, water resources, compressed air and oxygen in production and to mobilize the efforts of collectives of employees to ensure the envisaged parameters for saving fuel and energy resources and reducing energy consumption rates.

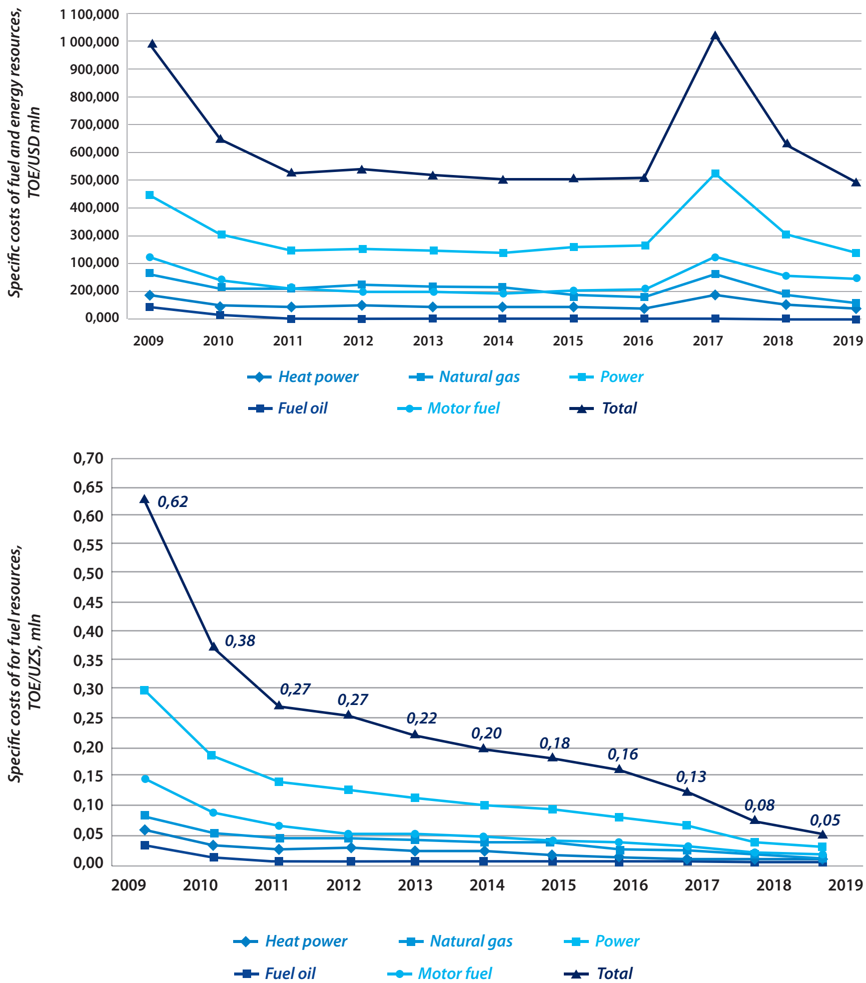

Fig. 2.15. Dynamics of changes in the unit cost of fuel and energy resources at NMMC until 2019

Based on the specifics of the mining and processing industries at NMMC, systematic work is being carried out to reduce the energy intensity of products, the introduction of energy-saving technologies and equipment, allowing to change the specific energy consumption for the extraction and processing of gold and uranium.

Saving FER is achieved by:

- improving the structure of production, transformation and use of energy resources;
- reduce all types of energy losses and increase the level of use of secondary energy resources;
- transition to energy-saving production technologies, reducing material consumption, improving the organization of production processes;
- introducing into production more energy efficient vehicles, machines and mechanisms of power equipment.

Fuel and energy resources used in the production of products have a significant impact on the course of any production process, since the disruption of the work of individual links of the energy sector leads to the deregulation of the main production. The largest share among consumed energy resources in the conduct of mining and processing work has electricity.

The energy saving system of Navoi MMC consists of a complex of economic, legal, scientific, technical and organizational measures aimed at the efficient use of resources. In this regard, the main areas of energy saving at the plant include: the introduction of scientifically based energy consumption rates for mining and refining at all levels, the widespread introduction of control and metering devices, the introduction of energy-saving technologies, reduction of unproductive energy losses, and the introduction of economic incentives for energy saving.

Savings of fuel and energy resources largely depend on the proper organization and feasibility of rationing fuel and energy costs. Rationing of fuel and energy resources is becoming more and more important, since the constant increase in power supply, the complication of work conditions, and their displacement to remote, hard-to-reach areas of Central Kyzylkum cause an increase in the consumption of fuel and energy resources. Currently, the mining divisions of the plant have more than 800 specific consumption rates of energy resources and about 500 standards of fuel consumption for production, services and work, while in 2001 they operated a little over 100. All divisions of the plant finished calculations and approved regulatory losses in the main, distribution electric, heat networks, gas, and water supply networks. In addition to the NMMC specialists, republican organizations, such as the Intersectoral Center for Strategic Innovations and Informatization, Uzgosneftegazinspeksiya, and EKOTEXXIZMAT Ltd, Advice-Audit LLC were involved in the development of specific consumption rates of fuel and energy resources for manufactured products. Work on the development and adjustment of specific standards continues.

One of the main factors impacing the volumes of diesel fuel and electricity consumption in the mining and metallurgical industry is mining and processing complexes. An increase in the volume of overburden of rock, ore mining and their supply to the hydrometallurgical plants will result to an increase in the consumption of diesel fuel and electricity for extraction of rock mass and transportation of ore. The dynamics of the values of the main indicators of the mining complex shows that the volume of rock mass transportation was 88.1 million cubic meters in 2010. meters. In 2019, this indicator is expected to grow by 177% versus 2010 and amounted to 156.0 million cubic meters (Table 2.14).

Table 2.14

Dynamics of changes in rock mass transportation values for NMMC in 2010 – 2019

Description of indicator	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Volume of rock transportation	mln. m^3	88.1	91.1	83.3	91.2	103.4	106.9	107.4	123.3	148.0	156.0
Fuel consumption	thous. tones	127.9	133.5	123.7	129.9	126.1	127.3	131.5	138.0	168.7	196.3
Specific consumption of diesel	l/m^3	1.75	1.78	1.80	1.73	1.48	1.44	1.48	1.36	1.38	1.53

An important indicator for calculating the efficiency of transporting rock mass is the specific consumption of diesel fuel for transporting rock mass, calculated as the ratio of diesel fuel consumption per volume of transported rock mass, with adjusting the value obtained by the factor of conversion of diesel fuel from ton to liter.

Performance indicators of the mining complex indicate a positive trend in the specific consumption of diesel fuel over the past 10 years. Thus, in 2010 the specific consumption of diesel fuel per 1 cubic meter of rock mass was 1.75 liters, while in 2019, it is expected that it will decrease by 12.5% and will amount to 1.53 liters (Fig. 2.16).

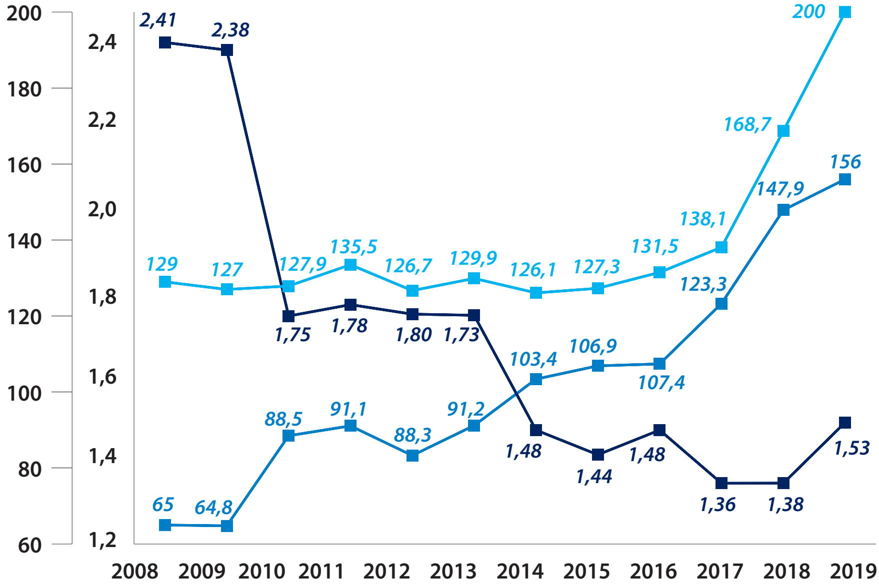

Fig. 2.16. The trend of rock mass export, diesel fuel consumption and specific rate of diesel fuel consumption

The priority area for saving diesel fuel by the mining complex is the measures to reduce the consumption of petroleum products as taken annually. A significant result of the work of the plant‘s specialists in this direction is introduction of the information system „Fuel Control“ since 2012, which stipulate the installation of trackers and fuel control sensors on vehicles and mechanisms.

The system allows to ensure:

- reduction of empty runs of transport;
- reduction in fuel consumption;
- exclusion of inappropriate use of rolling stock;
- expedition in cargo delivery;
- road safety.

Currently, 3,300 units of vehicles and mechanisms are equipped with trackers (Fig. 2.17).

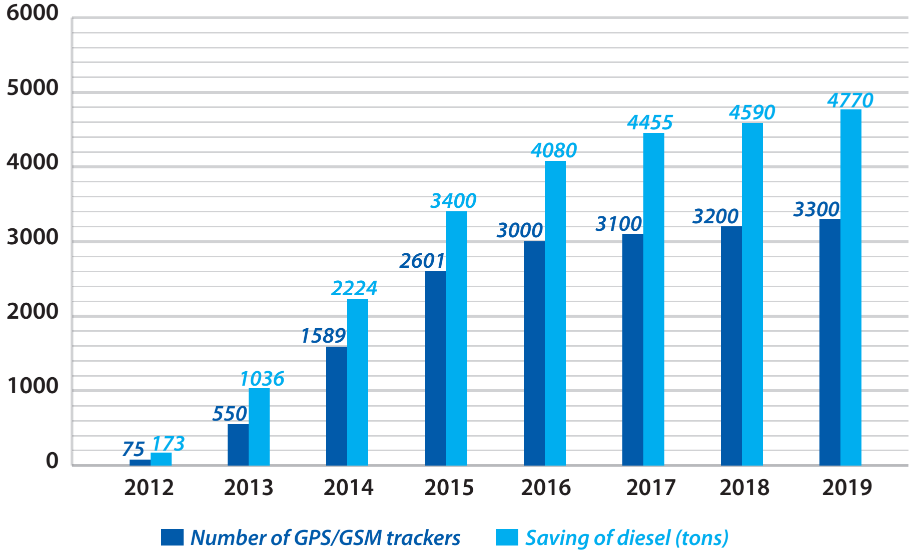

Fig. 2.17. Number of installed trackers and diesel fuel economy

The introduction of this system enabled to save more than 4.7 thousand tons of diesel fuel (Fig. 2.17).

Another area to save diesel fuel is to convert vehicles to alternative fuels – liquefied petroleum gas and liquefied natural gas (LPG and LNG). Vehicles are being converted to alternative fuels since 2011, and as of today, the plant operates 873 vehicles working on alternative fuels. Savings in fuel and lubricants as a result of re-equipment in 2011-2019 is expected to exceed 1,923 tons.

The measures for replacement of obsolete and physically worn-out vehicles, contemplating the purchase of brand-new, modern and cost-effective vehicles, is also important in optimizing diesel fuel costs.

In pursuance of the Resolution of the Cabinet of Ministers, dated April 19, 2012, No. 115 „On additional measures to expedite the renewal of obsolete equipment of industrial enterprises“, the plant has replaced 677 units of equipment during 2013-2015 for the amount of USD 76.0 million.

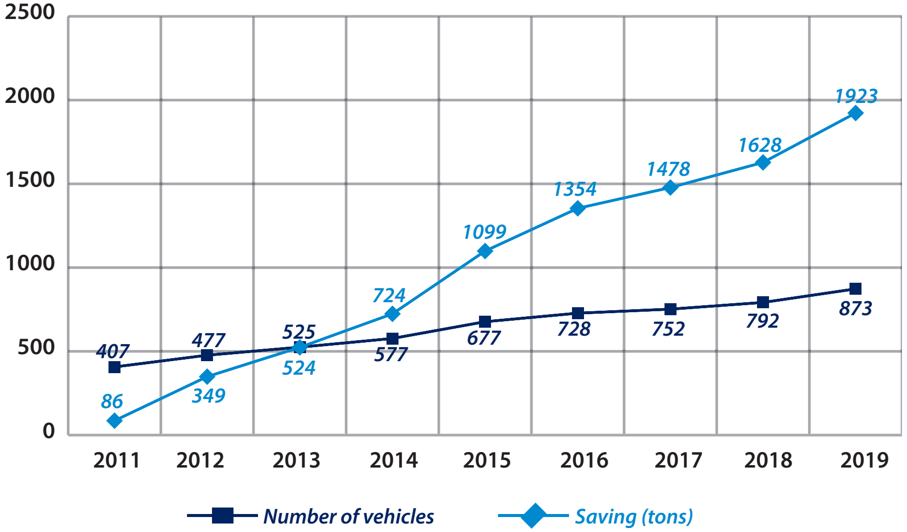

Fig. 2.18. Efficiency of work on conversion of vehicles to alternative fuels

Table 2.15

Replacement of process, power and auxiliary equipment

Year	Number of equipment	Amount, USD million
In pursuance with the Resolution of the Cabinet of Ministers, dated 19.04.2012, No. 115		
2013	181 units.	16.0
2014	252 units.	34.2
2015	244 units.	25.8
In pursuance with the Decree of the President of the Republic of Uzbekistan dated 22.12.2016, No. PP-2692		
2017	23 units.	13.1
2018	21 units.	18.6
2019	37 units.	36.1

In accordance with the Decree of the President of the Republic of Uzbekistan, dated December 22, 2016 No. PP-2692 „On additional measures for expedition of update of depreciated and obsolete equipment and reduction of production costs of the enterprises of industries subject to replacement and modernization in 2017-2020", the technical audit of production equipment was conducted and the technical condition of the basic production assets of the plant was studied, following this, the actions have been taken on updating of obsolete and physically worn-out fixed assets. According to the results of the technical audit, 180 units of equipment will be replaced from 2017 to 2020. To date, obsolete and physically worn-out equipment has been decommissioned and replaced with modern, world-proven equipment, 69 units in total for a total cost of USD 51.8 million (Table 2.15). As a result, this allowed the plant to strengthen its industrial potential and successfully introduce modern and energy-efficient equipment into production.

Vehicle upgrades have saved money not only on vehicle maintenance, but also on fuel resources. From 2016 to the end of 2019, it is expected to save 1,134 tons of gasoline for the amount of USZ 4,174 million and 2,218 tons of diesel fuel for the amount of UZS 8,698 million.

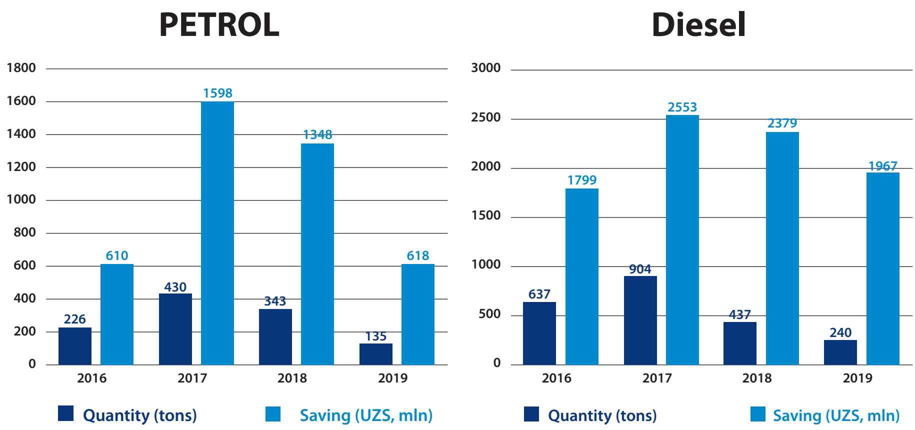

Fig. 2.19. Efficiency of work on updating morally and physically outdated vehicles in 2016-2019

Currently, the plant‘s miners have started development of the V stream of the Muruntau mine. In 2019, it is planned to increase the extraction of rock mass from the mine by 11%, versus 2018, including through overburdening works within the boundaries of the V stream of the Muruntau mine.

Under the project, in 2019 it was put into operation 11 units of heavy-haul dump trucks „BelAZ“ with load capacity of 90 tons, 13 units with a capacity of 55 tons, 8 units with a capacity of 220 tons, 3 units with a capacity of 136 tons, 4 units with a capacity of 45 tons and 2 units water sprinkler machine „BelAZ-76135“, as well as 18 units of MAN ore carrier with a load capacity of 25 tons.

In 2020, it is planned to acquire 36 units heavy-haul dump trucks „BelAZ“ with load capacity of 90 tons, 18 units with a capacity of 55 tons, 2 units with capacity of 45 tons, 2 units of SAT-789 with a capacity of 190 tons, 13 units of MAN ore carriers with a load capacity of 25 tons, 6 units of hydraulic excavators, and 80 units of auxiliary equipment.

Work in the field of energy saving is impossible without equipping consumers with energy metering devices. Therefore, commercial metering devices are installed for all types of energy resources and in all divisions. Work continues on the installation of devices in the residential sector of cities and towns that are on the balance sheet of the enterprise, and of technical accounting instruments in the divisions of the plant.

The management of energy use and energy saving (Fig. 2.20) is achieved by creating and putting into practice an energy saving system that includes the following areas: creation of a metering system for energy consumption and consumption in each division of the plant; development of specific norms of energy consumption for manufactured products (provision of services) both in general, by type of product, and separately for each unit; conducting a survey (energy audit) of all departments of the plant with the preparation of energy passports; analysis and implementation of continuous monitoring of the use of fuel and energy resources established by specific norms of energy consumption; development of specific energy intensity targets for the units; the creation of a reliable system of registration, accounting and reporting on issues of energy consumption and energy conservation; conducting research and development, development and implementation of energy saving measures, justification of economic efficiency and payback periods. Implementation of continuous monitoring of the implementation of adopted programs.

To complete the first stage of the energy saving system, an energy survey (energy audit) of the most energy-intensive enterprises of Navoi MMC was conducted. According to the results of the energy audit, energy passports of the divisions and additional measures to the energy saving program were developed.

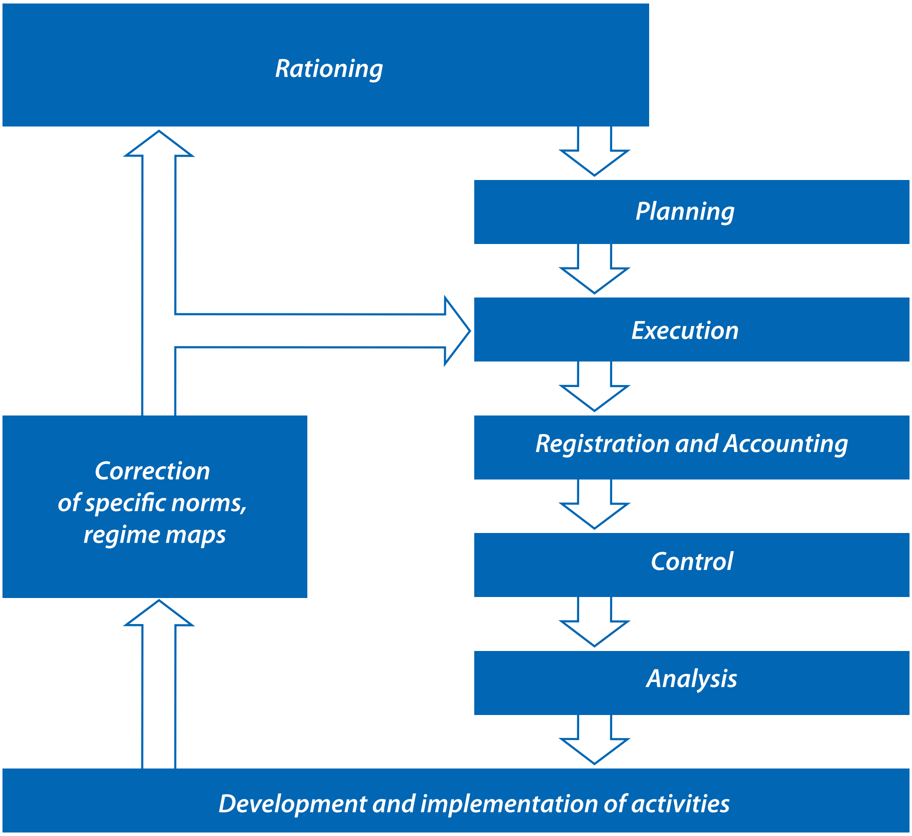

Fig. 2.20. Management of the use of fuel and energy resources

In fact, a base has been created for the transition to the 2nd stage of the energy saving system, where the main areas are:

- conducting an internal energy audit in all structural divisions of the plant with the corresponding development of energy passports;
- development of a standard of specific energy intensity and its introduction as one of the main planned indicators for each division of the plant;
- improving the efficiency of the implementation of the energy saving program by changing the mechanism for their implementation.

One of the priorities of the energy saving system is the training and retraining of personnel. Training of employees of the plant on energy saving and rational use of fuel and energy resources was conducted by specialists of

Uzgosneftegaz Inspection, MSTU. Bauman, Ural State Mining University, St. Petersburg Energy Institute for Advanced Studies. During the second stage of the energy audit, specialists of the plant and the Moscow Energy Institute plan joint special training for the employees of structural divisions.

The Fig. 2.21. shows the energy feedstock use by Navoi MMC in 2009-2019.

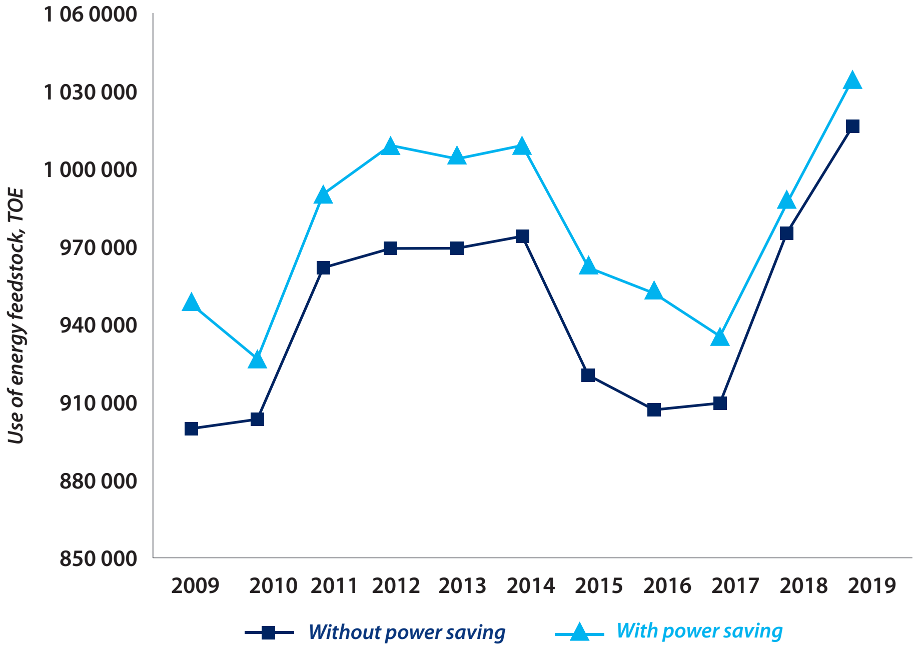

Fig. 2.21. Energy feedstock use by NMMC in 2009-2019

Unconventional energy sources - water, solar, wind and geothermal are an important reserve of energy supply in the Navoi MMC.

Introduction of solar collectors for hot water supply.

For NMMC, renewable energy technologies that use solar energy, geothermal energy and biomass energy are the most relevant.

Renewable energy sources operating in the plant‘s in-house divisions, ensure energy generation at a number of facilities and mines, in addition to existing energy sources. A significant advantage of renewable energy sources is that they release energy resources for their use as raw materials by the petrochemical industry, and renewable energy becomes the only economically viable, affordable and reliable source of energy for facilities and mines, both located in remote, inaccessible areas, and in mine administrations structures.

The climatic and natural conditions of Uzbekistan provide ample opportunities for use of renewable energy sources. With considering the available potential of solar energy in Uzbekistan, taking into account the locations of NMMC divisions, the Navoi, Bukhara, and Samarkand regions are acknowledged as the most favorable for using solar energy.

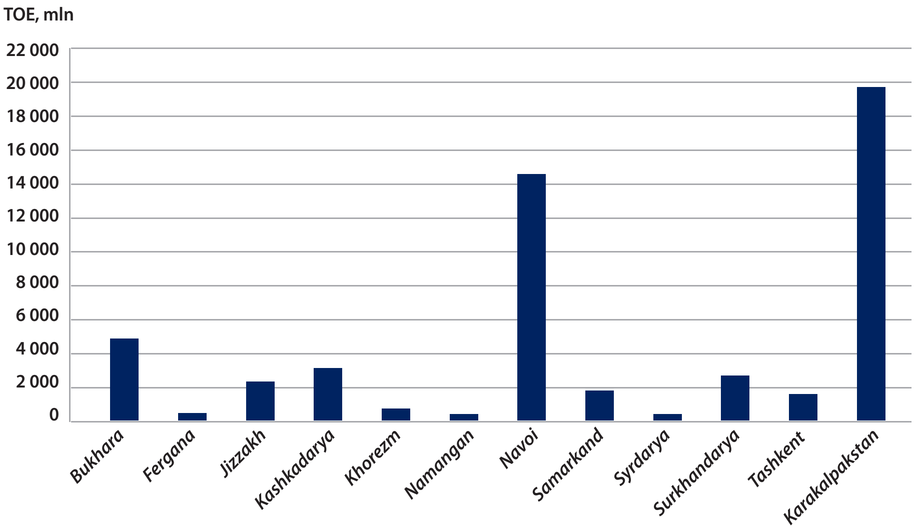

Fig. 2.22. Annual potential of solar energy by regions of Uzbekistan

The gross potential of solar energy, which is annually available on the territory of Uzbekistan, exceeds the energy potential of all the country's proven hydrocarbon reserves.

Taking into account the economic feasibility and efficiency of choosing a construction site, NMMC has implemented projects for using solar energy for hot water supply in the five most favorable regions of the Republic in this regard – Navoi, Bukhara, Samarkand, Tashkent and Jizzakh regions.

Fig. 2.23. Alternative energy policy in NMMC

Implementation of RES projects for the Navoi MMC.

The largest number (80%) of installed solar collectors at NMMC industrial sites are located in Navoi and Samarkand regions.

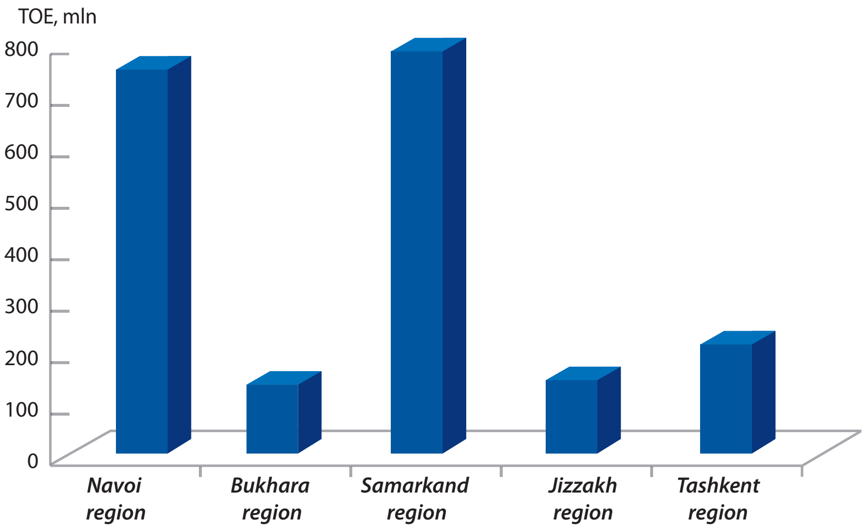

Fig. 2.24. Number of installed solar units, by region

The number of installed solar collectors in NMMC divisions in the regions of the Republic of Uzbekistan.

Solar units were put into operation in the Northern mine administration (NMA), in the Central mine administration (CMA), in mine administration No. 5 (MA-5); in the southern mine administration, in the „Navoi machine-building plant“ production association („NMBP“), mine administration HMP-1 and „Dustlik“ agro company.

Currently, the divisions successfully operate 2,442 units of solar collectors with an area of 5,540 m^2 and a total capacity of 2,985 Gcal per year, which provides annual savings of up to 3.5 million kW/h of electricity consumption.

The in-house divisions of the plant, have started use of solar collectors in 2001. The first unit was installed at the Kokpatas mine of the Northern mine administration, which is located at a great distance from the heat supply sources. However, the most widespread introduction of solar energy units was started in 2009.

Thus, during the period from 2001 to 2007, only 289 solar collectors were built with a total area of 486 m^2, with a total annual saving of 513.8 thousand kW/h per year.

Within the period from 2009 to 2019, it was implemented projects for the construction of 2,153 units of solar collectors with total area 5 054 m^2, with a total annual savings of 2,706.2 thousand kW/h per year.

According to the Comprehensive Program developed at the plant for the development and expansion of renewable energy sources for the NMMC, the total capacity of the implemented projects will reach 4.0 million kW/h per year by the end of 2020.

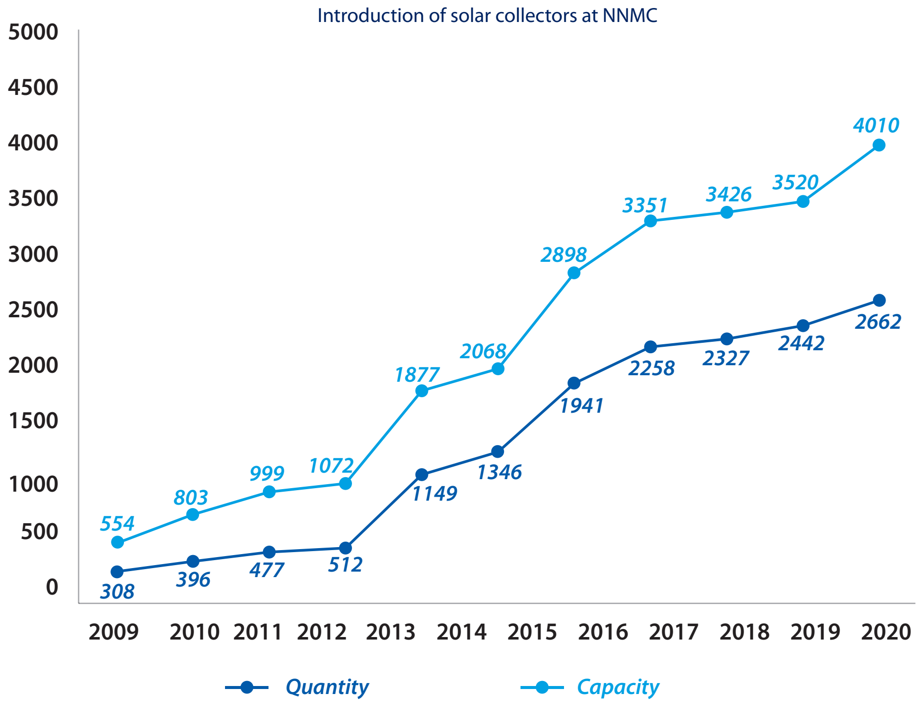

Fig. 2.25. Use of geothermal energy

The use of geothermal energy from underground waters also plays a special role in saving NMMC's fuel and energy resources. Geothermal water is used in the Southern Mine Administration to supply hot water to the people of the city of Nurabad.

Geothermal water is supplied to the Nurabad boiler house from well No. 9 of the Janub water intake facility, located at a distance of 5 km from the boiler house.

The well was developed and put into operation in 1980.

Since 2008, geothermal water has been used for the city's hot water supply. The flow rate of the well is 70-85 m^3/h, the temperature of the incoming water from the well is 37-40°C.

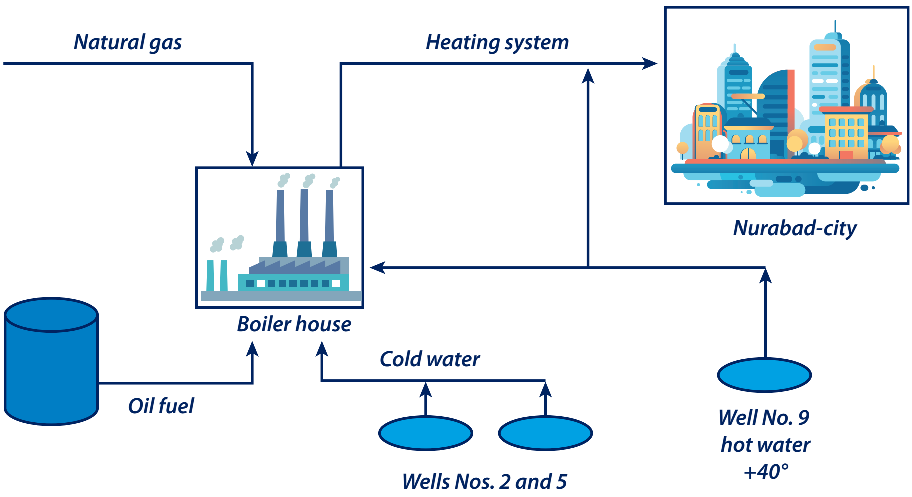

Fig. 2.26. Block diagram of geothermal energy use

Geothermal water flows through filters to the boiler room, where it is heated to the required temperature and fed to the heating network for heating and hot water supply to the people and infrastructure of the city.

Annual savings from the use of heat from a geothermal source, in terms of conventional fuel, are up to 1,000 tons of conventional fuel or 0.9 million cubic meters of natural gas.

Introduction of biogas plants.

In order to use practically the alternative energy sources as the most important factor for sustainable development and increasing the competitiveness of the economy in face of a reduction in global hydrocarbon reserves, work was started on the accelerated introduction of technology for processing waste of large cattle – 3,500 tons/year of manure (1,000 cattle) and poultry farms 1,260 tons/year of bird droppings (30,000 birds) on the basis of the „Dustlik“ agro company.

Design and survey work were carried out for construction of two biogas plants with a capacity of up to 200 m^3 of biogas per day on poultry manure and 400 m^3 of biogas per day on cattle manure. The design, engineering of the main process equipment, production of equipment and construction of units was performed by specialists of NMMC‘s divisions.

In accordance with the approved „Comprehensive program for the development and expansion of use of renewable energy sources for 2015-2020 for NMMC“, a biogas plant was commissioned in 2019 at the Termez poultry farm in Surkhandarya region, with a capacity of up to 200 m^3 of biogas per day and an annual output of 56 thousand m^3.

Biogas plants convert organic waste into high-quality fertilizers with the production of biogas, which is burned in gas-using equipment. In a short period of time, a pilot biogas plant with a total production capacity of 200 m3/day on a poultry farm and an industrial biogas plant with a production capacity of 400 m^3/day on a dairy farm were put into operation at Dustlik agro company.

For the period from 2013 to 2018 and 9 months of 2019, the total production of biogas was 698.9 thousand m^3, and 46.9 tons of fertilizers were obtained in dry form (biohumus), and in 6,464.9 liquid form.

The biogas produced by those plants is used for own needs to prepare hot water for the dairy farm, ensures the work of the forge, and is used in the fruit and vegetable processing shop.

Thus, the strategy of transition to energy-efficient production at NMMC, based on a comprehensive solution to the issues of economy and energy saving, allows you to manage the use of energy resources and to ensure a reduction in the consumption of fuel and energy resources by existing mining and processing industry.

2.4 Features of formation of the investment program in Navoi MMC

In accordance with the Decree of the President of the Republic of Uzbekistan dated May 14, 2019, No. UP-5717 „On measures for transition to a qualitatively new system of making and implementation of the Investment program of the Republic of Uzbekistan“ an Investment program for „Navoi MMC“ was developed for a period of three years with annual updating and adjusting its basic parameters based on the approved concept and program development of the plant.

The list of projects (facilities) as implemented under the Investment program for 2020-2022 was made the following basic principles adopted as foundations:

- coverage of investment projects starting from 2019, stipulated in previous Decrees of the President of the Republic of Uzbekistan, first of all, in the Decree of the President of the Republic of Uzbekistan, dated December 19, 2019, No. PP-4067 „On measures for implementation of the Investment program of the Republic of Uzbekistan for 2019“;
- inclusion of major investment projects contemplated by the industry program approved and by the Decrees of the President of the Republic of Uzbekistan, dated 03.01.2017 No. PP-2713 and dated 01.03.2017 No. PP-2806 „Program for increasing the production of precious metals until 2026“;
- formation of projects as implemented on the basis of the relevant protocol instructions given during the visits of the Head of State to the regions of the Republic.

The distinctive features of the formed project of the Investment program from the programs of previous years are as follows:

first, the program for utilization and attraction of investments is approved for a three-year period, that is, for 2020-2022;

second, at the same time, the program approves the target parameters for utilization and attraction of investments for 2021 and 2022 for all sources of financing;

third, the targeted part of the program includes only such projects which have design and estimate documents with definition of specific sources of project financing.

I. Expected results of the approved list of investment and infrastructure projects for 2019 for Navoi MMC.

The lists of investment and infrastructure projects for 2019 were approved by the Decree of the President of the Republic of Uzbekistan No. PP-4067, dated December 19, 2019.

By the end of 2019, the expected parameters for utilization of investments in fixed assets from all sources of financing will amount to **USD 645.9 million**. In order to achieve the specified amount of development, the Ministry of Finance provided USD 89.9 million of financing, the Fund for Reconstruction and Development – USD 158.01 million, commercial bank loans – USD 397.1 million. Compared to 2018, the growth rate of capital investment development is 158%.

However, it should be noted that in 2018-2019, the volume of capex for modernization, technical and technological re-equipment is only 16.6% and 14.5% of the total capex.

In 2019, 7 projects are being introduced with a total cost of USD 234.07 million, 288 jobs are created:

- Construction of a mining complex based on the deposits of the Zarmitan gold zone (stage III). „Urtalyk" („Promejotochnoye") deposit with a total value – USD 97,03 million;
- Improvement of the technology for gold recovery from refractory ores at Kokpatas and Daugyztau deposits with a total cost of USD 114.0 million.
- Creation of a children's camp for the children of the Shodlik house of mercy on the basis of the hotel of the Central Mine Administration with a total cost of USD 3.0 million;
- Construction of a reserve reservoir of technical water in Uchkuduk-city with a total cost of USD 2.56 million;
- Construction of a poultry farm in the Tahiatash district of the Republic of Karakalpakistan with a total cost of USD 1.60 million;
- Construction of a metal galvanizing train at the Takhiatash metal-ware plant and non-standard equipment with a total cost of USD 2.68 million;
- Power supply of industrial facilities of the project „Expansion of processing capacities of HMP-2" (I-II stages) with a total cost of USD 13.20 million.

As a result of prompt and high-quality implementation of investment projects, it is expected to increase gold production by 102% compared to 2017, silver **by 117.5%** and **uranium by 103 %**.

II. The main provisions of the investment program of Navoi MMC for 2020-2022.

Investment program for Navoi MMC, as implemented at the expense of direct foreign loans has been developed by the investment department.

The investment program for 2020-2022, was prepared following a comprehensive analysis of investment programs of previous years and forecasts for the period 2010-2026 (see Fig. 2.27 and 2.28)

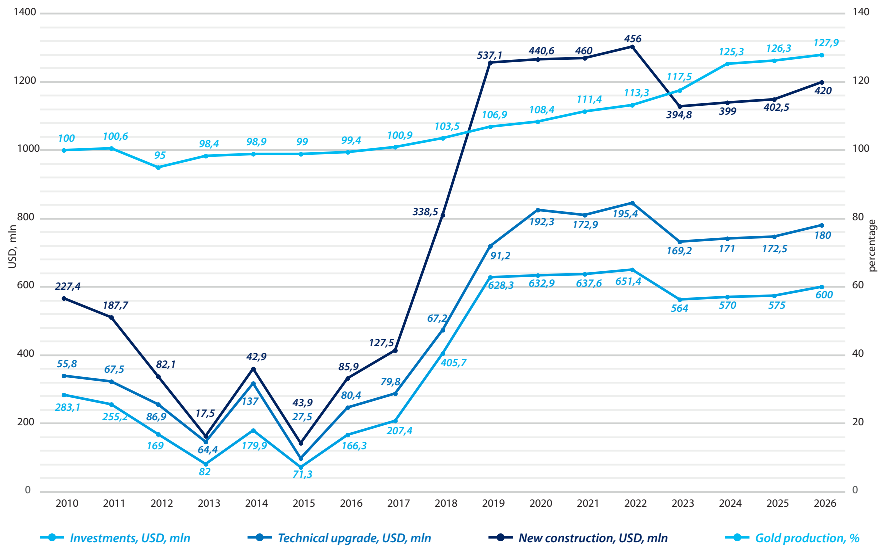

Fig. 2.27. Dynamics of the increase in metals production during utilization of capital investment for the Navoi MMC for 2010-2026

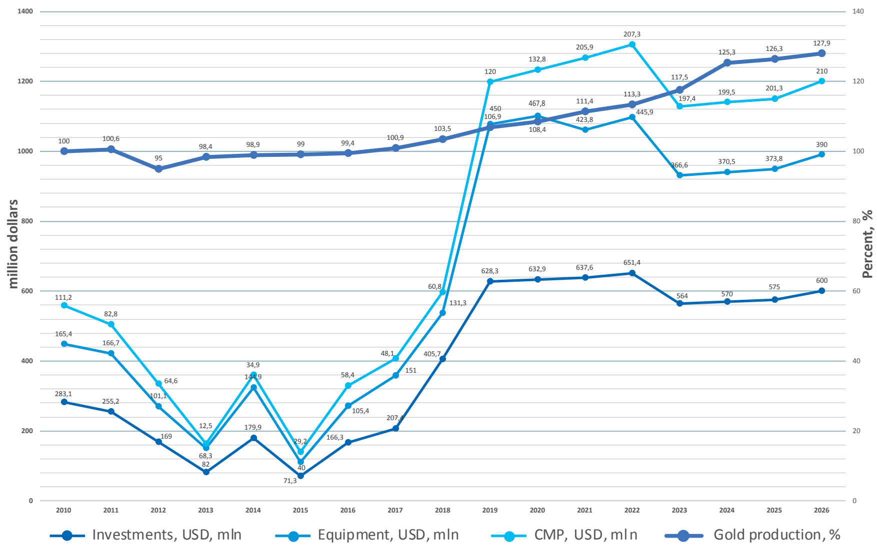

Fig. 2.28. Dynamics of the increase in precious metals production during utilization of capital investment for the Navoi MMC for 2010-2026

As a result of a comprehensive analysis, it was confirmed that optimal amounts of capital investment for new construction and modernization, technical and technological re-equipment of production are of great importance for increasing the production of precious metals.

The diagram 1 shows that despite the decrease in capex for new construction and with an increase in capex for modernization, technical and technological re-equipment of production, gold production has been steadily increasing since 2013. In 2014, the volume of capital investment for modernization, technical and technological re-equipment of production is 76.2% of the total volume. This means that in 2012-2015, investment programs were prepared with inclusion of a small number of large, strategically important investment projects.

By virtue of the Decrees of the President of the Republic of Uzbekistan, No. PP-2713, dated 03.01.2017 and No. PP-2806, dated 01.03.2017, in respect of Navoi MMC, it was approved a Program to increase the production of precious metals until 2026 and it is implementing 27 large, strategically important investment projects, this program and is currently being successfully implemented.

Given the above mentioned, the target parameters for utilization of investments in the framework of the Investment program for production of gold for 2020-2022 will be:

- *for 2020, utilization of **USD 632.9** million. attraction of **USD 645.4** million;*
- *for 2021, utilization of **USD 637.6** million. attraction of **USD 626.6** million. - for 2022, utilization of **USD 651.4** million. attraction of **645.2** million.*

1. Investment program for 2020 for the „Navoi MMC“

contemplate of implementation of 25 investment projects for production of gold with a total cost of USD 3,222.7 million, with a residual value of USD 2,219.9 million as of 01.01.2020, and creation of more than 7,600 new jobs. Among them:

- *new construction – USD **1,565.4** million.*
- *modernization, technical and technological re-equipment of production – USD 654.5 million.*

10 major strategic and important investment projects were included into ***large-scale construction***. Of them, 8 projects are transitioning and 2 ones – are newly launched investment projects. It should be noted that implementation of ***6*** large-scale investment projects will be completed in 2021-2022, and the plant will have additional processing capacity with connections of mining and mining transport capacities.

- Construction of a mine for the extraction and processing of gold-containing ores from the Auminzo-Amantoysky ore deposit (HMP-5), I-II-stages with a total cost of USD 528.4 million, implementation period is 2017-2022.
- Construction of a complex for processing man-made waste at the GHLP of HMP-7 (stages I-II), with a total cost of USD 247.6 million, implementation period is 2018-2021.
- Stripping, preparation and mining of 660 m and 600 m horizon in the Eastern part of the „Charmitan“ deposit with shaft No. 10 at the Zarmitan mine, with total value – USD 26.6 million, implementation period is 2018-2020 years.
- Power supply of industrial facilities of the project „Construction of a complex for mining and processing of „Pistali“ gold ore deposits (HMP-6)“, total cost is USD 28.1 million, implementation period is 2020-2021.
- Expansion of the processing capacity of HMP-2 (stages I-II), with a total cost of USD 168.3 million, implementation period is 2018-2023.
- Expansion and reconstruction of the HMP-2 tail farm with a total cost of USD 45.0 million, (II-stage), implementation period is 2016-2022.

Additional processing capacity is provided by the construction of HMP-5 and HMP-7, as well as with taking into account the expansion of the processing capacity of HMP-2, with this, an increase shall be 32 million tons. As a result, the processing capacity of the plant will increase by 148% in 2022 compared to 2016 and the production of the first metal by 119%.

Implementation of 4 large-scale investment projects to be completed in 2024-2026, including

- „Development of the Muruntau mine“ (V stream), stage 1, with a total cost of USD 733.9 million.USA.
- Power supply of industrial facilities of the Muruntau mine with a total cost of USD 109.7 million.

- „Development of the lower horizons of the mining complex based on the deposits of the Zarmitan gold zone“ with a total cost of USD 235.6 million,
- „Construction of road transport and engineering communication infrastructure“ with a total cost of USD 253.4 million.

As a result of the implementation of these projects, just the Muruntau mine will increase the volume of rock mass by 3 times in comparison with 2016, and the volume of ore production will reach 47 million tons per year, as for the Zarmitan block, the volume of output of the first metal will increase by 122% by 2024.

It is commonly known that correct, timely and high-quality planning and design, as well as implementation of investment projects for modernization, technical and technological re-equipment of production, remains an acute problem in the mining and metallurgical industry.

„***Modernization*** - improvement, development, upgrade of machinery, equipment, technological processes in accordance with the latest achievements of science and technology, requirements and norms, technical conditions.

Technical and technological re-equipment of production is a set of measures aimed at improving the technical and economic level through the introduction of modern technology and advanced technology, mechanization and automation of production processes, modernization and replacement of obsolete and physically worn-out equipment, improving the organization and structure of production, as well as other organizational measures without expanding production areas and increasing the number of jobs.

In accordance with the regulatory documents, modernization, technical and technological re-equipment of the production is carried out with the development of appropriate design and estimate documentation and mandatory due diligence.

In this regard, the investment program is prepared with paying special attention to the investment project for modernization, technical and technological re-equipment. In contrast to the investment programs of the previous years, independent investment projects for ore management are provided. This will make it possible to ensure timely implementation and monitoring of investment projects with monthly provision of information on the status of implementation of investment projects and analytical materials to the management of the plant and the authorized bodies.

The main objective of the investment program in terms of modernization, reconstruction, technical and technological re-equipment of production is to ensure the viability of the enterprise and the stability of production. Based on the tasks, the following principles of preparation of an investment program were adopted:

- replacement of morally and physically obsolete equipment;
- assurance of the growth of labor productivity;
- saving material and fuel and energy resources, increasing resource efficiency;
- reducing the self-cost of output and production costs.

As a result of a comprehensive approach to study the submitted projects, 15 units of the most important investment projects for modernization, technical and technological re - equipment of production were included in the investment program for 2020-2022. Among them:

1. In order to provide the mining and processing complex with spare parts and maintain equipment in working condition, and expand the production of localized products, the investment project **„Expansion of production capacities for NMMC" was included.**

To date, the production capacity of NMMC does not enable full implementation of work on the manufacture and restoration of large-sized parts, components and mechanisms. In this regard, the downtime in the repair of the above equipment increases, which leads to a decrease in the main production indicators.

The implementation of the project „Expansion of the production facility of NMMC" will significantly expand both the range of items and the number of manufactured spare parts for the mining and processing complex due to the acquisition of modern metalworking machines and foundry equipment.

The project stipulates the purchase of a CNC turning and boring machine and a CNC gear milling machine to increase the productivity of crowns for mills and excavators, 100% (15 units) and 172% (19 units), respectively. This will allow to producte up to 30 crowns for mills and up to 30 crowns for excavators per year.

2. In order to reduce the cost of limestone and supply the lime for hydrometallurgical production, as well as to create a favorable air basin in Zarafshan, the investment project **„Construction of a crushing and sorting plant in the Bessapan limestone deposit of the Central Mine Administration of NMMC“** was included into the investment program with a total cost of USD 15.0 million, implementation period is 2020-2022.

Since 2012, the Central Mine Administration conducts operation for rubble stone production at the Zarafshan II deposit in order to recover construction rubble, which is used for the production of lime used in the process cycle of hydrometallurgical production of HMP-2, in the construction of facilities of Zarafshan Construction Department and NMMC divisions. The nearest major settlement is the city of Zarafshan located just 3 kilometers westward from the Zarafshan II deposit.

However, when mass explosions are made, the sound effect from the detonation of explosive wells causes negative emotions in the population of the city and there is an excess of the concentration of dust in the city.

In addition, crushed stone is transported by rail for 45 km to the Bessapan site to the lime kilns of HMP-2 for firing to produce lime. The annual cost of transporting crushed stone by rail is ≈ UZS 1.0 billion.

In order to resolve the problems that have arisen, the Bessapan limestone deposit was explored to the North-East of Zarafshan at a distance of 40 km, and its reserves were approved in the State Reserves Committee by Protocol No. 1208, dated 25.08.1987. According to the degree of study, the deposit is prepared for commercial development. The calculation by category of reserves A+B+C1+C2 in the contour of the Bessapan limestone quarry gave a figure of 13.5 million m^3. With an annual capacity of 350 thousand m^3, the supply of raw materials is 39 years.

3. In order to replace the physically worn-out equipment of the Zarmitan, Guzhumsay and Mardzhanbulak mines, as well as to comply with the standards of stripped, prepared and ready-to-be-excavated reserves and reliable provision of gold-containing ore, HMP-4 is included in the investment program **„Technical and technological re-equipment of mining and transport equipment at the mines of South Mine Administration for 2020-2022“.**

According to this investment project, in 2020-2022 it was purchased 39 items of technological equipment for the Zarmitan mine, 46 items for the Guzhumsay mine, and 15 items for the Mardzhanbulak mine. The total cost of the project is USD 54.8 million.

Based on the calculations performed in 2020, purchase of 25 units of mining equipment and auxiliary equipment enable to produce 823.7 thousand m3 of rock mass.

4. The purpose of the investment project **„Technical and technological re-equipment of the Vostochny mine of Northern Mine Administration for 2020-2022“** included into the investment program is to maintain and partially increase the production capacity of the Vostochny mine to ensure the unconditional fulfillment of the state order for production of precious metal, by adding an additional amount of basic technological, auxiliary, energy and road construction equipment.

Under this investment project, it will be purchased 21 items of the process equipment in 2020, 31 items in 2021, and 4 items in 2022. The total cost of the project is USD 32.4 million.

As a result of the project, the existing capacity is maintained and the rock mass production will increase by 16%.

5. The aim of the investment project **„Technical and technological re-equipment of the production of the Daugiztau mine of Northern Mine Administration for 2020 - 2022„** is the maintenance and partial increase of the production capacity of the Daugiztau mine to ensure the unconditional fulfillment of state order for production of the precious metal as well as to comply with the norms in respect of stripped and prepared reserves by purchasing additional number of the main and auxiliary mining, energy and road construction equipment.

According to the draft due diligence, it will be purchased 39 items of process equipment in 2020, 24 items in 2021, and 4 items in 2022.

As a result of the project, rock mass will increase by 13.3%.

The investment program for 2020 for the Navoi MMC stipulates development, endorsement and approval of decisions by Government with respect to 5 feasibility studies of projects for financing and development of capital investments in 2021. The total cost of these projects is USD 726.6 million, with creation of more than 2,500 new jobs. Among them:

1. „Construction of a complex for the extraction and processing of gold-containing ores from the Pistali deposit“.

Pistali deposit. The preliminary total cost of the project is USD 248.0 million, implementation period is 2020-2025

Objective of the Project: involvement of gold ore of Pistali deposit in mining and processing.

It is located in Nurata district of Navoi region of the Republic of Uzbekistan. Nearest settlement: Dzhizak-city – 190 km, Nurata-city – 42 km, Navoi-city – 105 km.

The main valuable component of ores is gold. The gold is native. The size of gold from hundredths of a millimeter to 0.1 mm or more. There is also pulverized, subdisperse gold. Gold is mainly found in association with quartz and arsenopyrite as single inclusions, as well as small nests.

Given the favorable mining and geological conditions and the nature of the terrain, the project feasibility study provides for an open-source method for developing the deposit.

According to the data of the State Reserves Committee of the Republic of Uzbekistan as of 01.01.2019, the proven reserves of gold-containing ores of the Pistali deposit (Pistali+Oltin Dier) are 35.93 million tons of ore and 57.8 tons of gold. To date, exploration work continues on studying the flanks to increase reserves of Pistali. The forecast increase in the reserves of gold-containing ores of the Pistali deposit is expected to be 130 million tons of ore and 100 tons of gold with the approval of the forecast reserves by the State Reserves Committee of the Republic of Uzbekistan in 2021.

Based on above, designing the mining complex shall include two phases with respect to the production capacity of the enterprise for the extraction of gold-containing ores of the deposit: Phase 1 – 2.0 million tons per year, with an increase in reserves in Phase 2 by 2.0 million tons per year, the total production capacity is 4.0 million tons per year.

The project‘s feasibility study contemplates processing of ore by using gravity-sorption technology. The processing scheme stipulates large-scale crushing of the initial ore up to 350 mm, two-stage grinding with a gravity enrichment cycle, thickening and sorption extraction of gold from gravity tails with using activated carbon. The gravity concentrate is processed at the scheme of intensive cyanidation, with desorption of loaded carbon. Solutions of intensive cyanidation and desorption eluates are subjected to electrolysis to recover cathode gold, which is the finished product, following further processing at HMP-1.

When the design capacity in HMP-6 is achieved, the annual volume of gold in value terms will be USD 226.2 million.

2. „Development of the reserves of Chukurkuduk deposit“.

The preliminary total cost of the project is USD 166.7 million, implementation period is 2020-2024 Objective of the Project: involvement of gold-containing ores of the Chukurkuduk deposit into the development in order to supply gold-containing ore to HMP-2.

Chukurkuduk deposit. It is located on the Eastern flank of the Muruntau ore field and is a natural Eastern extension of the ore-bearing zones of the Mutenbai deposit. It is localized in the sand-shale deposits of the Bessapan formation, which is covered in the area of the deposit by sediments of the upper structural floor with a capacity of 5 to 250 m. The length of the ore-bearing zone is more than 2000 m, the capacity is more than 600 m. The Western end of the ore-bearing zone of the deposit contacts the Eastern end of the ore-bearing zones of the Mutenbai deposit, through a low-power latitudinal fault (15-20 m) that separates Chukurkuduk deposit from the Mutenbai.

In terms of the complexity of the geological structure, Chukurkuduk deposit belongs to group III. At the early stages of work, the deposit was studied in 1993 by core wells on the 160-80x 160-80m network, the reserves and resources of the deposit were calculated from the temporary conditions of open-pit mining.

The calculation of the gold reserves of the Chukurkuduk deposit was performed for 10 ore deposits located between the 90-109 exploration lines, to a maximum depth of 500 m from the surface.

Delineation of ore deposits and calculation of reserves thereon was performed according to the conditions of parameters approved by the State Reserves Committee in 2016 for open development of Muruntau and Mutenbei deposits.

Given the favorable mining and geological conditions and the nature of the terrain, the project feasibility study provides for an open-source method for developing the deposit. According to aggregate calculations (in the program MICROMINE), the optimal pit outline of Chukurkuduk contain estimated at 118 million tonnes of geological ore reserves with an average gold content of ore at 1.05 g/ton (cut-off grade 0.5 g/ton), rock mass is 327 million m^3, the average strip ratio is 3.37 m^3/ton.

The feasibility study stipulates 5 (five) million tons per year of the deposit capacity and the expected Chukurkuduk deposit life with consideration of the starting period and the attenuation is more than 23.6 years.

The ore extracted from Chukurkuduk mine will be delivered to the hydrometallurgical plants of HMP-2 for processing. With this, the ore will be delivered to HMP-2 by railway.

When the design capacity in HMP-6 is achieved, the annual volume of gold in value terms will be USD 209.7 million.

3. „Construction of quarry mining on the basis of Balpantau and Tamdybulak deposits".

The preliminary total cost of the project is USD 98.9 million, implementation period is 2020-2023 Objective of the Project: Stabilization of the quantitative and qualitative characteristics of the raw materials shipped for processing by HMP-2, by involving the gold-containing resources of the Balpantau and Tamdybulak deposits in order to ensure the recovery of the required amount of precious metals by Navoi MMC.

According to the conclusion of the previously performed preliminary feasibility study, the development of the Balpantau ore field was determined by an open method with the delivery of ore to the HMP-2. The preliminary feasibility study was developed with consideration of the recommendations of the „Conceptual solutions" prepared by IntegraGroup LLC and VNIPIIpromtechnologiyi (Russia).

The project's feasibility study is developed by the Central Design Bureau of Navoi MMC.

The Balpantau deposit is located 8 km South-East of the village of Tamdy and 27 km North of the Muruntau mine complex. The Tamdybulak deposit is located 3.5 km South of the village of Tamdy and 6 km West of the Balpantau deposit.

The feasibility study of the project stipulate development of Balpantau, Tamdybulak, Mayskiy, Kyz yiltish, Taiman, etc deposits. Given the favorable mining and geological conditions and the nature of the terrain, it is contemplated an open-source method for developing the deposits.

Geological reserves of C1+C2 category: ore – 38,851.1 thousand tons, gold – 56,040.1 kg, average content – 1.44 g/ton. Losses – 5.3%-7.0%. Attenuation – 12.8%-15.0%. Commercial reserves of C1+C2 category: ore – 42,205.7 thousand tons, gold – 53,007.8 kg, average content – 1.26 g/ton.

The volume of rock mass is 131,950.1 thousand m^3, the volume of overburden rocks is 115812.1 thousand m^3, the average overburden coefficient is 2.74 m^3/ton, and the period of mine life is 16 years.

The annual volume of the ore processed by HMP-2 is 3.0 million tons; the average amount of metal in the ore – 3,678 kg; grade 1,226 g/ton; end-to-end recovery of the metal in the finished product 87,19%; annual finished products in terms of price is USD 152.1 mln.

4. „Expansion of production and processing capacities for the development of the Turbay and Boztau deposits“.

The preliminary total cost of the project is USD 133.2 million, implementation period is 2020-2023 Objective of the Project: involvement in of gold ore deposits of Turbay, Boztau, Telkitau, Dalniy, Kaskyrtau, Daykoviy, Barhanny, Sardor and Severny into mining and processing in order to supply gold-bearing ore to HMP-3.

The Turbay gold deposit is located in the Central part of Eastern Bukantau on the South-Eastern slopes of the Turbay mountains.

The deposit belongs to the gold-quartz formation, and according to morphological features – to the linear, veined-interspersed-stockwork type.

Along the stretch, the ore shoots were found from 40-60 to 750-1,170 m, and down to 250-360 m (in the contour of the project mine – up to 170 m).

According to testing data, 23 ore shoots have been contoured in the deposit, which are mostly located sub-parallel to each other. Of them, 21 ore shoots are located in the contour of the project mine, their reserves were calculated (except for ore shoot No. 9).

In terms of the complexity of the geological structure, the deposit is reasonably assigned to the 3rd group, according to the „Instructions for applying the classification of reserves to the gold deposits“, dated 2000.

Boztau ore field is located in the territory of Uchkuduk district of Navoi region. The composition of the ore field includes the areas of Boztau and Severniy, also Jelsay gold bearing zone.

– **The area of Boztau** with an area of 6,3km^2 is a hilly plain with absolute elevations from 460 to 485 m. The distance from the site to the village of Kokpatas is 25 km.

– **The Severny site** with an area of 3,0 km^2 is a relatively flattened low-mountain area with absolute elevations from 178 to 366 m. The distance from the Severny site to the village of Kokpatas is 17 km. The exposure of the site is weak. The area is covered by a cover of Quaternary deposits from 1.0 m to 10.0 m.

- **The Jelsay gold bearing zone** with an area of 1.2 km^2 is a hilly plain, with absolute elevations from 470 m in the South to 500-510 m in the North. The exposure of the site is poor, almost 90% of the area is covered with a cover of Quaternary deposits with a capacity from 2.0-2.5 to 10-15 m. Distance from Jelsay gold bearing zone to the village Kokpatas is 24 km.

The proximity of mineralization to the tectonic zone and the associated increased fracturing of rocks resulted to a large capacity of the oxidation zone, that is, from 60 to 85 m. The distribution of gold in the ore is uneven, the content in individual samples ranges from 1.0-1.5 to 34.6 g/ton.

Okzhetpes ore field is located in the territory of Uchkuduk and Tamdyn districts of Navoi region. The composition of the ore field includes: gold zones #2 and #9, Sardor and Barhanny sites.

- **Gold bearing zone #2** is located 33 km South-West from the village of Kokpatas. The gold ore zone No. 2 is localized in the South-Western wing of the Okzhetpes brachyanticline, which is a separate dome-shaped highland that stands out on a poorly shaded plain.

- **Gold bearing zone No. 9 (Zarkatlam)** is located on the Southern slopes of the Bukantau highland, in the North-Western part of the Okzhetpes upland.

The total length of the ore-bearing zone is about 800 m, with a width of 50 to 90 m, it falls almost vertically. Two ore bodies are found within the zone (ore bodies #1 and #2).

The Sardor site is located at the Southern end of the Bukantau mountain range in the Central part of the Okzhetpes ore field.

The depth of the oxidation zone in the Sardor site reaches a depth of 90-100 m from the surface. According to rational analysis, the gold in oxidized ores is presented in native form and in accretions with ore components: chlorides, sulphates, sulphides of silver.

- **Barhanny deposit** is located in the North-East flank of the ore field Okzhetpes and confined to the Eastern wing of the anticline of the same name.

Mineralization refers to the gold-sulfide-quartz type. Oxidized ores are mainly developed up to 70-75 m from the surface. Gold is mainly represented by the native form in the form of free secretions and in accretions with quartz, carbonate, hydroxides and iron sulfates. Gold is fine and small in size from 0.001 to 0.01 mm, often forming nests of up to 0.1 mm.

Table 2.16

Reserves of the above-mentioned deposits

The name of the deposits	Category of reserves	Ore, million tons	Content, g/ton	Metal, ton
Turbay, Boztau, Gold bearing zone # 2, Elsoy(Jelsoy), Zarkatlam (Mineralized zone # 9), Telkitau, Dalniy, Kaskyrtau, Daykoviy, Barhanny, Sardor, Severny.	C_1	29.169	1.66	48.372
	C_2	34.008	1.75	59.351
	C_1+C_2	63.177	1.71	107.723

Gold deposits of Telkitau, Daykoviy and Severny of Kokpatas ore field are located in the Central Kyzylkum desert on the territory of Tandym district of Navoi region. It is confined to the Southern slopes of the Bukantau mountain range, the Central part of which is called Kokpatas. The Kokpatas deposit of the ore field is confined to the wings of the steepy Kokpatas anticline, complicated by numerous discontinuous disturbances and crumpling zones.

Processing complex.

Currently, the hydrometallurgical plant No. 3 of Northern Mine Administration is processing refractory gold-sulfide ores from the Kokpatas and Daugyztau deposits, for which all six existing mill blocks are used.

The feasibility study of the project „Expansion of production and processing capacities for the development of Turbay and Boztau deposits" with processing of oxidized ores at HMP-3 in the amount of 4 million tons/year, stipulates construction and commissioning of additional production facilities, including mill and classifying equipment, as well as equipment for thickening and sorption leaching. Processing of oxidized ores is supposed to be carried out according to the scheme of direct sorption cyanidation using activated carbon as a sorbent. Therefore, it is necessary to consider the need to expand the desorption, reactivation and electrolysis unit.

As a result of this project, it is expected to increase the volume of production of the first metal as of USD 246.2 million in monetary terms, after reaching the design capacity.

5. Construction of a foundry-mechanical production of the Central Mine Administration

The preliminary total cost of the project is USD 20.0 million, implementation period is 2020-2022.

The main objective of the production is to produce small and medium-sized castings for the mining and metallurgical industry with an annual output of 12 thousand tons.

Taking into account the production of castings by weight and based on the nature and scale of production, the number of equipment and the number of employees, as well as the complexity and variety of accepted technological processes, the project feasibility study, contemplates seven productional departments:

- melting, molding, filling and knocking, rod, mix preparation, heat-pipe, model and laboratory.
- the project feasibility study is developed by the Institute „Modern foundry technologies" (Russia). Deadline to complete the feasibility study of the project is 1-quarter of the current year.

When the design capacity is achieved, the annual output will USD 15.9 million, at the foundry and mechanical production shop of the Central Mine Administration

In order to implement effective mechanisms for monitoring investment projects, the National Agency for project management under the President of the Republic of Uzbekistan has developed an automated information system „Control and monitoring of the implementation of investment projects", which is a component of the Unified national information system for project management, involving all participants concerned in the implementation of investment projects, including:

- automatization of the processes of accounting, control and monitoring of project implementation;
- control of project deadlines, budgets, goals, and indicators;
- generation of reliable data in terms of the volume of attracted and utilized investments, including foreign direct investments;
- identification of risks for timely commissioning of capacities during project implementation;
- tracking the achievement of the project documentation targets in the post-investment period.

The Regulations for the implementation and operation of the automated information system „Control and monitoring of investment projects" was approved.

2.5. Localization and cooperation in the region

The Decree of the President of the Republic of Uzbekistan, dated May 1, 2019, „On measures for further development of industrial cooperation and expansion of production of demanded products" described the priorities for development of industrial cooperation in the Republic for the long-term prospective.

Among them:

- regular holding of industrial fairs with targeted involvement of economic entities of all segments of the industrial product market, with the organization of detailed informing of all interested circles about the types, technical characteristics and quality parameters of industrial products produced in the Republic;
- organization of functioning of the electronic cooperation portal as an important tool for finding partners, establishing business relationships,

including long-term ones, with the provision of an opportunity for fast entering into business agreements (contracts) for supply of industrial products remotely;

- implementation of state support measures that contemplate establishment of industrial parks and small industrial zones, shaping the stable demand for domestic products through the public procurement system.

The document approved the List of ready-made products, components, raw materials and materials that are in demand in the domestic market and export-oriented, recommended for development by business entities in 2019. This list includes products of 99 names, in particular, margarine, milk chocolate bars, pasta, such manufactured products as denim, knitted fabric, children‘s clothing. The authorities recommend that the production of syringes with needles, veterinary vaccines, wallpaper, toothpaste, shampoos, etc. to be developed in the Republic more intensively.

The basis for import substitution is as follows:

In order to create a competitive modern market economy, it is necessary to carry out technological modernization of the production sector, that is, to introduce advanced equipment and technology, mechanization and automation of production, modernization and replacement of outdated and physically worn equipment with new, more modern and cost-effective ones. In order to implement technical and technological re-equipment, there is a need to import goods and services. But any import is a dependence on a foreign supplier of components, spare parts and foreign specialists. In addition, the existing production and technological chains in the domestic economy, arranged with using standards and technologies, are often unable to include imported technologies and equipment.

In recent years, the government of Uzbekistan has pursued a policy of import substitution and production of goods that are not produced on the territory of the Republic of Uzbekistan, which has a steady demand not only in the domestic market, but also in the markets of Central Asia and the CIS.

This policy is part of the Program of localization of production of finished goods, components and materials based on industrial cooperation for which the Ministry of Economy, Ministry of Investments and Foreign Trade, the State Competition Agency of the Republic of Uzbekistan are responsible for.

The localization program is approved by the government of Uzbekistan annually and the program includes investment projects that are important for the further development of industrial production based on local raw materials, materials and components of Uzbekistan At the same time, a clear mechanism has been created and the entire process of reviewing and submitting documents for the investment project to be included in the localization Program by private companies and foreign investors has been established. More precisely, the mechanism for implementing projects has been approved by a number of Decrees of the President and the Cabinet of Ministers of the Republic of Uzbekistan.

A striking example of localization carried out according to this program is the Navoi MMC. According to the schedule of production of localized products for 2019, since the beginning of the year it was made the products under 83 projects for the amount of UZS 129.07 billion, including 14 brand-new types of products for the amount of UZS 7.27 billion.

In addition, 318 types of import-substituting products were produced for the amount of UZS 79.44 billion, which were not prescribed in the localization program.

According to the schedule of target parameters for reducing imports by localizing the production of imported products and expanding inter-industry industrial cooperation, it is stipulated to allocate USD 57.29 million to the Navoi MMC in 2019.

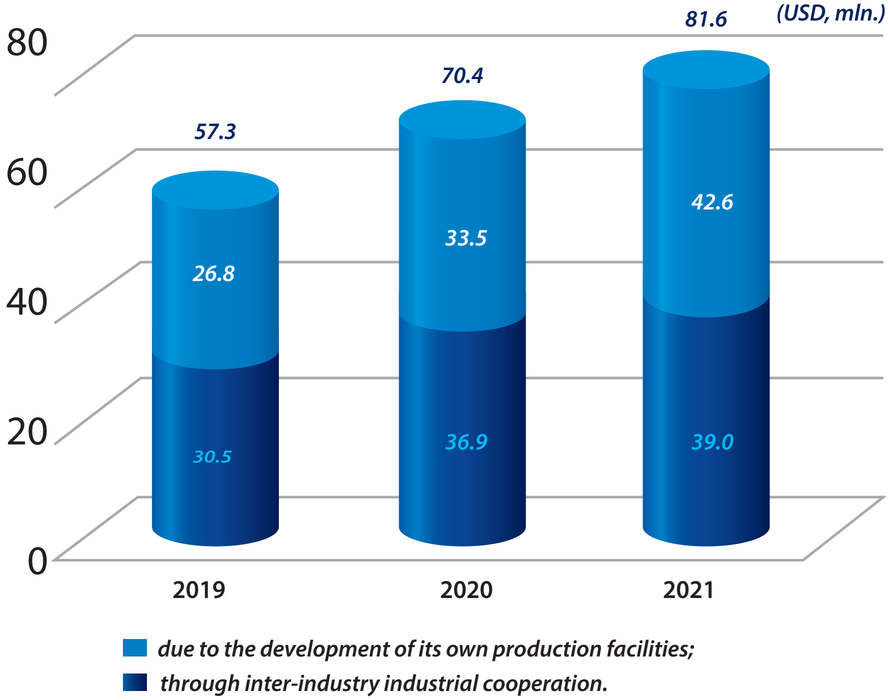

Fig. 2.19. Target parameters for reducing imports of goods by NMMC

Industry is the basis of social and economic development of the Kyzylkum region. Almost all types of industrial activity are represented in the region.

Mining and metallurgical production is the main activity in the industry of the Kyzylkum region, which accounts for more than 88% of the total volume of shipped goods of its own production, works and services performed by its own forces, and industrial products of the region.

A distinctive feature of the industrial structure of manufacturing industries in the Kyzylkum region is the high proportion of machine-building sectors (58.4% and 12.5%, respectively).

The largest enterprises in the territory of the Kyzylkum region: „Navoi mining and metallurgical combine", „Navoiazot" JSC, „Kyzylkumcement" JSC, „Electrokhimzavod" joint-stock company, „Navoi Thermal Power Plant" Joint-Stock Company, „Kyzylkum phosphorite complex" Joint-Stock Company and others.

In addition, the structure of processing industries in the Kyzylkum region is represented by the production of food products, the production of leather products and footwear, chemical, textile and clothing production, and the production of wood products.

The priority direction of development of the industrial complex of the Kyzylkum region, which allows to consolidate positive trends in the economy of the Kyzylkum region, is the development of internal and interregional cooperation:

1) despite the fact that many industrial enterprises pay special attention to the development of internal cooperation and localization of production, the average level of cooperation between enterprises producing finished products and providing services in the territory of the Kyzylkum region is low.

The directions and features of internal cooperation are determined by the industrial structure of the region.

The largest part of internal cooperative relations falls on the enterprises of the mining and metallurgical complex and the chemical complex of the Kyzylkum region.

Metallurgical industry enterprises demand supplies of sand, clay, kaolin, graphite, and quartzite, and the development of those deposits requires large financial expenses.

The development of iron ore base within the territory of Kyzylkum region is the potential development of intra-industrial cooperation for the basic raw material, namely, development of deposits of titanium-magnetite ores of Tebinbulak is spatially and genetically associated with the same gabbro-pyroxenite intrusive massif.

More than 100 deposits of various minerals are known on the territory of the Kyzylkum region, of them, 213 are deposits of solid minerals.

At the same time, mining companies are among the largest consumers of heavy transport engineering products. Therefore, there is a significant potential for restoring and developing these cooperative relationships: supplies of mining, metallurgical, rolling, forging, transport, energy, machine tools, and spare parts.

An example of cross-industry industrial cooperation of Navoi MMC is shown in Fig. 2.20 and Table 2.17.

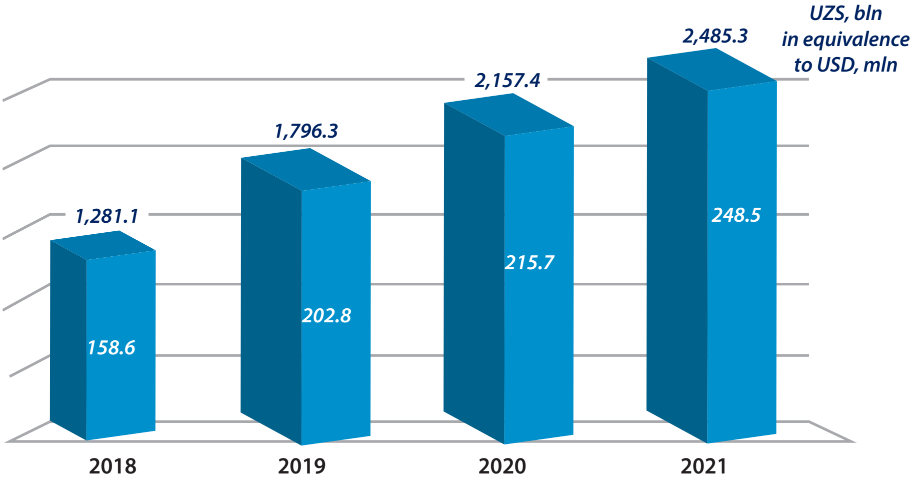

Fig. 2.20. Indicators of inter-industry industrial cooperation in 2018-2021 (forecast)

As a result of reducing imports due to inter-industry industrial cooperation in 2019, it was signed the contracts between local enterprises for a total amount of USD 30,477.0 thousand.

The Navoi MMC has the most homogeneous cooperative relations with metallurgical enterprises due to the high metal content of machine-building products and the proximity of suppliers.

At the same time, the heterogeneity of internal cooperative relations of the machine-building enterprise is noted in the direction of supply of components, while it is possible to note the predominance of direct links with manufacturers.

Table 2.17

Target parameters for reducing imports by NMMC for 2019-2021

Description	2019 (forecast)	growth rate, %	2020 (forecast)	growth rate,%	2021 (forecast)	growth rate, %
The reduction in imports, total *including at the expense of:*	57.3	114.1	70.4	122.8	81.6	116.0
inter-industry industrial cooperation	30.5	129.2	36.9	120.9	39.0	105.9
development of its own production facilities; including:	26.8	197.1	33.5	125.1	42.6	127.1
- production of localized products under the existing projects	14.9		15.0		16.9	
- development of new types of localized products	0.9		2.4		7.5	
- development of import-substituting products	11.0		16.1		18.2	

Analysis of the state of cooperation between enterprises of the chemical complex of the Kyzylkum region shows that the comapnies purchase raw materials directly from manufacturers (Russia, Kazakhstan, Belarus, Ukraine, China, Germany). Regional companies of the chemical complex supply their products to enterprises of mining and metallurgy, machine building, agriculture, and construction industries.

One of the important aspects of this cooperation is the scientific and industrial cooperation of enterprises and research institutes based on higher education institutions, such as the Navoi State Mining Institute, which carry out scientific activities, take part in exhibitions with scientific and technical developments, industrial samples, which are not only fundamentally new solutions, but also effective from a commercial point of view.

However, the main problem of educational institutions is the lack of experience, knowledge and funds to launch an industrial design into mass production in order to make profit in future. At the same time, regional enterprises in the course of their activities face problems which, if resolved with the involvement of scientific institutions, can significantly increase the commercial attractiveness and quality of the final product, reduce the time for its development.

Thus, the main factors that hinder the development of internal cooperative relations are the lack of information on the production capabilities of enterprises, the lack of interest of a potential performer in establishing cooperative relations, and the low innovative component of production.

In order to build a high-performance intra-regional production cooperation, it is necessary to implement a set of measures aimed at creating open information resources, organizing a closer connection between science and production, introducing an innovative component in the production process, using more economical, highly specialized equipment by attracting enterprises with the necessary equipment fleet to cooperation;

The foreign trade turnover of the Kyzylkum region amounted to USD 8 billion in 2018, including USD 5 billion 200 million as export, and USD 2 billion 800 million as import.

As for import, the amount of customs payments transferred and collected to the state budget for imported goods in 2018 amounted to USD 12 (11 percent more than the level of 2017 – USD 11.4).

In the value of imported goods, 93 percent are imported from foreign countries, and 7 percent are imported from CIS countries.

In comparison with 2013, the value of imports from non-CIS countries decreased by 15 percent, and from CIS countries – by 59 percent.

The physical volume of deliveries from the CIS countries also decreased by 27 percent, while deliveries from non-CIS countries remained virtually unchanged (an increase of 1 percent).

As for export, the physical volume of exports in 2018 exceeded 1.5 million tons, 60 percent of this volume was exported to non-CIS countries, 40 percent – to the CIS countries, while, compared to the same period in 2013, the weight volume of exports to the CIS countries decreased by 6 percent, and to non-CIS countries increased by 2 percent.

Problems of import substitution and scientific and production cooperation in the industries of the Kyzylkum region.

Negative factors that directly or indirectly impact the development of import substitution and scientific and production cooperation in industries include:

- production and technological factors. This group of factors can include the restrictions as follows:

- insufficient volume of products with a high share of added value (decrease in the number of enterprises with a full production cycle and increase in the number of assembly plants in the territory of the Kyzylkum region);

- low level of capacity utilization, availability of available production areas, buildings and structures, low quality of management;

- unbalanced research and development sector and insufficient elaboration of mechanisms for its strategic development in accordance with the requirements of the industrial complex;

- the presence of risks for enterprises in the development of production of products for cooperation and import substitution, associated with the possible presence of historical cooperative relations between enterprises of the industry and the need to offer new technical solutions for the production of import-substituting products.

Financial factor. This group of factors can include the restrictions as follows:

- the lack of opportunities for enterprises in the Kyzylkum region to provide consumers with financially attractive conditions for contracts for the supply of complex technical products in comparison with foreign manufacturers;

Information factors. This group of factors can include the restrictions as follows:

- lack of a single information portal in the Kyzylkum region on the development of import substitution and scientific and industrial cooperation;

- difficulties in obtaining information by industrial enterprises about promising commodity markets for the development of import substitution.

Potential of region.

The Kyzylkum region has a significant scientific, technical, and human resources potential and is a leader in Uzbekistan in terms of these indicators. More than 1,200 people are engaged in research and development. The industrial production of the Kyzylkum region involves 19 innovative and active organizations, of which the majority (85.1 percent) is concentrated in manufacturing industries. The cost of technological innovation in industrial production in 2019 was USD 5.5 million, of which, 61 percent was produced in manufacturing. Industrial enterprises develop and implement investment projects and research and development projects that promote import substitution.

To expedite the development of new industries and basic elements of innovation infrastructure in the Kyzylkum region:

1) a Industrial Park has been created to offer the investors the cost-effective conditions that allow them to significantly reduce their financial expenses and shorten the project implementation period;

2) a multi-modal transport and logistics complex of NMMC was created. The main direction of the complex is storage and logistics support of goods delivered from different regions;

3) a machine-tool cluster is being formed for production of large-size (heavy) various machinery with a processing length from 1,000 to 6,000 millimeters, tool machines (machines for sharpening and grinding tools), large-size milling processing centers with numerical control, injection molding machines (not manufactured in Uzbekistan), machinery for processing wood and other machine products, lathes;

4) in the Central MIne Administration, a foundry is being created for the production of mill linings;

5) there are 2 educational organizations of higher education.

Thus, the analysis of the current state of the industries of the industrial complex proves the relevance of the chosen vector of development of the Kyzylkum region, aimed at creating production of substitute goods at enterprises of the Kyzylkum region and the development of import-substituting production in order to increase economic and industrial independence and security.

2.6. Principles of sustainable development of the regional economy

The peculiarity of the current situation in the Kyzylkum region is that the change of the economic strategy of development and management from extensive to intensive implies the need to develop a conceptual model of the social and economic development of the region.

This is contributed by the fact that the reserves of deposits with a high initial content of useful components and easily enriched ores are depleted. Thus, the mining complex based on the Muruntau deposit has already reached the top of its capabilities with a predicted drop in gold output, compensation of which is possible due to more intensive development of other deposits, requiring additional financial resources and the availability of qualified personnel.

Estimating the social and economic status of the region, it is necessary to bear in mind that it still has a significant resource potential, and therefore the optimal, effective volumes of extraction of mineral resources, estimated by global standards (standards) of energy, and labor costs taking into account the need to preserve the environment and a fairly high standard of living of the population. It should be clearly understood that it is important to timely and correctly, dispose of the resource potential of the region, until the question of diversification arises.

The region as an object of management is governed by relations and relations between its constituent components and the external environment. Characteristic features of such systems are determined by the integrity, structure, hierarchy of components depending on their location, function and interaction in the system. Human activity is thus decisive.

Comprehensive substantiation of the concept of sustainability and sustainable development of the regional economy allows revealing the content of this quality (economic, social, institutional, etc.), as well as its potential, the algorithm of best use, etc.

The scientific concept of sustainability and sustainable development of regional economies should include:

- theoretical understanding of sustainability as a universal property of social and economic systems, which consists in their ability to perform their functions under negative impact - within certain limits in strength and time - of external and internal factors, as well as actively adapt to positive changes;

- indications that the origins of this quality lie in the objective existence of various proportions; this can be considered as a specific resource, having a certain potential, appropriately reproducible, manifested and used in special forms;
- selection of sustainable development of the regional economy as a specific object of management in the market model of management;
- criteria and indicators of sustainable development, as well as sound goals and objectives of management for regions of different taxonomy and types of development;
- generalized conclusions on promising methods of stabilization activities of the central government, regions of the country, local government structures, as well as ways to optimize internal and external economic proportions;
- justification of ways to overcome the methodological barriers that have arisen in connection with the tendency to absolutize the ecological content of sustainability and sustainable development; preservation in many respects of abstract views on the problems of sustainability of territorial social and economic systems that have been formed under the influence of more synergetic than the practices of a regional organization; indications that the most significant factors for the violation of the sustainable development of the regional economy are the danger of physical destruction of fixed assets, refusal to correct reforms, in particular, to strengthen their social orientation, state regulation and stimulate production.

Qualitative property of the region is the multidimensionality of the structural organization. Even if we focus only on the economy, it is necessary to take into account its links with other regional subsystems. The scheme of functioning of the region should include at least three interconnected blocks: “economy”, “population”, and “natural environment”. In addition, it is necessary to take into account the presence of state structures affecting the ongoing processes, as well as the external sector (for the region, this is not only a foreign economy, but also the economy of a neighboring region).

That is, as an object of management, the Kyzylkum region develops under the influence of external and internal forces that are constantly changing their intensity. The process of forming the concept of sustainable development of the region is very complicated, since the concept must be constantly adjusted in accordance with the development of the object and the incoming information about it. The use of a strategic approach to the management of social and economic processes in the region, proposed by I. Ansoff, makes it possible to consider the development process in a dynamic aspect and consists of the following.

Firstly, the external environment of the region, national and foreign, becomes no less, and in some cases more important than the internal. The external environment of the region is characterized by uncertainty and variability, incompleteness of information, fraught with threats and challenges.

Secondly, in order to survive and develop in such conditions, reduce information incompleteness, uncertainty and environmental risks, an image of the desired future (vision, mission, goals) of the region and ways to achieve it are developed through the development of an appropriate strategy. The goals to be set should be related to the resources, capabilities, and potential of the region.

Thirdly, the behavior of the regional system is mainly directed not at responding after what happened (eliminating the consequences or adapting to the environment), but at anticipation, anticipatory actions. In this case, the behavior of the regional system becomes proactive.

Fourth, the region provides not just economic growth, but its own qualitative change, that is, social and economic development.

Based on the above, it is possible to formulate some principles of sustainable social and economic development of the Kyzylkum region.

1. Regional policy should be based on a methodology that regards a region as a complex living (self-developing) system.

2. A balanced solution should be provided to the problems of social and economic development and the preservation of a favorable environment and natural resource potential, meeting the needs of present and future generations, since the development of any living system is aimed at extending its livelihoods.

Extending sustainable living is possible due to:
- holistic approach to the system;
- complications of the system;
- reduction of specific energy consumption for maintaining connections and relationships;
- acceleration of the processes taking place in the life support system;
- operational monitoring of system development and organization of feedback stabilizing processes.

3. The main goal of social and economic management should be to improve the quality of life of the population of the region, since it is man as a creature whose quality of life is determined materially (the quality of food, housing, health, etc.) and spiritually (knowledge, moral and aesthetic principles) is at the center of regional and state policy.

4. From the standpoint of the state regional policy, the region should be considered simultaneously as a simple and complex system. At the same time, a region of national interest by type of activity (system-forming factor) is considered as a simple system, in other cases it is considered as a complex system with its own goals and independence. This will allow a policy that takes into account the interests of the country and the region; describe the objects of management; specify the main and private objectives, while determining the mechanisms of financial, legal and personnel support; determine the roles of the main groups of the population and, as a result, improve the quality of management of the region at the state and regional level.

5. High quality management is a key condition for the sustainable development of the region.

The principles listed above enable a clearer description of the region as an object of management, allow formulating the goals of its development, including determining the place (hierarchy) of specific goals in the state-region relationship in time and escape the vagueness of management boundaries regarding management levels.

In accordance with the principles outlined above, a strategic development goal for a region can be formulated.

The strategic goal of the development of the Kyzylkum region is the formation of a sustainable social and economic system of the innovative type, capable of providing a decent level and high quality of life for its people, solving, basically, the problems of raw material security of Uzbekistan based on high-tech, knowledge-intensive, energy-saving and resource-saving technologies and creating financial prerequisites for the implementation of national strategic priorities in the world community.

Achieving this goal involves the following main tasks:

- creation of conditions for balanced environmental management, the subordination of the tasks of economic growth in the region to the goals of creating a new humanitarian-ecological civilization of the future with the goal of preserving natural resources and ecological balance;
- identifying priority areas for the functioning of the basic sectors of the regional economy based on the use of high-tech, knowledge-intensive, energy- and resource-saving technologies and increasing the complexity and completeness of the use of mineral raw materials;
- development of the legal framework in order to stimulate innovation and investment processes in the field of environmental management;
- assessment of the impact of the implementation of the basic industries development strategy on the state of the social sphere of the Kyzylkum region (dynamics of production volumes and taxable base, employment, wages of employees, etc.);
- definition of forms and mechanisms of support by authorities of priority directions and projects in the basic branches of the regional economy.

2.7. Social policy in NMMC

The main tradition in the plant is attention to the person — this is social protection, full support for those who need help. The welfare of people and the development of the social sphere are among the main directions of the „Strategy for action on the five priority areas of development of the Republic of Uzbekistan in 2017-2021“, approved by the Decree of the President of the Republic of Uzbekistan, dated February 7, 2017. Under this document, the country moves on with a consequent increase in real incomes and employment, improving the system of social protection and health with increasing sociopolitical activity of women, targeted programs are implemented to build affordable housing, development and modernization of road-transport, engineering-communication and social infrastructure for improving living conditions of the population, develop education and science, improving the state youth policy.

- Initially, the purpose of creating trade unions was not to obtain material benefits and vouchers to health resorts, but to solve pressing issues and problems of workers, such as decent wages; creating normal working conditions; safe organization of the production process and work; solving social issues; and providing pensions. The presence of a trade union organization at the enterprise to this day, confirms its success.

- In this regard, the Council of Trade Union of the Navoi Mining and Metallurgical Combine is a worthy example. It operates on the Basis of the law „On trade unions" and the Collective agreement, which is a local normative legal act regulating labor and socio-economic relations between the employer and employees of NMMC.

- The Trade Union of NMMC is an extended organizational structure that includes 6 joint trade union committees and 21 trade union committees of the plant's divisions. Today, more than 73 thousand people are members of the plant's trade union. Almost every employee of the plant aspires to join a trade union, because in this case, he/she will get the right to all social and economic norms and benefits provided for in the Collective agreement. But the the employee is not the only party which needs the union, the employer needs it too. The trade union and the employer are social partners who work together to solve emerging problems, both in the social and industrial sphere. And this tandem cooperates successfully in NMMC.

- Labor protection and treatment of citizens is under constant control.

- Many employers finance occupational safety issues on a residual basis in order to get more profit. Therefore, almost every year thousands of workers die and become disabled in the world, receiving labor injuries. In Navoi MMC, this work is under special and constant control, since mining and metallurgical production is associated with a certain risk due to with the presence of complicated technological processes. In order to improve the safety of production, the plant introduces new, safer technologies, and constantly modernizes equipment and existing technologies. In this regard, the rationalization movement is supported.

- The state of working conditions, the level of occupational injuries and occupational diseases are systematically analyzed, and the effectiveness of measures taken to optimize working conditions and safety is evaluated. Together with specialists from the labor protection and safety departments, the employees of the miners‘ union also participate in the investigation of accidents that occurred with employees of the plant at work, take part in the certification of workplaces for working conditions, which results in the preparation of action plans agreed with the union to improve working conditions in the divisions.

- For workers working in harmful working conditions, there is a medical and preventive nutrition (MPN), the quality and delivery of which is controlled by specialists of the trade union council. Also, the issues of providing employees with work clothes, special footwear and other personal protection equipment, the state of industrial sanitation and industrial life in the plant‘s divisions are under constant control. In order to improve the social and living conditions of employees at remote industrial facilities, in workers‘ dormitories, eating and rest rooms, funds are allocated from the union‘s budget to equip them with microwave ovens, refrigerators, televisions and other necessary household appliances.

- The trade union council also exercises public control over labor protection through its representatives located directly in the plant‘s divisions. They carry out their activities in accordance with regulations, instructions for the safe conduct of production operations, printed and video manuals, and are financially stimulated at the expense of the plant and the union‘s budget. Certification of workplaces is carried out, compliance with labor discipline is monitored, etc. The contests „The best expert of laws and regulations on labor protection and safety“, „The best commissioner for labor protection of NMMC“, „The best young specialist of the year“ have become traditional. As a result of this work, working conditions improve and the number of accidents decreases annually.

- One of the most effective forms of implementing the protective functions of NMMC employees is the review of appeals from workers and pensioners of the plant by the trade union. Among the appeals are issues of protection of labor rights, provision of material assistance, payment and labor protection, compensation for victims in the workplace, solving housing problems and other issues. Most of them are solved positively.

- Health is a guarantee of success.

- Another important area of activity of the trade union council of NMMC is the health improvement of employees. The medical department of the plant unites five major medical institutions located in the cities of Navoi, Uchkuduk, Zarafshan, Nurabad, and the Zafarabad village with coverage of 200,000 people. All institutions are equipped with modern medical and diagnostic equipment. In 2016, a mother and child screening center was opened on the basis of Medical Station 3. Doctors of medical units are systematically trained in advanced training courses at leading clinics in Tashkent and the Russian Federation.

To improve the health of workers in Navoi, there is a health resort „Metallurg“, equipped with modern equipment and providing a wide range of health procedures, with comfortable cottages and rooms for vacationers. In Uchkuduk, there is a Konchi („Miner“) dispensary, which will be repaired this year and will also acquire a modern look. In the city of Nurabad located in the balneological sanatorium „Nurobod“. On May 25, 2019, it was the opening ceremony of the sanatorium „Navoi Mining and Metallurgical Combine“ for 150 seats, built in Zaamin district of Jizzakh region on the initiative of Mr. Shavkat Mirziyoyev, the President of our country.

The sanatorium provides facilities and services organized at a very global level. The sanatorium is equipped with modern specialized medical equipment.

- The Gornyak boarding house in the foothills of the Chimgan mountains is open all year round for recreation of workers and their families. While for seasonal recreation, there is a summer recreation center „Tudakul“ and in addition, the trade union purchases vouchers to sanatoriums of the Republic of Uzbekistan, as well as to Yalta and Kislovodsk.

Fig. 2.21. „ZOMIN“ sanatorium in the Jizzakh region

- Good leisure encourages work

- Navoi MMC has also created favorable conditions for workers and their families to realize their sporting and creative abilities.

- To do this, the NMMC has 2 palaces of culture, 2 houses of culture, 2 clubs, a cultural and sports center, a children‘s creativity house, and a choreography house. They created more than 170 creative groups of Amateur artists and clubs, 41 of them have the title of „People‘s“ and „Exemplary“. In total, about 5,000 children and adults are engaged. It is gratifying that amateur teams of the plant have repeatedly become winners of national and international competitions, festivals, and exhibitions in many countries of the world.

- Every year, creative teams of cultural institutions of the plant hold more than 2.5 thousand mass events, in which about 650 thousand workers of the plant and their families participate. In addition, amateur groups go to concerts in remote rural areas, in the NMMC‘s divisions during the celebrations on the occasion of commissioning of new facilities, public holidays. Another great tradition has been born in recent years, namely, the creative teams of NMMC cultural institutions, consisting of more than 450 people, in early May, show charity concerts in the large Tashkent palaces „Turkiston“ and Istiklol.

- The cities of Navoi, Uchkuduk, Zarafshan, and Nurabad have also libraries with a total book collection of more than 360,000 copies. At the end of last year, the number of library-goers was 23.8 thousand people, including 8.2 thousand children under 15 years of age.

- Since 2013, the Museum of the History of NMMC has been operating in the building of the Farhad recreation center in Navoi. In its spacious halls there are about 1,000 exhibits, historical artifacts that demonstrate the ancient history of the Kyzylkum land, the richest storehouse of the famous desert. As well as photos of pioneers and stages of development of the desert, books about the history of the plant, which capture each of the 60 years of development of the plant. Stands with cups and awards awarded to NMMC for high quality products, a picturesque layout of the world-famous Muruntau mine, samples of minerals and much more also attract attention. Every day, the Museum is visited by hundreds of visitors from the city of Navoi and the plant, groups of workers from all departments, students and school students. It is possible that they will join the Navoi MMC workforce in the future.

- Children is the future of the plant

- Annually, children‘s health camps of the plant are acknowledged as the best in the country according to the results of the competition of the Council of the Federation of Trade Unions of Uzbekistan. Those are such children‘s health camps as „Sarmysh“, „Bolajon“, „Sogdiana“, „Zarafshon“ located in the country-side. During the years of independence, another camp was built – children‘s sports and recreation center „Pahlavon“ on the bank of the Charvak reservoir. There are also 5 urban day camps for children, including two labor and recreation camps in Zarafshan and Navoi for 15-17-year children. Every year in the summer, more than 10 thousand children have a rest in the children‘s health camps of NMMC. Among them are the children of „Mehribonlik“ and „Shodlik“ orphanages, children from low-income families in remote areas of Tamdy, Nurata, Kanimeh, Zarafshan and Uchkuduk. In 2017, the NMMC received on its balance the children‘s health camps „Zolotinka“ located in the picturesque Urgut district of the Samarkand region, which, after capital restoration will take even more children of the plant‘s workers in this year.

- Sport is a priority

- The NMMC is actively working on the development of children's sports, health improvement, promotion of a healthy lifestyle, and harmonious physical development. About 30 thousand workers and their families are participants in the sports life of NMMC. Physical culture and recreation and mass sports work is carried out in 8 physical culture and sports clubs (FCSC) located in the cities of NMMC, and 96 physical culture groups. For full-fledged classes, there are stadiums, sports complexes with spacious halls for team sports, modern stadiums, swimming pools. The plant's athletes participate in international and national championships. Hundreds of gold, silver and bronze medals are in their collection.

- In recent years, new sports complexes and training halls, clubs and cultural centers have been built in the villages of Zarkent, Zafarabad, Mardzhanbulak, Zarafshan, and Uchkuduk, the planned repair and reconstruction works are being carried out.

- The structure of FCSC Sogdiana (Navoi), Alpomysh (Zarafshan) and Lochin (Uchkuduk) also includes comprehensive children's and youth sports schools with branches in Nurabad and Zafarabad, with a total coverage of more than 2,800 children. More than 6 thousand people are engaged in adult sports and health groups. The classes are held at a convenient time for employees, before and after work, at lunchtime, on weekdays and weekends. Every year, the NMMC workers' sports contest is held in three stages. Modern sports complexes, swimming pools are available to any worker of our plant and his/her families.

- The sports facilities of the plant have earned a high reputation in the country, and their students achieve significant success in national and international competitions. Thus, Mahliye Tagayeva is the winner of the Asian weightlifting championship, Malika Khakimova – in fencing, Umida Saidova – in Sambo, Lola Kodirova is recognized as the winner of the Afro-Asian championship and the Asian Cup in weightlifting. Istam Kudratov is the champion of Asia on Sambo, two-time world champion. Mohinur Kahramanova is champion of the Republic of Uzbekistan in chess, Zariya Kosimova, Herod Zhumanova, Dilnoza Kamolov are laureates of State prize named after Zulfiya. In 2017, Gulnoza Akhmadova, a Zarafshan student of the weightlifting school, became a silver medalist at the World Championships in Thailand and an Asian Champion in Nepal. Istam Kudratov won a bronze medal at the V Asian indoor games in Ashgabat.

- It is worth noting the work of the Navoi swimming center „Oltin SUV", founded in 1995. It can be rightfully called as a forge for training of high-class athletes, winners of Asian and world competitions. In 2017 only, at the Asian swimming Championships, Khurshid Tursunov won 3 gold medals, Danil Tulupov – one gold medal, Alena Tomina – 2 gold, one bronze medals, Alena Vasilyeva – gold, bronze and 2 silver medals.

- It should be noted that Navoi MMC is the general sponsor of the swimming Federation of Uzbekistan, the general sponsor of the football team „Kyzylkum", which has consistently played in the top league of the championship of the Republic of Uzbekistan for many years and shows good results.

- It should be noted that the trade union of the plant participates directly in the construction, reconstruction and repair of medical, sports and cultural institutions in NMMC's cities, allocates funds for equipping them with the necessary equipment, for trips of our creative teams and athletes to competitions and competitions of various levels.

In general, the sports and recreation activities as carried out by the combine and the trade union council contribute to the promotion of a healthy lifestyle, the development of children's sports, the improvement of the younger generation and workers, and the harmonious physical development of the combine's employees and their families. And most importantly, ensuring decent work, full-fledged leisure, life and social security of the plant's workers.

CHAPTER III

Research of the effect of natural, technical, ecological and social and economic factors on the development of the region.

The use of natural resources in the course of economic activity, whether it is mining of minerals or emissions of industrial waste into the atmosphere and water bodies, inevitably leads to a gradual depletion of natural capital: the reserves of natural resources are reduced, and the assimilation capacity of ecosystems is reduced. In the light of the concept of sustainable development, regional income, the creation of which caused damage to the economic system in the form of external costs, lost profits, is not evidence of a high level of development of the territory.

Further assessment of the level of sustainable development of the region and the role of natural capital in it should be carried out taking into account the consumption of natural and physical capital. The task of ensuring the rational use of natural resource potential becomes one of the most important, and its successful solution affects the development of the economy and the strengthening of social stability in the region.

3.1. The impact of the natural resource Potential of the Kyzylkum region on its development

The integral resource of the natural-industrial system is a systematic combination of all types of natural (material, energy and information) resources, which, in combination with material, financial and labor resources, determine the parameters of the life of a society (Fig. 3.1). A system exists at the expense of this resource, which is completed from the integral resources of its hierarchical levels, and a systemic set of resources is manifested in the fact that a qualitative or quantitative change in one of them inevitably leads to qualitative or quantitative changes in the others. In any case, a decrease in the integral resource below a certain level leads, ultimately, to the degradation of the natural-industrial system.

Therefore, both the state and the region always try, if not to increase, then at least, to preserve their integral resource, and for this it is necessary to know in advance when its quantitative or qualitative changes will occur in order to take compensatory measures in a timely manner. Such compensating measures can be the mobilization of resources from other systems or the movement of resources within the system to focus efforts on the priority task.

The preservation of the integral resource of regions with the dominant role of the mineral and raw materials industry has some peculiarities, because changes in resources are clear and predictable, since any field has one indisputable property - its reserves eventually, but inevitably run out. As a result, it is necessary to make a decision on the future fate of the mining complex, which must be prepared in advance.

However, the importance of such training by the subjects of the system is often degraded by the effect of "seeming well-being", generated by a misunderstood thesis about the wealth of the subsoil. Therefore, the adoption of appropriate decisions and the implementation of compensatory measures are delayed in time. As a result, an allegedly unexpected decrease in the share of the mining and processing complex in the integral resource of the region radically changes the situation, which is perceived as an extremely negative phenomenon of subjective origin at the upper levels of the system.

In part, we can agree with this, since only timely implementation of compensatory measures depends on the subjects of the natural-industrial system. And the main subjective factor in this case is the lack of a strategy for the development of mining complexes, regions and industries, based on government priorities in the development of mineral resources and a vested coordinating and controlling role (status of the regulatory document).

However, the presence of such a strategy is a necessary but clearly insufficient condition for the timely adjustment of the situation, since it still needs to be implemented by changing the established movement of internal and external system resources and directing them to solve emerging problems. But, a change in the movement of resources inevitably leads to the infringement of the interests of other subjects of the system and the possible emergence of conflict situations. This development requires that the subjects of the system seek compromises, often at the expense of their own interests. Therefore, other less "flawed" paths that are considered as a temporary measure, and the solution of the main task is postponed "for later".

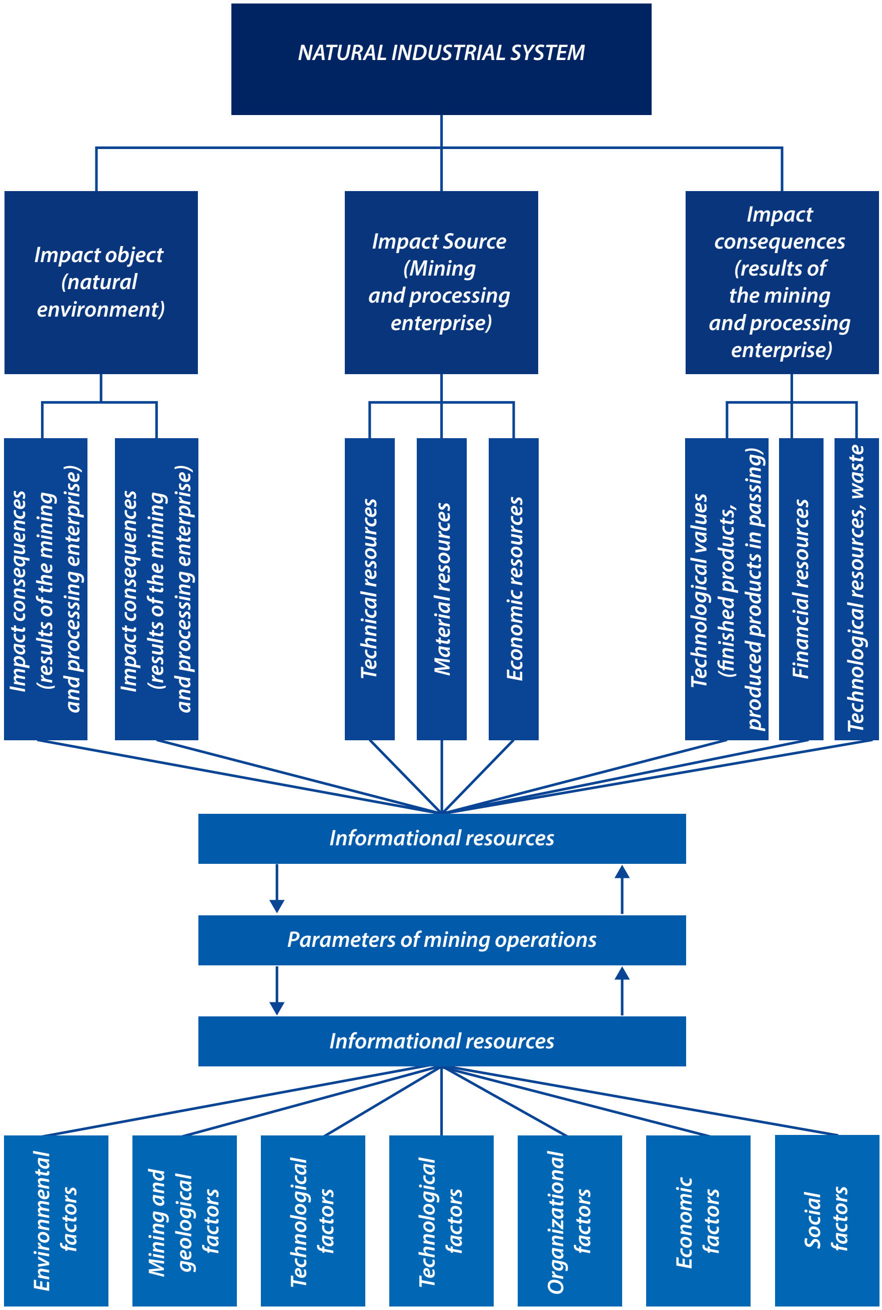

Fig. 3.1. Structural scheme of the interaction of resources and factors in the natural-industrial system

The motivation of this choice is based on the "Principle of remoteness of an event", according to which problems distant in time and space seem to be less significant today and therefore with their permission one can wait. As a result, resources are diverted to tasks that are of secondary importance for the region, and the effect of "apparent well-being" is created in society. The result of such actions is quite predictable - an inevitably sharp and, as it were unexpected exacerbation of the situation, for the resolution of which you will have to pay more, which is quite consistent with the "Law on Reducing the Energy Efficiency of Environmental Management".

Giving the development strategy of the mining and processing complexes the status of a normative document will serve the subjects of the natural-industrial system as an incentive motive that will guide their actions in accordance with government priorities in the development of mineral resources.

It should also be borne in mind that measures aimed at compensating for the integral resource in the mineral and raw materials industry require advanced investments, the size of which does not always correspond to the capabilities of the mining and processing complexes, regions and even individual states. Therefore, the sources of such funds must be determined in advance, the conditions for their receipt and return are known, and the size is commensurate with the tasks. Only in this case, the developed strategy will get real chances for implementation.

Based on the above logical reasoning, we can conclude that the integral resource of the natural-industrial system is manageable.

To illustrate this conclusion, we will consider typical examples of managing this resource in the Kyzylkum region, which is based today on the mineral resources of the Muruntau, Kokpatas and Daugyztau gold deposits provided with water, energy, material, social, human resources and human resources for their development.

Example 1. The situation develops in such a way that in a few years the remaining reserves of the Muruntau, Kokpatas and Daugyztau deposits cannot ensure gold production at the achieved level, therefore, first the volumes of mining and then the volumes of ore processing will start to decrease. In accordance with the existing project estimates, mining at these fields, gradually decreasing in volume, will be almost completely stopped in the period from 2020 to 2035.

This will lead to a significant reduction in labor requirements, unused production capacities will appear, and the main source of maintenance for the cities of Zarafshan and Uchkuduk will be almost completely depleted. At the same time, there will be problems in the region, which interacts with this mining and industrial complex and well-being of which largely depends on the efficiency of its mining and processing facilities. As a result, a degradation of the region may begin, which can be prevented by replenishing the lost part of its integral resource.

The most realistic way of such replenishment is the development of new types of mineral raw materials with the construction of new diversification and conversion of existing mining and processing industries. Basic prerequisites for this are available. In particular, the Zarafshan industrial complex can be reoriented to the development of silver deposits and, mainly, granular phosphorites, reserves of which in the region are estimated at ~ 2 billion tons.

Uchkuduk industrial complex can be focused on the development of uranium-vanadium deposits in black shale, the reserves of which are estimated only partially, and their main part requires exploration work. Moreover, the cost potential of these deposits is significantly higher than the cost potential of promising gold deposits in the area.

In addition, in the area of accessibility of these complexes are significant reserves of sandy-clay raw materials, which can be successfully used for the production of building materials, ceramics, glass, etc.

Thus, there are prerequisites for maintaining the integral resource of the Kyzylkum region as the reserves of existing gold deposits are developed. These prerequisites are based on the possibility of developing new types of mineral raw materials that will require not only the creation of new ones, but also the conversion of existing industries. This raw material may not be as prestigious as gold, but for the region, in fact, it does not matter in principle how its integral resource will be saved - due to the development of gold, silver, phosphate, uranium or sand and clay.

For the realization of the existing prerequisites for the preservation of the integral resource of the region, it is necessary for the subjects to realize the considered natural-industrial system:

- the inevitability in the foreseeable future of the reduction in production volumes, focused on the development of gold fields;

- the need to make a decision on the further development of the region on the basis of state priorities in the development of mineral resources with the development of a corresponding strategy, focused on maintaining its integral resource and providing for this to attract additional resources „from outside“;

- the expediency of giving the developed strategy the status of a regulatory document with coordinating and managing functions.

Example 2. In 2005, foreign co-founders of the former joint venture Zarafshan-Newmont, sensing the extremely high attractiveness of processing off-balance ore accumulated in Muruntau open-cast mine warehouses, proposed replacing the heap leaching method with the traditional redistribution method with the construction of a grinding plant with a capacity ~ 12-14 million tons per year. According to the factory technology, it was supposed to process not only the off-balance ore remaining in the warehouses (-100 million tons), but also the “tails” of the heap leaching (~ 120 million tons), hoping to get at the same time by an increase of ~1.5 ~ -1, 6 times the extraction ratio of the additional amount of gold.

The implementation of this proposal required allocation from the common resource of the region a significant amount of water and energy resources, which are almost fully involved in the mining and processing facilities of the NMMC. Their redistribution in accordance with the received proposal would entail a decrease in production volumes in the plant and, as a result, the integral resource of the region.

Therefore, it was rejected.

This example clearly demonstrates the need for coherence in the creation of new or the development of existing facilities of the mineral industry, based on the common integral resource of the region.

3.1.1. Efficiency of using geo-resource potential of deposits

Analysis of the effectiveness of using geo-resource potential of the fields involves the use of certain principles of the organization of the mining and processing industry (Fig. 3.2) and the creation of conditions for the involvement of all mineral and raw material resources in economic circulation.

This factor is of particular importance today, when the conjuncture for mineral raw materials may change both in the direction of deterioration and in the direction of improvement in an unpredictable way. The situation is also complicated by the predictable and unpredictable changes in the geological and mining conditions of the deposits.

The processing industry has been developing intensively in recent years. Fig. 3.3 shows the current structure of the processing of gold-bearing ores in NMMC.

An analysis of the situation shows that in order to maintain the planned output of gold at HMP-2 under the conditions of a decrease in the gold content in the ore supplied by Muruntau open-pit mine, an increase in its processing at HMP-2 is necessary. Under these conditions, the stable performance of the mining and processing complexes is largely determined by the ability to reliably manage the existing raw material base. The accumulated experience in the development of the Muruntau field allows some generalizations to be made in this area.

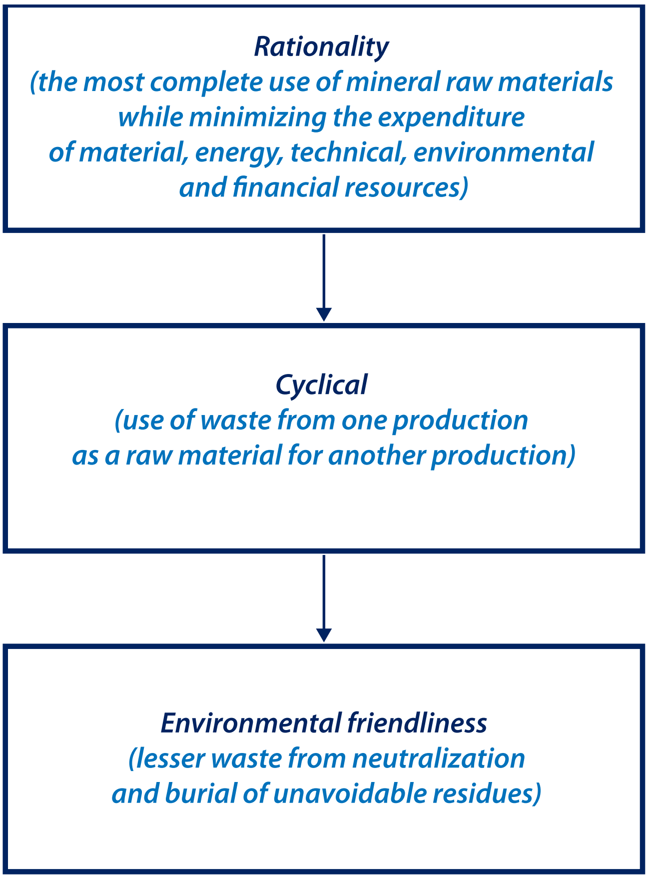

Fig. 3.2. Principles of the organization of mining-processing industry

Under the management of the raw material base of the enterprise, we will understand the purposeful change in the active reserves of mineral resources in accordance with the projected program for the sale of finished products. The controlled parameters in this case are the quantitative and qualitative characteristics of mineral resources. At the same time, the mining and processing complex is considered as a natural-industrial system with different levels of management.

Control levels are a set of controls grouped and separated according to a hierarchical principle. The following hierarchically interrelated elements of a mining enterprise are taken as following levels of management: excavator face, working area of the quarry, quarry, and deposit. With this, such a fact considered that each level of management in the spatial hierarchy corresponds to a well-defined level of management in the time hierarchy: shift, day, month, quarter, year, 3-5 years, the duration of the career development stage, the lifetime of the mine, the term of the deposit. Such a relationship between the spatial and temporal hierarchy is due to the significant inertia of open mining and characterizes the ability of the mining enterprise to respond to control actions (changing mining conditions, product prices, etc.). For example, when the quality of ore in the bottomhole changes, it may take from several hours to several days to implement a control action, in the working area of the quarry it may take from several months to several years, etc.

Let us consider in more detail the two upper levels of management of the raw material base, since it is at these levels that the development strategy and such parameters of the mining and processing enterprise are determined as productivity and the period of existence, the volume of finished product, etc. One of the elements of the resource base management is the choice of such a methodology for calculating reserves, the use of which would ensure the minimum discrepancy between the calculated and actually obtained at the extraction characteristics of the mineral.

Initially, approved reserves of the Muruntau quarry as of January 1, 1969 were calculated using the vertical section method based on testing geological exploration wells to a depth of 350 m drilled through a network of 80x60 m. They served as the basis for designing the 1st and 2nd quarters of quarry. However, they differed significantly from the forecasted reserves and had quite reasonable prerequisites for the increase.

Therefore, simultaneously with the development of the 1st stage of the open-pit mine, intensive exploration of the flanks and deep horizons of the field was carried out. To this end, a geological exploration party (GEP-3) was created as part of NMMC, and a geological exploration mine was built, which allowed the deposit to be explored by mine workings at a depth of up to -500 m, and the drilling one - at a depth of up to 1000 m from the surface.

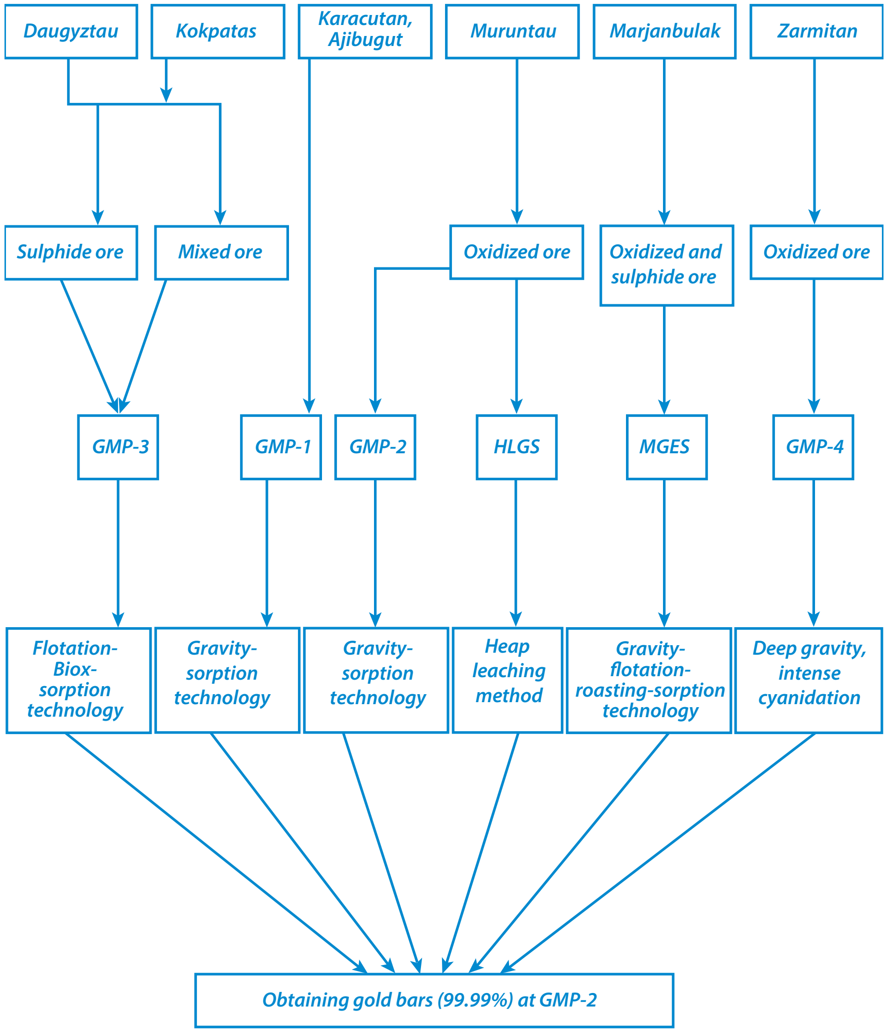

Fig. 3.3. The current structure of gold ore processing

Table 3.1

Main control parameters, influential factors and management methods of HMP's feedstock base

Hierarchical level of management	Control parameters	Influential factors	Management methods
Face	Losses and dilution	Complexity of ore body formation	1. Selection of method to prepare grade plans 2. Selective development of face 3. Management of massive distortion during explosion loosening of rocks
Work area	Volume and quality of rock mass with different consumer properties	The degree of saturation and the features of ore body distribution in the rock massif	1. Selection of network for rock in-mine sampling 2. Update of ore outline 3. Selection of cutting depth 4. Change in parameters of extracting machinery 5. Cargo flow management
Quarry	Volume and quality of saleable ore	Ratio of barren saleable and unpayable ores	1. Defining of specific natural and process zones and update of their boundary limits 2. Resue stoping, transportation and storing of various barren, saleable, and unpayable rocks
Deposit	Active and passive reserves of mineral resources	Accuracy of reserves estimation. Technical capabilities and commercial viability of open-pit operations and mineral feedstock processing	1. Update of deposit boundary limits 2. Selection of reserves calculation method 3. Defining of quarry development phases 4. Putting unpayable rocks in operation

By 1985, the exploration units of the plant had drilled 250 km of wells and completed 60 km of underground mine workings, which in 1986 made it possible to develop a project for the 3rd stage of the quarry, which ensures the development of reserves to a depth of 460 m.

At that time an urgent need to recalculate the reserves of the field appeared, due to:

- a significant amount of additional data on testing new exploratory wells and underground workings, which expanded the concept of the deposit boundaries;
- a large amount of information on operational testing, which allows to compare the results of the initial inventory calculation with the actually spent reserves and, if necessary, make the appropriate adjustments to the calculation methodology;
- the discrepancy between the accepted method of calculating the reserves of the technology of mining the field in horizontal layers (ledges).

In 1985, the method of calculating reserves by section was replaced by the method of counting by horizontal sections, which made it possible to adapt it to the technology of open pit mining. At the same time, correction factors were introduced into it. Their introduction is connected with the fact that when comparing the estimated geological reserves with actually spent for 19 years of the quarry, the average gold grade was overestimated by 24%. The changes made it possible to increase the reliability of the planning of production volumes while reducing losses and dilution of commercial ore. In 1992, based on the reserves calculated by the new method, a feasibility study for the construction of the fourth stage of the quarry was drawn up, and the prospect of a subsequent transition to the underground mining method with the development of the field to a depth of 950-1000 m was estimated.

The next stage in the evolution of the methods for assessing the raw materials base of the HMP-2 was the use of computer technologies for processing geological information. These works were carried out jointly by specialists from INTEGRA GROOP LTD (USA) and NMMC and were completed in 1998 by building a block mathematical model of the field and calculating its reserves. The work was performed using progressive computer technology that had not been used previously in world practice.

The main features of this technology, characterized by the novelty and large-scale solution of the problem, are as follows.

The first fundamental difference is that using nonlinear interpolation methods in each elemental volume of the subsoil (in the specific case, a cube measuring 15x15x15 m was taken as such an elementary volume), the expected distribution of the content of the useful component was calculated, rather than its average as it is customary in similar programs of other firms (Datamine, etc.). The indicated distribution was calculated using samples whose geometrical parameters were determined by the method of exploration of the field.

The second fundamental difference is that the operator was determined to transform the expected distribution of the content of the useful component when changing the geometric parameters of samples (for example, when switching from testing geological exploration wells with a diameter of 76 mm to testing explosive wells with a diameter of 250 mm).

In general, the developed computer technologies for processing geological information made it possible, based on the probability of the distribution of the content in each elementary volume of the subsoil, to calculate the field's reserves for any cutoff grade of the useful component and to obtain a comparable estimate of these reserves based on operational exploration results.

Compliance of the mathematical model of the field and the developed method of calculating reserves with the real distribution of mineral resources in the subsoil was checked on the used volume of the field. In order to do this, a comparison of the reserves determined (1985) by the traditional method according to detailed exploration data and by the method of mathematical modeling (1998) with the results of their redemption according to operational exploration data (a network of wells 5,6 X 5,6 m) was made. In this case, the reserves, determined according to operational intelligence, were taken as a reference option. The results of the comparison are presented in table 3.2.

Mathematical modeling and calculation of reserves by the developed method was also performed for the Myutenbay field and the off-balance ore of the Muruntau mine, accumulated over the 30 years of its existence.

Table 3.2

Average comparative errors (in %) of the estimate of the Muruntau deposit reserves (as compared with the operational exploration data)

Cut-off grade, cu	**Estimation of reserves using the mathematical model**			**Estimation of reserves using the traditional method (1985)**		
	ore	**content**	**metal**	**ore**	**content**	**metal**
1.0	9.5	9.4	14.8	20.7	12.7	23.2
1.5	11.9	8.8	17.8	22.4	13.8	26.3
2.0	17.5	10.1	22.7	28.0	14.3	29.8

Thus, for the first time in the history of the development of the Muruntau and Myutenbay fields, their reserves were presented in the form of a block mathematical model and evaluated according to world standards, allowing the use of modern computer technology for the development of quarries, which is an important consequence of the work done. The practical implementation of these opportunities allowed revising the parameters of the 4th stage of the Muruntau open-pit mine, defined in the feasibility study, and increasing its depth from 575 m to 735 m while maintaining quantitative and qualitative parameters for commercial ore and simultaneously reducing the volume of mining operations by 160 million m^3.

At the same time, there was made an assessment of the technical feasibility and economic feasibility of increasing the depth of the pit up to 1,000 m, with a corresponding increase in the raw materials base of HMP-2, but without expanding its boundaries within the 5th stage. Already, technical solutions aimed at accomplishing this task are being implemented. The main ones are:

- ensuring the safety of mining operations due to the consistent formation of a stable pit side profile (rectilineal to a depth of 100÷150 m → convex to a depth of 450÷500 m → convex in cissoid to a depth of 700÷750 m → concave-convex in the catenoid of rotation to a depth of 1,000 m and more);
- ensuring the personnel safety working in the polluted atmosphere of a quarry by equipping the cabs of mountain transport equipment with filtering installations that have been used effectively since 1992;
- expanding the scope of cyclical flow technology through the use of steeply inclined conveyors;

- remote control of the open pit transportation complex with the formation of ore cargo traffic of the required quality and visualization of the correctness of mining operations in the excavator faces.

Involvement of off-balance ore into processing is another significant element of the management of the raw material base of an enterprise.

Orientation to the expansion of the resource base due to off-balance ore was adopted as a promising direction almost from the very beginning of the Muruntau deposit. To this end, in the first years in Muruntau quarry, separate mining and warehousing of commercial, off-balance, and overburden ore were conducted.

Originally, off-balance ore was attributed to ore with a content of 2.0 cu $< C < 2.5$ cu, which stowed into the warehouse No. 2, and ore with a content of 1.5 cu $< C < 2.0$ cu (warehouse number 3). Then they began to allocate a separate cargo traffic and ores with a content of 1.0 cu. $< C < 1.5$ cu (warehouse number 4), and ore with a content of more than 1.0 cu began to be considered as a promising raw material base of HMP-2. Rock mass with a content of less than 1.0 cu to date belongs to overburden rocks and is not stored separately.

Inclusion in the raw material base of HMP-2 stocks with a content of more than 1.0 cu became possible as a result of the continuous increase of the processing capacity of the plant and the improvement of processing technology.

In order to increase the efficiency of using the geo-resource potential of a deposit, the schematic diagram of the formation of which is shown in Fig. 3.4, it is expedient to organize additional cycles along the line of processing both off-balance ore and rock containing mineral components, as a result of which it is possible to isolate the proportion of ore with an increased gold content of 1.4 - 2.2 times. This may be a batch sorting of dump trucks using satellite navigation technology combined with a photometric sampling system based on laser scanning of the rock mass in the truck body. It may also be the allocation of gold-rich ore mass in the development of warehouses by the method of lump sorting using modular units. In this case, the enriched fraction (20 - 60% of the total) meets the requirements for commercial ore.

The remaining not extracted part of mineral resources (“economic” and “technological” off-balance) to extract and process today is not profitable for economic and technological reasons. However, if you reduce the cost of production by reducing the overburden and reduce the cost of transport work, it becomes expedient to organize additional cycles for its processing. Reducing the loss of mineral raw materials can be based on the following technological, technical and organizational decisions:

- defining the boundaries of the pit taking into account prospective conditions;
- targeted formation of manmade deposits;
- separation of rock mass by grades in the planning of mining operations;
- application of satellite navigation technology to determine the quality of ore in the dump truck;
- separation of ore grades using laser technology;
- lump sort;
- the formation of a uniform ore flow.

Now, when individual quarries, having reached a depth of 300-350 m, have undergone more than one reconstruction, it is possible to draw certain conclusions about the general patterns of the development of deposits by deep quarries. These patterns are largely generated by the phased development of deposits with the release of intermediate quarry contours or repeated revision of the final depth of the quarries with a change in their boundaries along the surface.

The positive consequences of staged development of deposits include such factors as: possibility of reducing the volume of mining and overburden operations at the first stage of development; accelerated commissioning of a quarry; smaller length of transport communications in the first years of operation; However, these advantages of phased development are, firstly, relatively short-term in nature, and, secondly, in most cases are significantly overlapped by long-term negative factors: Artificial reduction of the mining front leads to temporary conservation of a part of the working area of the quarry to install main openings, transport communications, transshipment points, shunting stations, etc.; the need to eliminate and reorganize in the new contours practically the entire transport system developed at the previous stage of the development of the open pit mine and the corresponding opening scheme, which is very difficult in terms of organization and cost in the economic plan; the desire to move the restructuring of transport communications to a more distant period due to the undesirable decrease in the production capacity of the existing enterprise and the difficulties of financial order, thereby taking the transport beyond the economically feasible area of work and aggravating the situation in the future.

Under these conditions, the tasks of developing a general strategy for the phased development of deep quarries are put in the forefront with the justification of the patterns of formation of their transport systems in changing mining and technical conditions, the establishment of rational areas for the use of various types of transport, taking into account technical progress in technology and technology of open mining. In general, the analysis of the development features of the largest quarries over time (Table 3.3) allows us to draw conclusions about the transition of quantity to quality and the need to change the approaches to them as an object of research and exploitation.

Table 3.3

Maximum parameters and indices of quarries

Description	Value		
Generation of quarry	1	2	3
Quarry depth, m	100	400	1000
Production rate, mln. T / year:			
- of minerals	10	30	100
- of rock mass	15	60	400
Lifetime (years)	20	50	100
Number of reconstructions (queues)	1	3-4	5-8

Phased construction of quarries, substantiated by Professor V.S. Khokhryakov, showed that even in case of the largest “superquarry” in its parameters, the selection of development stages in time and space allows initially to design a quarry using traditional methods. However, already at the construction of the second-generation quarries with a depth of 300-400 m, the limitation or even unacceptability of the traditional design methods for the third-generation quarries was clearly manifested. This situation is explained by the fact that the quarries of this generation should be considered as time-evolving and space-changing complex natural-industrial systems, consisting of also evolving subsystems of development, transport, mining safety, personnel safety, dump formation, etc. Therefore, a deep quarry development strategy should be developed taking into account such an evolution both of the system as a whole and its individual subsystems.

Analysis of the main shortcomings of the theory and practice of building deep quarries clearly revealed the need to develop a strategy for their evolutionary development to technically achievable boundaries, and the development of their subsystems is supported by capital investment schedules with the definition of sources of financing and repayment of borrowed funds. At the same time, the production capacity of the various stages of the existence of such quarries must be balanced with the mining and economic capabilities of the enterprise. The increase in overburden, along with the increasing demand for mineral raw materials and the systematic increase in its value, determine the need to create a complex of scientific and technical methods. These methods should provide an opportunity for a reasonable cyclical selection of promising technology and mining technology, anticipating periodic evaluation of mining equipment operating conditions, identifying ways to improve the quality and quantity of ore mined through the organization of additional processing cycles for efficient use of mineral resources.

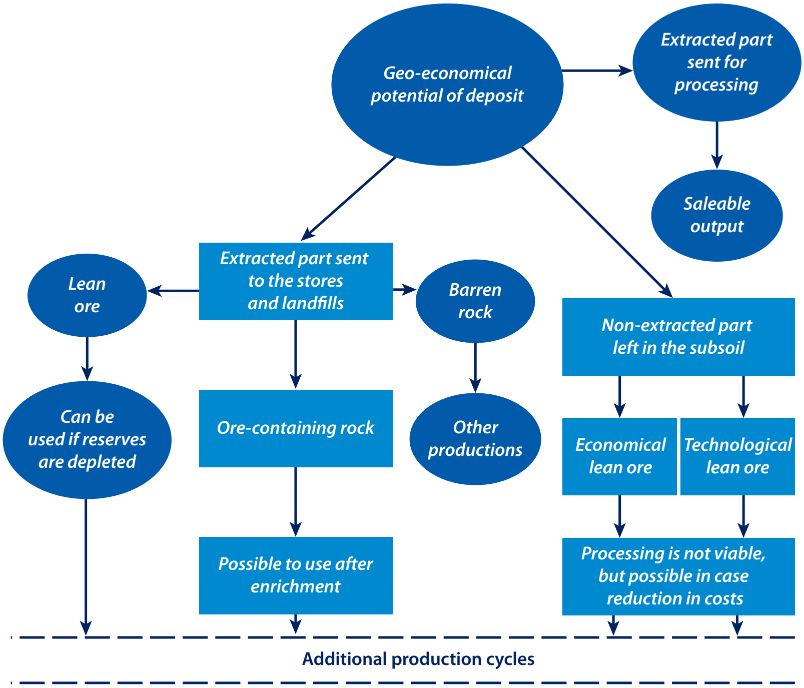

Fig. 3.4. The flow diagram of geo-resource potential formation structure of deposit

3.1.2. Theory and practical implementation of the use of the raw material potential of granular phosphorite deposits

Organization of production of complex mixed fertilizer. World agricultural practice has established that 50% of crop yields are accounted for by the use of mineral fertilizers. Among the six macronutrients (nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium) that are essential for plants, phosphorus plays an important role.

In Uzbekistan, the main agricultural crops are cotton and wheat. The gross yield of raw cotton is about 3.5 million tons, and that of wheat – 7.5 million tons. It is known that one ton of raw cotton takes 15 kg of P_2O_5 from the soil, and one ton of wheat – 10 kg of P_2O_5. With such a harvest, only the above crops from the soil annually are carried away with a yield of more than 100 thousand tons of P_2O_5. But other cultures also take a fairly large amount of phosphorus from the soil.

The situation is aggravated by the fact that the utilization of phosphorus from the phosphorus-containing fertilizers introduced into the soil by plants is extremely low and does not exceed 20%. The rest of the phosphorus is fixed by the soil and shows a slight positive aftereffect.

In this regard, the Government of the Republic of Uzbekistan pays great attention to the issues of increasing the volume of production of phosphate fertilizers. In order to provide our plants with their own raw materials, the Kyzylkum phosphate complex (KPC) was built in the republic. In 1998, the first phase of this plant was launched with a capacity of 300 thousand tons of phosphoric flour.

At present, the production capacity of KPC has reached 800 thousand tons of phosphate raw materials.

It is known that the Jeroy-Sardarinsk phosphate deposit of the Central Kyzylkum region in terms of reserves and estimated resources has no analogues in the CIS countries and is among the top ten deposits in the world. The reserves of phosphate raw materials are estimated at 57.7 million tons of 100% P_2O_5, which ensures the need of agriculture of the Republic of Uzbekistan in phosphate fertilizers for more than 100 years. However, it is necessary to emphasize that the Kyzylkum phosphorites are low grade ores in terms of the content of the main component. They contain a significant amount of carbonate compounds (calcium module – $CaO:P_2O_5$:2.85), clay minerals and organic substances. Due to the high content of impurities, these phosphates are not acceptable for the production of ammophos, ammonium sulfate phosphate supraphos, produced at Almalyk Ammophos OJSC. Therefore, starting from April 2001, the Kyzylkum Phosphorite Combine produced annually 400 thousand tons of calcined phospho-concentrate. Starting from 2007, Navoi MMC annually supplies phosphate products in the following volumes: 400 thousand tons of washed calcined phosphocid concentrate with a content of up to 30% of P_2O_5: 200 thousand tons of washed dried concentrate with a content of 8-19% of P_2O_5; 200 thousand tons of phosphoric flour with a content of 16-18% P_2O_5. The washed calcined phospho-concentrate is fully used at Almalyk OJSC Ammophos for the production of ammophos, supraphos and ammonium sulfate phosphate. Due to the lack of high-quality phosphorite, the technological equipment of the enterprise operates at a load of only 40-50%. To date, 70 thousand tons of washed dried concentrate at OJSC Kukon Superphosphate Plant, 130 tons at Ammophos OJSC and about 100 thousand tons of ordinary phosphate flour at Samarkandkimyo OJSC are used to produce, respectively, simple superphosphate and nitro calcium phosphate fertilizer. Prospectively, following the proper reconstruction, Samarkandkimyo OJSC intends to prosess around 200 thousand tonnes of normal phosphate feedstock. In addition, Ammophos OJSC in Almalyk uses washed and dried concentrate as a secondary feedstock.

Thus, at this time, about 70 thousand tons of low-quality phosphate flour remains unused. During the mining and sorting operations, several hundred thousand tons of off-balance phosphate ore with a content of 12-13% P_2O_5 annually accumulate.

It should be noted that in the case of full processing of 800 thousand tons of phosphate rock, it is possible to provide only 35% of the agricultural needs of Uzbekistan in phosphate fertilizers. In this regard, in the future, the volume of mined phosphate ore will certainly increase at KPC. In this case, naturally, the volume of the unconditioned part of the phosphate will increase. The increase in the production of washed calcined phospho-concentrate, in our opinion, is inexpedient.

This is due to the high cost of phospho-concentrate due to the high heat and energy costs during the roasting. It should be emphasized that for the processing of various types of low-grade Kyzylkum phosphorites into simple superphosphate with a content of 9-10% P_2O_5, sulfuric acid is necessary. Today it is an extremely scarce raw material.

Based on the above, it becomes clear that the amount of high-quality phosphate raw materials is limited, a sufficient amount of sulfuric acid is absent, but there is a sufficient amount of non-balance phosphorite ore. Is it possible under these circumstances to significantly increase the amount of phosphorus-containing fertilizers using low-grade Kyzylkum phosphate rock?

Based on the results obtained in the laboratory of phosphorus fertilizers of the Institute of General and Inorganic Chemistry (IGNC) of the Uzbekistan Academy of Sciences, as well as on the world experience in the processing of low grade phosphorites into phosphate fertilizers, the following is recommended:

1. Obtaining organic mineral fertilizer (OMF) by composting cattle manure with phosphate. The technology of obtaining and recommendations on the use of organic mineral fertilizers was developed at the Institute of Agricultural Engineering, Uzbekistan Academy of Sciences, together with the Institute of Cotton-Growing of the Ministry of Agriculture and Water Resources of Uzbekistan in 2003. The cost of P_2O_5 in OMF is 4-5 times cheaper than P_2O_5 in ammophos. This problem should be solved centrally. In the process of production of OMF, it will be possible to process 100-150 thousand tons of low-grade phosphate annually.

2. Low grade Kyzylkum phosphates can be successfully used in the technology of nitrogen-phosphorus fertilizer production. This technology will be implemented at Navoiazot JSC in the coming years. Nitrogen-phosphorus fertilizer production with a production capacity of 180 thousand tons will be organized. Currently, technology is being tested at a pilot plant. The annual need for low grade phosphorite for this technology is 50-60 thousand tons.

3. IGNC Academy of Sciences of the Republic of Uzbekistan developed a simplified technology for producing complex mixed fertilizers by mixing low grade Kyzylkum phosphates with ammonium sulfate, ammonium nitrate, supraphos and ammophos, with subsequent grinding. The most effective nitrogen-containing raw material is ammonium sulfate (produced by Maxam-Chirchik JSC), as well as supraphos and ammophos (produced by Almalyk OJSC Ammophos). This technology does not require an acid reagent for implementation. When grinding the mixture of reagents phosphorite is subjected to activation with ammonium salts, and the phosphorus contained in the phosphate, goes into digestible form. The cost of P_2O_5 in these fertilizers, depending on the type of used ammonium salts, compared to P_2O_5 in traditional phosphate fertilizers is 1,5-3 times cheaper. The production of complex mixed fertilizers can be organized at the Chigirik processing station of the South Mine Administration of NMMC. The choice of the place of organization of production is due to the fact that:

- firstly, there is a workforce, territory, premises and the possibility of using some equipment, etc.;

- secondly, the Maxam-Chirchik OJSC and Ammophos-Maxam OJSC are located nearby. They produce ammonium sulfate and ammophos, supraphos, respectively.

Certainly, there will be a need for these fertilizers. Due to the relatively low prime cost of fertilizers, the latter in large quantities will be used in farms and private household plots, and will also be exported.

Crosscutting technical and economic calculations of the stages of extraction, enrichment of phosphate rock in the amount of 1 million tons per year and its processing into phosphate fertilizers. In accordance with the order of the Prime Minister of the Republic of Uzbekistan No. 04 1-514.-g, dated 03.08.2007, the Institute “Uztyazhneftgazkhimproekt” assessed the integrated technical and economic calculation (UTEC) and carried out the crosscutting technical and economic calculations of the stages of extraction and enrichment of phosphate rock at Kyzylkum Phosphoritic Complex (KPC), as well as its processing at the enterprises of SJC Uzkimyosanoat (Almalyk JSC Ammophos) to decide on the feasibility of implementing a project to increase the supply of phos-products in two options in the amount of from 800 thousand tons to 1 million tons per year by the Kyzylkum phosphate complex.

Option 1

Supply of 400 thousand tons of washed calcined phos-concentrate with a decrease in the content of P_2O_5 in washed calcined phos-concentrate from 30% to 24–26%. Preservation of the supply of washed dried phos-concentrate (18-19% P_2O_5) in the amount of 200 thousand tons. Increases in the supply of refined raw materials: (16-18% P_2O_5) from 20-30 thousand tons to 400 thousand tons per year. With this, according to the UTEC of Navoi MMC, for the implementation of these tasks will require USD 33.559 million of capital investments excluding VAT (USD 40.271 million including VAT).

Option 2

Increase in the supply of washed calcined phoconcentrate of achieved quality (28-30% P_2O_5) from 400 thousand tons to 600 thousand tons per year; Preservation of supply volumes of Phosphate raw material (16-18% P_2O_5) and washed dried concentrate of 200 thousand tons per year. Capital expenditures for option 2, according to the UTEC data, will be USD 131.9 million, excluding VAT (USD 158.3 million, including VAT).

Option 3

The transition to the production and supply of fossil products with a content of 20-24% instead of 28-30% P_2O_5 reduces the production of EPC. Also, in this case, an increase in the cost of raw materials regarding P_2O_5 and the cost of its transportation by 12%, expenditure rates for production of products by 5% in phosphate raw materials in 100% expression, consumption rates of sulfuric acid by 20% due to an increase in the value of calcium module from 2.0 to 2.3, as well as a decrease in technological indicators of production due to an increase in the consumption of fuel and energy resources at the stage of processing phosphate raw materials into low concentrated extraction phosphoric acid and at the stage of processing the latter into ammophos when removing it, reducing the degree of phosphorus extraction from phosphate raw materials, washing it from phosphogypsum, and, as a result, reducing the economic yield of P_2O_5, increasing the yield of P_2O_5 with phosphogypsum twice, the volume of forming phosphogypsum at the expense of increasing the calcium modulus from 2.0 up to 2.3, consequently an increase in the cost of evacuating and storing the phosphogypsum per unit of P_2O_5 in products, and a decrease in the production capacity of the equipment of the EPA workshops due to the high thermal effect of the process.

The implementation of the first option will inevitably worsen the quality of the product – ammophos, the content of P_2O_5 is expected at the lower limits of the State Standard indices (44-45%), which casts doubt on the competitiveness of products on the world market (at least 46%) and excludes exports. In addition, the gross output of 100% P_2O_5 will decrease by 18%, the underproduction of 100% P_2O_5 will amount to 15.6 thousand tons, and the rise in the cost of 1 ton of 100% P_2O_5 will be 13-15% in the finished product.

In addition, according to this option, an unclaimed additional volume (200 thousand tons per year) of non-enriched phosphorus is formed. At the enterprises of SJC „Uzkimyosanoat“ currently there are no facilities for processing additional volume of this type of raw material.

As a result, the total output of phosphate raw material at the Kyzylkum phosphate complex in terms of 100% P_2O_5 in the implementation of the first option will decrease compared to the existing production volume by 12 thousand tons per year.

According to the submitted calculations of the Institute of UZGEORANGMET, the production cost of obtaining phosphate concentrate in terms of 1 ton of 100% P_2O_5. will amount to USD 207.2 eq., full costs of products sold will be USD 266.7.

At the declared sales price of phosphate concentrate at USD 163.00 including VAT per ton of 100% P_2O_5 KFC incurs losses. Profitability is achieved with a minimum sales price of USD 270.00.

According to the calculations of Uzkimyosanoat, the production of ammophos at Ammophos OJSC from phosphate concentrate (100% P_2O_5) at a price of USD 270 per ton, taking into account transportation costs, will increase the prime cost by 35%. The sale price of ammophos will increase.

The calculations confirm the unacceptability of the choice of the first option of the project, in which the cost of phosphate raw material (100% P_2O_5) will increase by 65.6%, and the cost of ammophos will increase by 32%.

At the same time, the quality of manufactured products will impair (the content of P_2O_5 will decrease to 44-45%) and as a result it will become uncompetitive in the external market, and subsequently, the growth of prices for fertilizers will increase the price of local agricultural products.

Option 4

With an increase in the supply of washed calcined phos-concentrate of achieved quality (28-30% P_2O_5) from 400 thousand tons to 600 thousand tons per year, it is projected that consumption rates will decrease and the quality of products will be improved by stabilizing the production process, reducing the production cost of 1 ton of products in terms of 100% P_2O_5 to 4% of the energy consumption for the processing of phosphorus, an increase in gross output in physical weight by more than 30% and 100% P_2O_5 by more than 40%. In this case, there will inevitably be an increase in the export potential of the enterprise, an improvement in the financial condition of Ammophos OJSC due to an increase in production growth rates up to 30%.

By the Decree of the President of the Republic of Uzbekistan No. PP-420, dated July 18, 2006, only after completion of modernization and reconstruction works of OJSC Kukon Superphosphate Plant and OJSC Samarkandkimyo, processing of 200 thousand tons of washed dried phosphate concentrate and 200 thousand tons of raw phosphorite flour is planned.

At the same time, it should be noted that in enlarged fuel and energy resources, commissioned by NMMC, expenses for the purchase of equipment for the washing and roasting line, which have additional productivity for the production of washed calcined phosphate concentrate (with a content of at least 28% P_2O_5) in the amount of 400 thousand tons per year, i.e. with CI in the amount of USD 131.906 million excluding VAT (USD 158.287 million including VAT), the productivity of phosphate should increase from 400 thousand tons to 800 thousand tons per year. And the cost of maintaining existing equipment in working condition should be charged to depreciation charges for KPC. According to the calculations of the Institute of UZGEORANGMET, the production cost of obtaining phosphate concentrate in terms of 1 ton of 100% P_2O_5 will be USD 42.2, the total costs of products sold - USD 310.1. With the declared sales price of phosphate concentrate at USD 163 excluding VAT for 1 t 100% P_2O_5 KFC incurs losses. Profitability is achieved with a minimum sales price of USD 315 without VAT. According to the calculations of Uzkimyosanoat, the production of ammophos at JSC Ammophos from phosphate concentrate (100% P_2O_5) at a price of USD 315 per ton, taking into account transportation costs, will lead to an increase in cost by 43%. The sale price of ammophos will increase by 40%.

With an increase in the production of ammophos with a content of 16% to 216.1 thousand tons (Option 2) Capital investments in the amount of USD 158.3 million are required. And it is almost 4 times more than in Option 1.

Proposals for the further promotion of the project:

1. Implementation of Option 1, which provides for the expansion of production of phosphate raw material with a reduced content of 24-26% P_2O_5 at KPC, and the processing of this phosphorus material worsens the technical and economic indicators of the production of phosphate fertilizers at Ammophos and is technically and economically impractical.

2. Implementation of Option 2 with an increase in the production of phosphate feedstock containing at least 28% of P_2O_5 will increase the production of high-quality phosphate fertilizers necessary to ensure agriculture of the republic, as well as increase the export potential and efficient use of production capacity of OJSC Ammophos. At the same time, it should be noted that the increase in production volumes according to the second option leads

to a significant increase in the cost of phosphate fertilizer, which, in turn, will lead to an increase in the volume of costs for the production of agricultural products and, as a result, to an increase in their prices.

3. Due to the fact that the equipment accepted in UTEC according to Option 2 with a capacity similar to the line existing at KPC, producing a phoconcentrate with a content of at least 28% P_2O_5 in the amount of 400 thousand tons per year (total 800 thousand tons), and the calculations were made for 600 thousand tons of products, we consider it appropriate to make appropriate adjustments to the UTEC, taking into account the actual capacity of the washing and firing lines. The technical solutions adopted at UTER will ensure the production of 800 thousand tons of washed calcined concentrate with a content of at least 28% P_2O_5 321.6 thousand tons of washed dried phosphate raw materials and 200 thousand tons of raw materials, in total 1,321.6 thousand tons in physical weight or 315.9 thousand tons in terms of 100% P_2O_5. Also, when adjusting the UTEC, it is necessary to take into account the remarks of the Institute of "Uztyazhneftegazkhimproekt" regarding economic calculations. It should be noted that the existing capacity at Ammophos OJSC makes it possible to process up to 800 thousand tons of washed calcined phosphate concentrate with a content of 28–30% P_2O_5 without significant costs.

Option of reorganizing the production of phosphate fertilizers. There is a contradiction in the existing organizational structure of production of phosphate fertilizers, which is based on the disunity of the functions of the mining and processing organizations with different status. The different status of these interacting organizations gives rise to polar interests. Thus, the mining organization (NMMC) is interested in reducing the content in commercial ore and supplying the consumer with mineral raw materials with minimal pretreatment. This interest is based on the possibility of involving in the processing of additional amounts of poor ore, thereby reducing the burden on the quarry and mining costs, but increasing processing costs. At the same time, the processing organization (JSC „Uzkimyosanoat") is interested in increasing the content of the received raw materials and increasing the volume of its pre-processing, which reduces its production costs, but increases the cost of mining and ore processing. Instead of searching for a compromise solution, a decision was made in favor of an organization with less investment opportunities, and the NMMC had to introduce a more energy-intensive and costly technology only to satisfy the chemists‘ opinion. The following ideology of using the raw material potential of a granular phosphorite deposit is proposed:

- three types of phosphorus products are produced: two by factory technology (“high grade” 26÷28% P_2O_5 and “low grade” 16÷18% P_2O_5 concentrates) and one of the mining wastes with a content of 12÷14% P_2O_5 (low grade ore);
- “high grade” products are mainly exported to cover foreign currency expenses of JSC “Uzkimyosanoat” and to remote areas of the republic;
- “low grade” products are directed to agricultural areas around processing plants;
- mining waste is stored in the areas closest to KFC for production “on site” (Fig. 3.5);
- a combined supply of certain areas with all types of production.

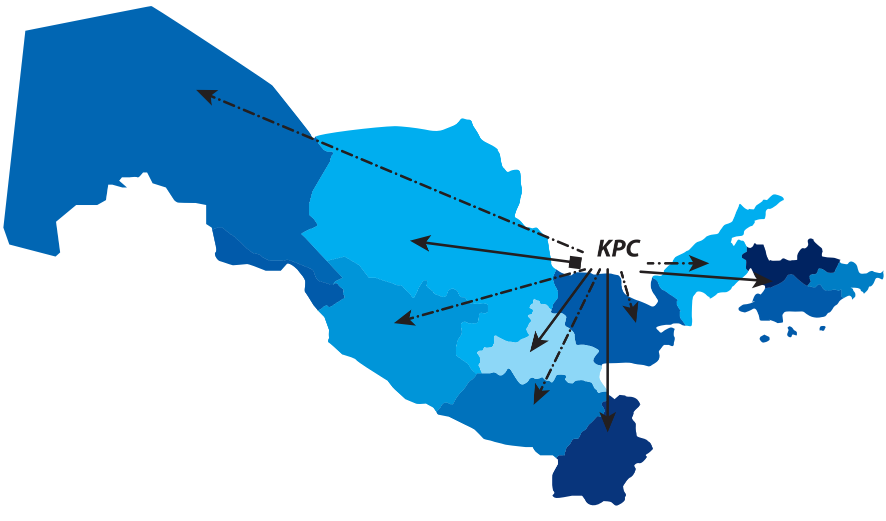

Fig. 3.5. Scheme of supply of poor phosphate ore for the production of organic fertilizer „on site“

The scope is determined by the presence of transport links, the organization of the components (manure), agricultural efficiency and the cost of delivery, production and application for crops.

Consider the option for the domestic market to reduce the content in calcined concentrate to 24 ÷ 26% P_2O_5.

It is also proposed to consider in a single complex of mining → concentration → processing. This will contribute to cost reduction due to:

- rational use of resources extracted from the depths (a compromise solution is located within a single complex);
- reduce the energy intensity of the processes due to the transition from thermal to chemical decarbonation;
- cost reduction due to the „avoidance" of VAT (15%) with today's products, which for subsequent processing will be a semi-finished product and will go at prime cost.

3.1.3. Processing of combustible shale

Laboratory studies that determine the possible value of products derived from Uzbekistan's combustible shale and which are being prepared for their industrial processing were originally carried out in Estonia, where the shale industry is focused on the production of domestic gas and petrochemical products. Along with the gas generator and chamber furnace in this republic, a distillation system with a solid coolant has been developed, which brings it closer to American horizontal retorts, which recycle solid heat carriers (the TOSCO II process - the rotary kiln and the Lurgi–Ruhrgas process - screw transport). The relative amounts and properties of the products obtained depend on the method of distillation, under the conditions of which the thermal decomposition of the solid OM of shales (kerogen) takes place. This requires compliance with the conditions of high-quality technology, profitability and competitiveness of commercial products, as well as monitoring the compliance with the purity of the environment.

During the dry distillation of combustible shale in the Fisher retort (500 °C), four main components are released: gas, tar, pyrogenetic water and coke.

The capture of gas, its condensation and fractionation allows to get sulfur, nitrogen, gasoline, household and flue gases. Sulfur is considered as a component for the production of sulfuric acid, nitrogen - ammonia; gasoline by pyrolysis is divided into light aromatic hydrocarbons (benzene, toluene, xylene, etc.); olefin-containing process gases - derivatives of ethylene, propylene and fuel oils; ethane and propane are obtained from household gas. Flue gas is cleaned and released into the atmosphere.

During the fractionation in the light (kerosene-gasoline), medium (gasoline) and heavy (diesel) fractions, olefinic hydrocarbons, surfactants, detergents, various phenols, paraffins, olefins, lubricants are generated

The pyrogenetic water contains volatile bases and acids, as well as various phenols (hydroxybenzene, cresol, resorcinol) and ketones.

During hydro- and pyrometallurgical processing, coke is decomposed into semi-coke gases and ash. The gases contain hydrogen sulfide, sulfur, methane, carbon monoxide, carbon dioxide, and hydrogen. Metals are concentrated in the ash. Its waste is used in the construction engineering and industry and for the production of agricultural fertilizers.

The following products can be obtained from combustible shales for the development of a number of areas of industrial (chemical, metallurgical), construction, agricultural and medical sector:

- alkirez-1 concentrate of alkaline solutions, used to increase the adhesive properties of the vulcanizer and cord, as well as to obtain cold-setting glues for wood;

- benzoic acid (technical), for conservation of feed in livestock farming and as raw materials in the chemical industry;

- benzene, in organic synthesis and as a solvent in the paint and varnish industry;

- shale bitumens, as a binder and insulating material for road and roofing works, with the device of a soft roof and in household chemicals;

- shale gas, as a fuel in industrial boilers and furnaces;

- medical ichthyol;

- kerogen-70 is a component of rubber and plastopolymer products;

- pitch coke, for the production of graphitized products, as well as anode matter and electrode products in the metallurgical industry;

- binder shale (foundry binder), for the manufacture of cores in the foundry;

- epoxy adhesive for metal, glass, ceramics, wood;

- shale lacquer, for coatings on metal and making glue and cold bitumen mastics;

- high-sulfur shale mazut;

- shale fuel oil;

- antiseptic oil, for impregnation of lumber;

- oil for road surfaces mixed with sand and gravel;

- STP oil, for the production of carbon black in the tire industry;

- mastic bituminous-latex roofing (BLR), for gluing the rolled materials of the roofing carpet;

- automobile slate mastic (ASM), to protect the bottoms of car bodies from corrosion;

- mastic shale sealing (MSS), for sealing glass fencing greenhouses;

- shale softener, for regeneration in the tire industry and in the production of leather;

- sodium crystalline thiosulfate, obtained in the process of gas purification from hydrogen sulfide, is intended for the manufacture of leather, fur and neutralization of industrial wastewater;

- sodium ichthyol - emulsifier and resin substitute in the production of neocreolin and in the process of opening and development of productive layers of oil wells;

- Nerosin – a preparation for fixing mobile sands on gas pipelines, to control the wind erosion of the soil and their contamination by agricultural pests;

- insecticide paste, for pest control (including nitrofen);

- preparations for fixing loose rocks in the bottom zone of oil wells;
„Prepax“ – antiseptic for exterior wooden coatings;

- shale plasticizer, to isolate underground gas pipelines from corrosion;

- technical sulphur;

- diphenolic resin DFK-4, for bonding fiberglass;

- diphenolic resin DFK-8, for gluing parquet to concrete, linoleum, etc.;

- shale solvent – solvent of varnishes and paints;

- sulfanol, for the preparation of detergents;

- grouting compositions TSD-9, TS -10 for wells;

- toluene - the raw material of chemical synthesis;

- shale phenols - synthetic tanning agents, grouting compositions, adhesive resins such as DFK;

- flotation reagent for flotation of non-ferrous metals;

- complex of rare, scattered and radioactive elements (the list of basic metals with the developed extraction technology includes: molybdenum trioxide, tungsten trioxide, aluminum trioxide, germanium dioxide, titanium dioxide, cobalt oxide, vanadium pentoxide, uranyl nitrate, rhenium-2 powder, nickel sulphate crystalline, metals with the developed technology by the method of underground leaching: selenium, scandium, rare earths, platinoids, gold, copper, silver;

- complex of products of the construction industry: pozzolan cement, portland cement, dense and cellular concrete, cement clinker, mineral wool, frost-resistant asphalt-concrete mixes;

- products of ash melting: glass-ceramic products, facing and refractory ceramics, metlakh tile, stone casting;

- gasoline, kerosene, engine oils, diesel fuel.

One of the promising areas for the use of combustible shale in the Kyzylkum region as the center of the gold mining industry can be attributed to the manufacture of adsorbents from shale products for sorption of gold and other precious metals, replacing imported ion-exchange resins.

This direction was successfully developed in Australia and New Zealand in the late 80s - early 90s, where a mixture of shale oil and coal dust was used. The contact of the ore pulp and the obtained agglomerate ensures the saturation of the granules with noble metals (or diamonds) in a few minutes (from 1 to 10 minutes). Granules with a particle size of 0.75 to 5.0 mm contain 1-5% bitumen, 15-25% shale oil (hydrocarbon liquid) by weight of the carbonaceous base. The investigated process of agglomeration, not inferior to cyanidation at cost, does not pollute the environment. The main advantages of agglomeration are ensuring high gold recovery with an upper limit of 0.5 mm ore size; further use of agglomerate in the subsequent metallurgical redistribution during sintering of sulphides; the possibility of obtaining agglomerates in the immediate vicinity of the mining and processing enterprises.

Methods of application of coal-sorption technology for the extraction of gold adsorbents derived from shale resin (phenols, furanoformolity) mixed with coal dust, due to the availability of used oil bitumen and combustible raw materials are also described in the Russian literature. In Ukraine, at the Donetsk University, the processes of magnetic separation of the slags of the oil-fired units of the Uglegorsk TPP containing V and Ni are studied. The proposed method is supposed to be used for the preparation of fuel oil slags containing S, V and Ni to the metallurgical processing. Given the high content of S, V and Ni in Uzbekistan's oil shale, along with other metals, the prospect of the magnetic separation method should also be taken into account.

In 1995-1996, the Tashkent State Technical University made the laboratory attempt to develop a technology for processing shale and extracting valuable components from it. From the sample of combustible shale, previously crushed to a particle size of 1.2 mm, as a result of thermopair treatment (at 400°C), three products were obtained: a cinder (semi-coke slate), condensate (bitumen from the organic part of slate), gas (mainly H_2S).

Ammonium sulfide is obtained from gas (consumers are mining and metallurgical enterprises); from cinder containing high-ash mineral part of shale, nonferrous, rare and rare-earth metals are extracted in various ways; the condensate is subjected to extraction with benzene (according to the scheme of Tashkent State Technical University), as a result of this process phenols, ethers and ichthyol oil are released.

The incompleteness of laboratory and semi-industrial technological research was compensated at the Dzhamsk oil-shale deposit at the initiative of R.V. Tsoi. At this facility, the technology of extraction of metals and high-sulfur phenols, including thiophene, was developed for the first time.

Almost all of the named products can be obtained in the processing of oil and coal. Thus, in the process of decomposition of coal at a temperature of 900-1000°C without air access (the process of coking), the following are released: heating gas, tar, benzene, ammonia. The same products are obtained by oil-refining, the pyroshale is considered as a raw material of a long-run prospect.

Due to the high metal content of combustible shale, using the example of the Dzhamsk deposit, a geological and economic assessment was given, the profitability of the pyroshale processing enterprise was shown, which was associated almost exclusively with the extraction of metals. Compared to the Dzhamsk deposit, there are lower metal contents in Sangruntausk.

As a result of research of technologists of the Saratov STU, two schemes were given for the processing of combustible shale of Uzbekistan: high-speed oxidative pyrolysis to obtain benzene, toluene, hyophene, sulfur, gas and semi-coke; Plasma gasification with Re capture from synthesis gas.

The output of resin from the Dzhamsk deposit was 8.6% for shale and 28% for OS. Resinification stops at 450°C. Light pitches contain 7.8% sulfur. It should be borne in mind that with dust and gases during high-speed pyrolysis, 20.5% Mo, 16.5% V and 40% REE are lost, and during plasma gasification – 31.0%; 5.9% and 7.1%, respectively.

From a sample of combustible shale of the Dzhamsk deposit weighing 300 kg, the following was obtained by the Saratov STU: pyrogas (10-11 MJ/m^3) – 35 - 45%; pyrobenzene with a thiophene content of 7 - 8% – 0.5% (in the Volga pyrobenzene shales up to 2.5%, thiophene – 1 - 20%). Thiophenols or thiophenic compounds are dissolved in ichthyol, an aqueous solution of the ammonium salts of sulfonic acids obtained from shale oil (resin). Thiophene is a heterocyclic compound in the form of a colorless liquid with a benzene-like odor. Melting point is 38°C, boiling point is 84.4°C. slightly soluble in water, easily soluble in organic solvents. Thiophene is mainly found in the benzene fraction of coal tar, as well as in the semi-coking products of the Volga and Uzbekistan's shale. Synthetically, it can be obtained by pyrolysis of a mixture of sodium salt of succinic acid with three-sulfur phosphorus; from butane and sulfur; from furan (method of Yu.K. Yuryev). Thiophene is a typical aromatic compound, easily halogenated, sulphurized, and alkylated. Some of its derivatives are used as biologically active substances (for example, modified penicillins, anthelmintic drugs). One of the preparations obtained is thiamin – vitamin B1, alerin, a heterocyclic compound in the form of colorless crystals with a characteristic odor. The physiological significance of thiamine is due to the congruent functions of its pyrophosphate ester - thiamine pyrophosphate (cocarboxylase). Other types of thiophenols are used in the synthesis of polymers, dyes, inhibitors of radical reactions, stabilizers, and additives to synthetic rubbers.

When setting up a pilot production for capturing volatile components from combustible shale with various organic sulfur contents, it is necessary to consider studying thiophenols and ichthyol as the most consumed in the production of medical preparations.

Uzbekistan's pyroshale, characterized in the geological literature of the CIS countries as highly promising, but poorly studied, has no analogues in terms of the set and content of metallic chemical elements sorbed by bitumoids, kerogen, clay minerals and sulfides. Pharmacological properties of the organic part of oil shale are of no less value. Of the medical preparations, thiophenols and ichthyols and their derivatives are of particular value: modified penicillins, cocarboxylases, etc. Almost all energy products derived from oil, gas and coal are extracted from combustible shale: fuel oil, gasoline, kerosene, engine oils, diesel fuel. A wide list of consumer goods requires a commodity-economic reassessment in a market economy and the development of modern technological schemes using by-products (sulfuric acid, the main components of the production of ion exchange resins), necessary for the redistribution of major ores (uranium, gold) of the local industry of Uzbekistan.

In the interests of the national economy of the Republic of Uzbekistan, it seems expedient to develop the pyroshale industry on the basis of Navoi and Bukhara regions using the potential of NMMC. Prospects for the use of metal-bearing pyroshale in the national economy of the Republic of Uzbekistan suggest the formation of a new direction in geology, technology and mining - the integrated development of rare metal, lithomedical, mining and chemical mineral raw materials, fertilizers for agriculture and industrial construction.

Ecological aspects of the development of the shale industry. Worldwide experience in developing oil shale deposits almost universally leads to environmental pollution due to the high toxicity of a number of chemical elements and compounds. Opencasting is associated with the alienation of significant land areas, violation of the soil layer, the living of the flora, even in the anhydrous rocky desert of Kyzylkum, where the land is used only for pasture farmed livestock. The five main types of pollution - particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide and traces of hydrocarbons require constant monitoring by stationary equipment, which should be provided as part of the main equipment of the mining enterprise to monitor the purity of air, solid waste, industrial effluents and groundwater.

We consider the most progressive drilling methods are the formation of a layer with a projectile equipped with a flexible tip (with a milling cutter capable of crushing a layer with a radius of over 5 m, extracting material by air blowing) and a conveyor method of delivering ore to the processing plant without intermediate storage of toxic mineral raw materials. It is necessary to study such methods of mining and processing of pyroshale, which would be favorable both in environmental terms and in terms of environmental protection.

The following factors may have an impact on the environment in the development of open pit deposits: the release of gases from internal combustion engines into the atmosphere; dust emission due to disturbance of the soil layer and dust of the pyroshale layer, oxidation of which will contribute to the decomposition of organic matter enriched with cancerogenic substances, which will lead to pollution of the earth‘s surface and poisoning of the air.

The progressive direction is the construction of underground reaction channels in productive layers of combustible shale for its underground thermal processing. Thermal processing products in liquid or gaseous state can represent economical and environmentally friendly hydrocarbon energy raw materials. In this connection, the solution of social problems with financial gain for investors is foreseen.

At one time, the following sequence of involvement in the development of combustible shale of the Republic of Uzbekistan as an integrated local mineral raw material was proposed.

Stage I.

Production of research on the topic: „Studies of Sangruntau shale and preparation of source data for process regulations for the design of a pilot plant for their use“ (an agreement with the Volga-Tekhnika Scientific Technological Enterprise with prepayment of about 15 thousand US dollars and delivery shale weighing 300 kg).

Stage II.

Formation of a business plan taking into account the installation of prices for final products. The search for a permanent consumer in the following directions: metallurgy, medicine, construction, chemical industry and consumer goods.

Stage III.

The construction of a small enterprise - a mini-plant in the contiguous areas of uranium deposits, developed by the UL method with deposits of combustible shale (Lavlya-kan-Sangruntau, Sabirsay-Djam, etc.)

3.2. The influence of technical and technological factors on the development of the Kyzylkum region

The deterioration of the mining-geological and mining conditions for the development of deposits, combined with the depletion of reserves, makes us pay close attention to the waste from the mining and processing industry. During the development of the Kyzylkum region deposits, a significant amount of gold-containing mining and processing waste has been accumulated, and the time has come to begin to study them from the point of view of possible use as a reserve source of raw materials in the future, considering them as manmade deposits (Fig. 3.6-3.8).

In order to do this, it is necessary to:

- assess the situation that has arisen with the formation of waste in the mining and processing industry and the formation of manmade deposits;
- develop a program for the involvement in the processing of waste from the mining and processing industries and the development of manmade deposits;
- develop a schedule for the development of manmade deposits.

3.2.1. Assessment of the situation

Assessment of the situation includes: identification of types of waste from the mining and processing industry; consideration of the prerequisites for involvement in the processing of waste mining industry; identification of factors that promote and prevent the involvement of waste in the processing.

Types of mining and processing industry waste. Waste from the mining and processing industry consists of open-cast and underground mining, as well as mineral processing.

Open and underground mining waste is represented by off-balance ore and overburden.

Off-balance ore is included in the raw material base of processing plants and in accordance with the projects is systematically involved in processing, so this ore can only be temporarily attributed to waste. Up to now, overburden rocks have not been considered as a raw material for gold production, therefore they are actually mining waste. Such wastes were formed and continue to be formed during the open-cast mining of the Kokpatas and Muruntau deposits (Fig. 3.6, a).

Mineral processing waste is represented by solid „tailing" and waste solutions of hydrometallurgical plants (HMP), processing gold ore of the Muruntau (HMP-2), Kokpatas, Daugyztau (HMP-3) and Mardjanbulak (MGRP- Mardzhanbulak gold recovery plant) deposits. Such waste is accumulated in specially created tailings (Fig. 3.6, b).

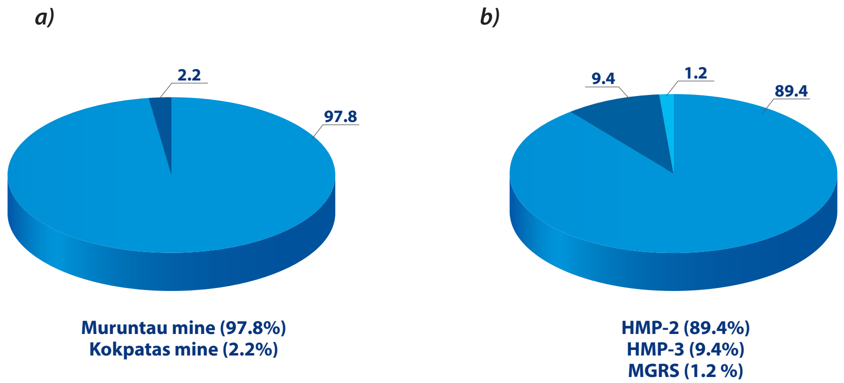

Fig. 3.6. Distribution of gold ore mining (a) and processing (b) waste by mining and processing facilities

Mining waste from the open-pit mining of the Kokpatas and Daugyztau deposits has accumulated in the quarry dumps in the amount of ~ 45 million tons, and ore processing waste in the amount of ~ 42 million tons in the tailing pit, which continues to be intensively filled. Since these deposits are at such a stage of development, when the question of reducing the volume of production is not yet relevant, the waste from mining and processing can only be considered as a potential source of mineral raw materials for the long term. Therefore, it is premature to underestimate the waste of these deposits today, especially since the amount of such waste is relatively small (~ 3% of the total volume of waste from mining and processing).

Production waste generated during the development of the Mardzhanbulak deposit has already been practically recycled, so today they are represented only by processing waste accumulated in the tailing dump in the amount of ~ 10 million tons. This waste requires the closest attention as a source of mineral raw materials, since there is practically no raw material base for the MGRP (Mardzhanbulak gold recovery plant) and the involvement of these wastes in processing can have a significant impact on the efficiency of the mining and processing complex and the social and economic situation in the area.

Waste from the mining and processing industry at the base of the Muruntau deposit is of the greatest interest, due to the fact that the social and economic situation in the entire region depends on the operation of this complex. This waste consists of reserves of overburden, “tailing” of ore mass processing by heap leaching, as well as “tailing” of hydrometallurgical ore processing at the HMP-2.

“Tailing” of hydrometallurgical ore processing at the HMP-2 in the amount of more than 700 million tons was laid in the tailing dump. Since the gold content in the dumped „tailing“ is 2.5-3.0 times lower than the economic limit, and it is not advisable to consider them in the foreseeable future even as a potential source of raw materials. Therefore, all attention should be focused on the mining waste.

At different stages of the deposit development, overburden rocks of the Muruntau open-pit mine belonged to a rock mass with different gold contents: first - less than 1.5 cu, then - less than 1.0 cu, and in the future - 0.5 cu. [12]. However, it should be noted that the specified rock mass is always stored separately. At the same time, as the processing plant’s productivity increases, the rock mass with gold content exceeding 1.0 cu actually transferred to the category of commodity ore and was involved in processing.

The overburden accumulated in the dumps during the existence of the Muruntau open-pit mine today represents mining waste. These dumps are formed from external and internal overburden rocks.

External overburden rocks are located outside the outer boundries of the ore deposits. The gold content in such rocks averages 0.15 cu, which is less than in the “tailing” of processing of a hydrometallurgical plant.

Internal overburden rocks are located inside the ore deposits. The average gold content in them is 26% less than its content in the lowest grade ore. Part of the internal overburden from January 1, 2009 is allocated to a separate cargo traffic with the formation of special warehouses. It should be noted that the balance ore inevitably lost during mining falls into the internal overburden rocks, as a result of which the gold content in them increases and interest in them grows.

To date, more than 2.0 billion tons of overburden has been accumulated in the dumps of the Muruntau quarry. These dumps were formed using automobile and conveyor transport from external and internal overburden, which were mixed with each other in an arbitrary ratio. It is known that the average gold content in such dumps is 0.35 cu.

In the "tailings" of heap leaching, 215 million tons of waste with an average content sufficient for cost-effective processing according to the "plant" technology has been accumulated. This waste is a homogeneous ore mass, crushed to a particle size of 3.25 mm, stacked and treated with cyanide solutions. In the future, the amount of such waste will reach -350 million tons, which will ensure the operation of HMP-2 for ~ 9 years.

Prerequisites for involvement in the processing of waste mining production. "Tailings" of heap leaching are included in the raw material base of the mining and processing industry, and their processing at HMP-2 can be started soon.

Interest in overburden dumps as a reserve source of raw material resources was manifested in 1998, when their first assessments were made of the distribution of gold content in the deposited rock mass. However, systematic work in this direction began in 2008 with the processing of accumulated mining and geological materials and conducting surface testing on a characteristic dump, which was chosen as one of the dumps of the CLT (cyclical flow technology) complex. Analysis of the obtained results allowed us to draw the following preliminary conclusions:

1. Automobile and conveyor dumps of overburden represent typical manmade deposits.

2. The nature of the distribution of gold in manmade deposits corresponds to the nature of the distribution of the deposits of natural origin, during the development of which they are formed.

3. In manmade deposits with a cut-off grade of 0.5 cu -25-30% of the rock mass with an average content sufficient for its cost-effective processing. This rock mass can be considered as a reserve source of raw materials for the HMP-2 for the period after 2020.

4. The potential reserve source of raw materials with the specified parameters are estimated at ~ 550-650 million tons, which will ensure the operation of HMP-2 for at least ~ 20 years. Naturally, the reduction in cutoff grade, for example, to 0.4 cu will increase potential reserves up to-850-900 mln. tons while reducing the average content by 10-15%, which will extend the work of HMP-2 by another ~ 10 years.

The factors contributing to the involvement of waste products in processing include:

- during the development of manmade deposits of overburden: the presence of transport communications with the points of loading of the ore mass in the railway dump cars, which allows you to organize its processing immediately after the decision;

- with the involvement in the processing of „tailing“ of heap leaching: the presence of crushed ore mass with a relatively even distribution of the content in it, which reduces the energy, material and financial costs of processing with increasing throughput (productivity) of the grinding and classifying equipment.

Factors that complicate the involvement in the processing of waste products include:

- in the development of manmade deposits of overburden: the need for geological exploration with the justification of mining parameters of mining operations;

- during the development of manmade deposits from the "tailings" of the heap leaching: low throughput of transport communications in the absence of loading points.

3.2.2. The program of involvement of mining production waste into the processing

The program of involvement of waste mining production into the processing should be based on the schedule for the development of available raw materials, concentrated in the contours of the quarry of the 4th and 5th stages, and in the manmade deposits.

An analysis of such an indicative schedule (Fig. 3.7) shows that the available raw materials in the open-pit and ore warehouse contours will not satisfy the needs of the processing plant since 2020. In this case, a dilemma will inevitably arise: to reduce production, or to attract additional resources with reduced consumer characteristics. Since the state policy in the field of economic development can be formulated as “Creating conditions for obtaining guaranteed incomes for the majority of the working population”, the answer to the question posed is almost straightforward: “Attract additional resources with lower consumer characteristics”. This solution will allow maintaining the integral resource of the region at a level preventing its degradation by extending the life of the mining processing complex based on the Muruntau deposit.

The program of involvement in the processing of waste mining production should include the following tasks.

Development of manmade deposits of overburden requires as follows:

- to conduct geological survey of dumps with the network rationale and sampling interval;
- to build a mathematical model of manmade deposits;
- to justify the value of the potential (extremely low) and basic cutoff grade (Fig. 3.7);

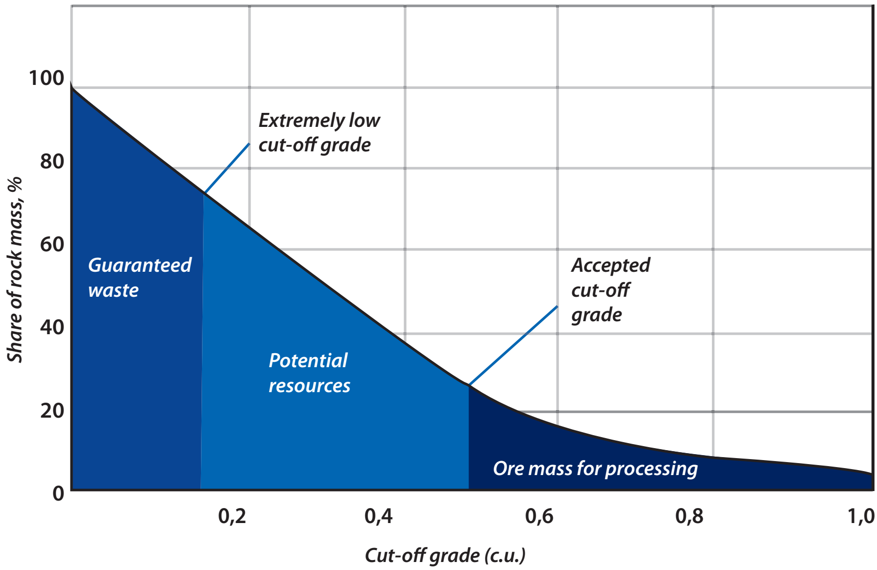

Fig. 3.7. The distribution of internal overburden according to consumer properties, depending on the cut-off grade

- to develop a forecast of the content change from the base value to the potential value;
- to work out the method of building profiled plans;
- to justify the technology of excavation (gross, selective) with the definition of its mining and technological parameters (the height of the ledge, excavation portion), taking into account the technology of the formation of dumps (automobile, conveyor);
- to determine the feasibility and scope of large-scale, small-scale or lump sorting, depending on the technology of the formation of dumps (automobile, conveyor);
- to carry out technological certification of manmade deposits;
- to determine the sequence of mining manmade deposits and re-fill the vacated space with new waste.

Naturally, different degrees of ore mass averaging require different approaches to the development of such dumps, and the data obtained allow us to consider dumps as manmade deposits that require the same approach as for deposits of natural origin. At the same time, in such fields, the substantiation of cutoff grade is very significant, because the residual resource of a field, which determines the existence of not only the enterprise, but also the whole region, depends on it.

Let us consider this question in more detail. Fig. 3.7 presents the graph of the output of the ore mass from the cutoff grade, adopted in the separation of internal overburden into balance and off-balance parts. At the same time, it was taken into account that the project for such a division was taken to have a cutoff grade of C_C= 0.5 c.u., And an extremely low cutoff grade equal to the losses during processing is C_C= 0.18 cu

As a result of this separation, internal overburden rocks are divided into three parts:

- reserve resources for processing (C6 = 0.5 cu.);
- potential resources for processing (0.18 < C6 < 0.5 cu.);
- guaranteed waste (C6 < 0.18 cu).

Thus, additional raw materials in the amount of 40 % of their total volume of overburden in dumps can potentially be separated.

However, the average gold content in these resources does not ensure the recoupment of the costs of their processing even with a double increase in its market price. Therefore, it would be advisable in the first approximation to assess the conditions for the involvement of these resources in processing, taking cutoff grade as a controlled parameter, and a tax on the subsoil and the market price of gold as uncontrollable parameters.

The results of the calculations are presented graphically (Fig. 3.8, a), analysis of which shows that at the current price of gold, the costs are paid off at C_C = 0.22 cu, taking into account the forecast for an increase, when the cutoff grade is less than the value of losses during the processing.

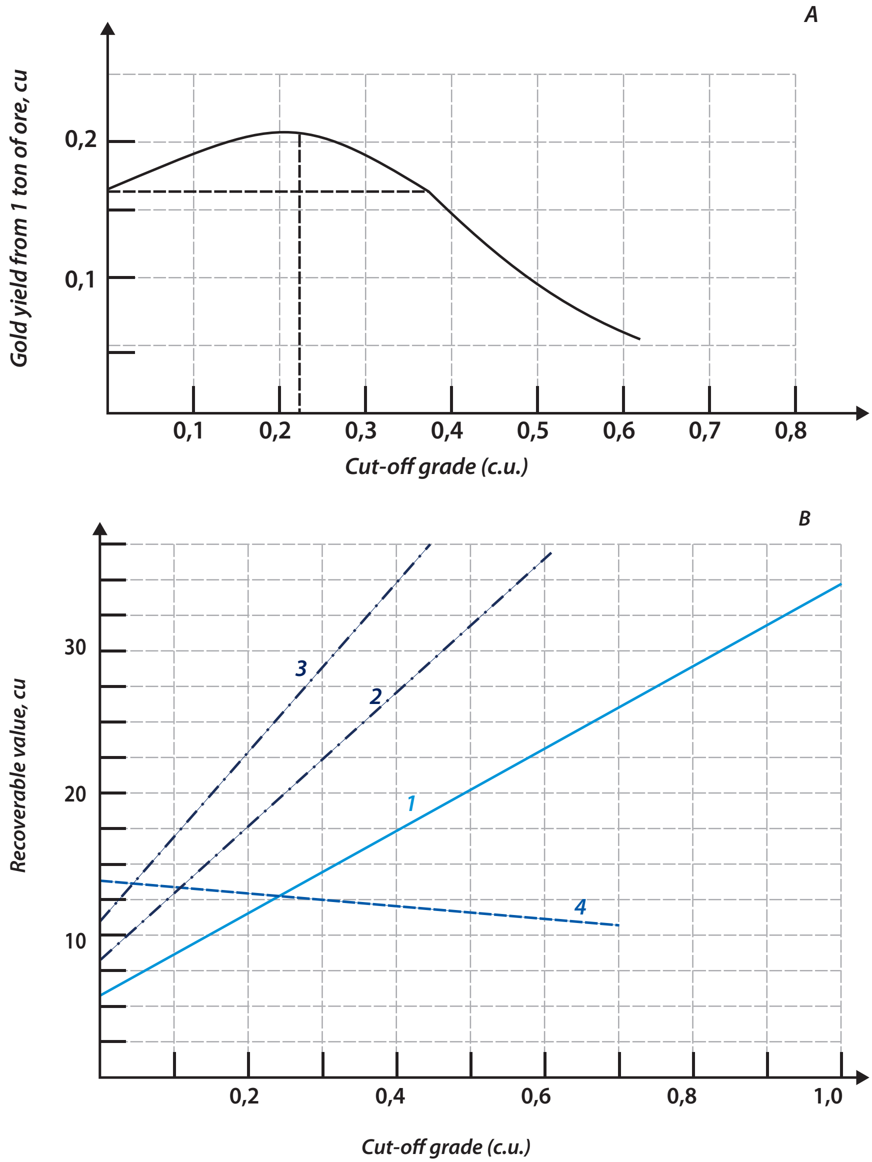

Fig. 3.8. Dependencies:

a) gold output for 1 ton of overburden;

b) recoverable value at different cutoff grade in overburden rocks: 1, 2, 3 at the market price of gold of USD 30, USD 45, USD 60/g; 4 – the cost price taking into account the reduction of the tax on the subsoil and the exclusion of depreciation

Based on this, we can conclude that the cut-off grade in internal overburden rocks should be taken at the level of processing losses (C_C= 0.18 cu). Then the volume of raw materials will increase by 40% and the amount of recoverable gold by 25%.

This gold yield is almost the same at C_C = 0.18 and 0.3 cu. (Fig. 3.8, b). Therefore, it is impractical to increase the volume of processing of overburden rocks, and to take cutoff grade Cc = 0.3 cu. Then 50% of overburden of their total amount (700 million tons) will be involved in processing. This will allow a 6–7% increase in the use of the resource potential of the Muruntau field.

Analysis of the geological structure and technology of open-cast mining of the Muruntau deposit, as well as the methods for the formation of warehouses and dumps, allows us to draw the following conclusions:

1. The deposit is characterized by a complex structure and high variability of ore body parameters.

2. In Muruntau quarry, selective excavation and separate storage of rock mass with various consumer properties is conducted. At the same time, the rock mass from different quarry zones with different technological and consumer properties can be put in the same dump or warehouse.

3. The complexity of the structure of the field and the adopted technology of mine transport work determine the complex structure of warehouses and dumps. Therefore, for their effective development, it is advisable to conduct exploration and technological mapping.

4. When choosing a technology for developing warehouses and dumps of the Muruntau open-cast mine, the complexity of their internal structure should be taken into account, which is in inverse relationship with the gold content in the deposited rock mass.

The outlined methodological approach to the choice of technology for the development of manmade mineral formations of the Muruntau open-pit mine has been tested in the implementation of the heap leaching technology.

In particular, when studying a stock of off-balance ore (the height of the warehouse is 37 m), it was found that its internal structure allows to conduct total excavation with intra bottomhole averaging, since the sections of non-conforming ore have a thickness of not more than 1.5 - 2.0 m with an area from 10-15 to 40 ÷ 50 m^2. This averaging was implemented as a result of the development of a warehouse with inclined layers (angle of inclination up to 25°) over the entire height using bulldozers, which allowed the average grade in the ore to be maintained at a given level during the entire period of the warehouse development.

When studying a stock of off-balance ore, corresponding to the qualities of internal overburden rocks (warehouse height 50 m), it was found that the power of substandard inclusions reaches 3-5 m with an area of up to 500 m^2. Therefore, the development of such a blade should be conducted selectively by horizontal ledges of 5 m height.

Thus, the experience gained during the development of manmade mineral formations of the Muruntau open-pit mine allows us to conclude that the development of such formations should be approached in the same way as natural deposits (operational exploration, the study of technological and consumer properties of the rock mass, technological mapping, determining the method of excavation of conditioned raw materials, the choice of parameters of the ledges and mine transport equipment).

Features of the formation of dumps with the use of various technologies of transportation are manifested not only through the averaging of the content in the deposited ore mass, but also through the segregation of rocks in the process of their movement along the dump slope. Taking into account the segregation of rocks when choosing a technology to develop, it is all the more necessary since a direct dependence of the gold content on the size of the pieces is established.

Research has established that when dumping using road transport, segregation of rocks by size is not significant, while at conveyor transport segregation of rock mass in dumps is pronounced, which creates prerequisites for their selective development taking into account changes in the particle size distribution according to the dump height. In this case, the key point is the assessment of the separation capacity of the dump slope and the determination of the mode and conditions of dumping, ensuring maximum accumulation of large rock classes in the lower layers of the heap. Taking into account the peculiarities of the distribution of pieces of large classes in the bedding massif, the following technological schemes for the development of heaps are developed. The dump formed with the use of road transport is processed by horizontal layers with the separation of the rock mass into ore mass intended for processing and waste sent for permanent storage. The technology of developing dumps formed during conveyor transport takes into account the segregation of pieces and includes:

- separation of the dump into the upper zone with pieces of grain size up to 50 mm and the lower zone with pieces of grain size greater than 50 mm (on the slope of the dump);
- selective mining of the upper zone with the division of the rock mass into ore for processing and waste;
- selective mining of the lower zone with the separation of lumpy rock mass into ore mass for processing and lumpy waste sent to the piece sorting with separation into conditioned and substandard varieties.

Development of manmade deposits from the "tailings" by the heap leaching requires as follows:

- to choose the method of transportation of the "tailings" of the heap leaching from the place of the stack to the processing plant (railway, pipeline, conveyor system, combined);
- to justify the technology of developing a stack of „tails" of heap leaching in the complex with the loading of the extracted material into vehicles;
- to determine the technological indices (extraction, productivity) of processing the "tailings" of the heap leaching according to the plant technology;
- to develop a technological scheme for processing „tailings" of heap leaching according to plant technology;
- to determine the method of detoxification of the material in the stack before the start of the excavation and loading operations.

To ensure the coordinated development of manmade deposits it is necessary to:

- conduct a technical and economic comparison of options for processing mining waste ("on-site", at a processing plant or in combination);
- substantiate the technological scheme (combined with mined ore and man-made raw materials or natural or man-made separated according to the origin of the raw material) and determine the rational ratio of the processing of mining waste and natural mineral raw materials;
- assess the feasibility of using simplified technologies for processing

waste based on gravity and dry enrichment methods to partially compensate for the decrease in output (slots after cessation of ore processing by heap leaching;

- organize the involvement in the processing of mining waste and „tailing“ of heap leaching (design, construction of transport communications, etc.);

- proper processing of mining waste and “tailings” of heap leaching.

3.2.3. The schedule for the development of manmade deposits

The schedule for the development of manmade deposits at the present level of knowledge can be done only in the evaluation version based on changes in the structure of the ore mass processed in time, but without reference to specific technological and technical solutions that still need to be justified or developed.

Therefore, such a schedule should be considered as a guideline for the timely completion of tasks.

It should be noted that the technological tasks for the development of waste must be solved within 6-7 years, the regulatory and economic tasks (feasibility studies, projects, etc.) – in 7-8 years and organizational and financial (decision making, selection means, reorganization of transport communications, etc.) – 8-10 years.

Thus, preliminary studies have established that the waste of mining (overburden) and processing (“tailings” of hydrometallurgical plants) of gold ore raw materials are typical manmade deposits that can be considered as reserve sources of mineral raw materials. At the same time, the development of such deposits should be approached in the same way as natural deposits, providing for the justification of the parameters of exploration, the development of the construction of varietal plans, the justification of the parameters of selective excavation (the height of the ledge, the size of the excavation portion), and the justification of the excavation technology (total, selective) and pre-concentrating (large-scale, small-scale or lump sorting). In general, the involvement of overburden rocks in processing will increase the use of the resource potential of the deposit by 6-7%.

Among such manmade deposits, the dumps of the Muruntau open-pit mine are of the greatest interest, where ~ 2 billion tons of overburden is accumulated from its different zones, therefore, gold containing overburden is mixed in them. A preliminary assessment showed that in these dumps from 25% to 40% of the rock mass contains gold in an amount sufficient for cost-effective processing. However, in order for such prerequisites to become a reality, the tasks of exploration of manmade deposits, substantiation of development parameters, creation of transport links, preliminary concentration, etc. must be solved.

3.3. Overview of the environmental situation in the Kyzylkum region

Modern environmental problems threaten the possibility of sustainable development of civilization (Fig. 3.9).

Further degradation of natural systems leads to destabilization of the biosphere, loss of its integrity and ability to maintain the quality of the environment necessary for the normal functioning of society. By the end of the 20th century, anthropogenic pressures on nature led to a mismatch of the natural laws of the biosphere and, as a result, to global environmental changes.

Global	*Regional*	*National*	*Local*
Climate change *Ozone factor* *Aral problem*	*The problem of the Aral Sea region Regional problems of water resources use Transboundary environmental pollution Desertification Spread of infectious and other especially dangerous diseases Cataclysms of natural technogenic character*	*Shortage and pollution of water resources. Provision of drinking water to the population. Landslides and floods in the village. Airspace pollution. Conservation of biodiversity. Impairment of public health. Disasters and accidents.*	*Radioactive contamination of certain territories* *Groundwater pollution*

Fig. 3.9. Modern environmental problems

A special place in the attack on global life processes is the destruction of long-term carriers of the laws of the evolution of the planet, which are mineral deposits. The development of subsoil is fraught with the consequences of changes in natural ecosystems - pollution of the atmosphere, destruction and reduction of soil fertility, quantitative and qualitative changes in the micro flora, etc. All this is directly related to the territory of the Central Kyzylkum, where in the bowels of the earth lie enormous reserves of ore and non-metallic minerals.

3.3.1 Environmental assessment of the effectiveness of natural and industrial systems

Uzbekistan is landlocked country and consists of 80% of desert and semi-desert areas. During the Soviet period of management, natural resources had no price, extensive and irrational methods of using mineral and water resources, toxic chemicals (especially in areas of intensively irrigated cotton growing) were used. The wasteful use of nature for many years was not only a consequence, but a condition for the viability of the administrative-command management system, which still causes great harm to the environment and human health.

In order to ensure sustainable economic growth and further human development, it is necessary to urgently resolve environmental problems inherited from Soviet times.

At present, technical criteria are well developed and scientifically substantiated, reflecting mainly quantitative and qualitative consumer effects. These include the following criteria: the volume of production, the performance of technological processes, the power of power plants and systems, the efficiency of plants, technologies, structures, etc. Environmental criteria are not explicitly associated with the above criteria and in most cases were used only on the latter, crisis stages of development of natural-technological systems, when there is direct damage to man and the material values. Naturally, such a situation cannot be recognized as correct.

The core of the basic provisions of ecology and environmental management (Fig. 3.10) that are of interest to us is the “Law of Internal Dynamic Equilibrium”, which is commented on by the four “Laws” of ecology (B. Commoner).

One of the indices, in the integral form taking into account the ecological state of the natural-industrial system, could be taken as the index of “impact on human health” or the index “impact on public health”. In the system of social values, human health occupies the most prominent place. It serves as an index of both the level of economic development and the social organization of society.

The main features and disadvantages of using this index as a criterion are that, firstly, the physiological and biological structure of public health is different in different climatic and geographical conditions. Secondly, in the organization of living conditions (sanitary and hygienic, industrial) there is a lag effect (6-8 years or more) between the impact and the response of the system, which is intensified during the period of rapid scientific and technical changes. Thirdly, this index is the final link in a long chain of causes and effects in the development of natural resources; it cannot take into account all the previous features of this process.

An important index may be the energy intensity of production, technology, and certain types of products. The index of total energy intensity recently used in the present work is more consistent with the goals, since it also indirectly characterizes the environmental parameters of production or technology, since in the final form of energy is nevertheless removed from the natural environment.

However, this parameter in its direct form reflects only the state of the manmade component.

Expanding the scope of the components composing the system, we come to the idea of developing a criterion that takes into account the full range of resources involved in the process of economic activity.

The main feature of the functioning of the mining industry is the interaction between natural and man-made components through the withdrawal, movement or introduction of various types of resources. At any mining enterprise consumes a large number of different types of resources. It is very difficult to characterize the resource intensity of production by a detailed accounting of the costs of all resources. Therefore, the costs of resources on any common basis are combined into a limited number of groups. The most acceptable is the method of classification according to their intended purpose in the production process.

In this case, it does not matter where and what purpose certain types of resources are spent for. It is only necessary that the resource costs included in the same group are of the same nature. Thus, labor costs, despite the fact that they are used in various areas of production, are combined into one group. The same can be noted, for example, with regard to electricity, which can be used for technological needs, lighting, transportation, etc., this use reflects the consumption of one type of resources – energy.

In industry, a single grouping of costs was adopted, as was the case for all industries. Despite the fact that this grouping serves as a monetary expression of the cost price, and we design the system in natural resource indicators, the adopted structure of homogeneous cost elements is well suited to our objectives. Having somewhat integrated the single classification of resources, we will accept it for use in calculating the end-to-end resource consumption in the following form: raw materials, basic and auxiliary materials, fuel, energy of all types, depreciation of fixed assets, labor resources, other expenses of resources.

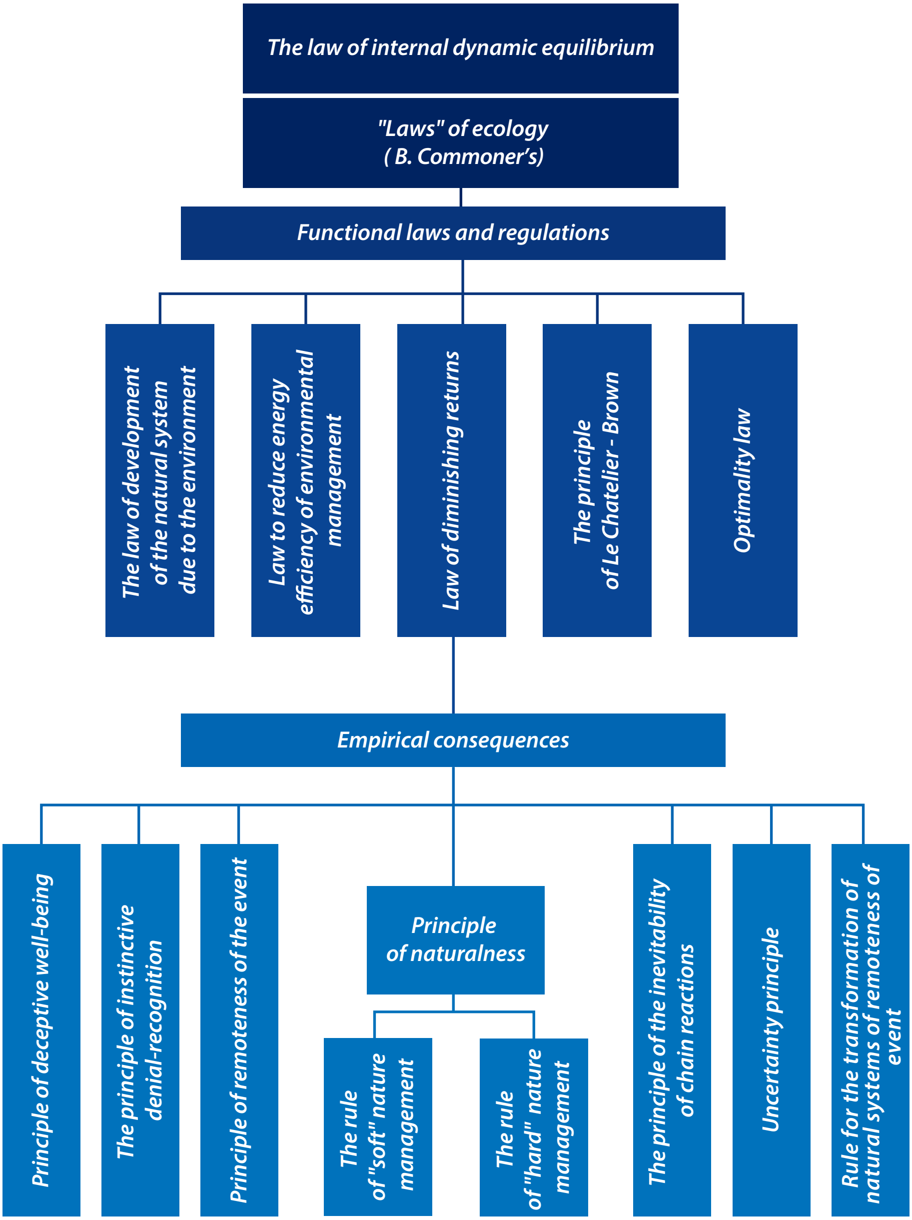

Fig. 3.10. The structure of the main provisions of ecology and environmental management, underlying the management strategy for quarries

The first three elements reflect the cost of resources in the form of objects of labor. The costs of resources in the form of means of labor are reflected in the depreciation of fixed assets. Fixed assets used in the production process play an unequal role. In the economic literature they are also grouped on the basis of participation in the production process. We divided the main production assets into two groups according to the average annual wear rate: a) buildings, structures and transmission devices; b) machinery, equipment, vehicles and tools. The costs of living labor are taken into account in the form of the reciprocal of labor productivity, presented in kind and characterize the number of people involved in the production of a unit of production. All other expenses of resources, relatively small, but unavoidable in the production and economic activity of the enterprise, usually refer to the item "other expenses". As applied to the conditions of the mineral complex, they are insignificant, and in the case when their size does not go beyond the limits of calculation accuracy, they are neglected or proportionally distributed among the main groups participating in the model.

The above structure of resource costs refers to the manmade component of the natural-industrial system, such as any mining enterprise. The cost of natural resources in the operation of this system includes the alienation of land for the placement of industrial and other objects, the destruction of land in the quarry quarters, areas of mine failures, the use of land for their intended purpose in recreation areas and utilities, the destruction or damage of underground hydrogeological systems, violation of the integrity of the lithosphere, violation of biocenoses. Such costs of natural resources occur in the production of basic and auxiliary materials, fuel, energy, as well as building materials for the construction, metal for the creation of machinery and equipment, etc.

Thus, taking into account the above considerations, it is possible to recreate the process of resource consumption during the operation of a mining enterprise and what, in general, will be characterized by full resource intensity, which means the total amount of resources used for the extraction and concentration of one ton of mineral [25].

Full end-to-end resource consumption, takes into account both the resources used directly in the manufacture of a unit of production, and the depreciable part of the resources involved in the manufacture of labor tools (equipment, buildings, structures, transport devices), as well as those involved in the social sphere in the main production and other industries serving this production. However, the source of any material or energy resource is the environment – ecotope. As a result of the removal from the natural environment of a particular type of resource, the soil, groundwater or surface water, the atmosphere, the biota, the lithosphere are disturbed to varying degrees. In this regard, the criterion for assessing the effectiveness of human economic activity can be the total end-to-end resource intensity of a specific type of activity, reduced to natural resources or, more precisely, to anthropoecological resources. For brevity, the term is referred to as "integral environmental resource intensity", taking into account the costs of resources, both direct and indirect (in the form of equipment, buildings and structures, social infrastructure).

The establishment of an integrated environmental resource consumption is preceded by a list of natural resources involved in the process of mining and technological development, which are classified according to the nature of use (alienable, damaged, destroyed) and by the type of environmental component (land, groundwater and surface water, atmospheric air, biotic systems, human resources). Thus, the natural resources involved in the development process are represented as a matrix. This matrix leads to one index - the integral environmental resource intensity. Such a reduction is carried out on the basis of a scientifically based methodological principle based on a deep analysis of the natural environment of a territory. When extracting mineral resources, the natural regional environment is deformed in a certain way, the ways of its functioning change, its internal connections are rebuilt. These restructuring should not disrupt the ability of the natural systems of the territory to their sustainable existence. The role of each of the components of the environment in ensuring its sustainability is different. The methodological basis for establishing the „weights" of natural components was adopted by a method that synthesizes two methods of assessment - expert evaluation and mathematical modeling. The principles for determining the quantitative parameters of the impact on natural systems are discussed above and are illustrated in the diagram in Figure 3.11.

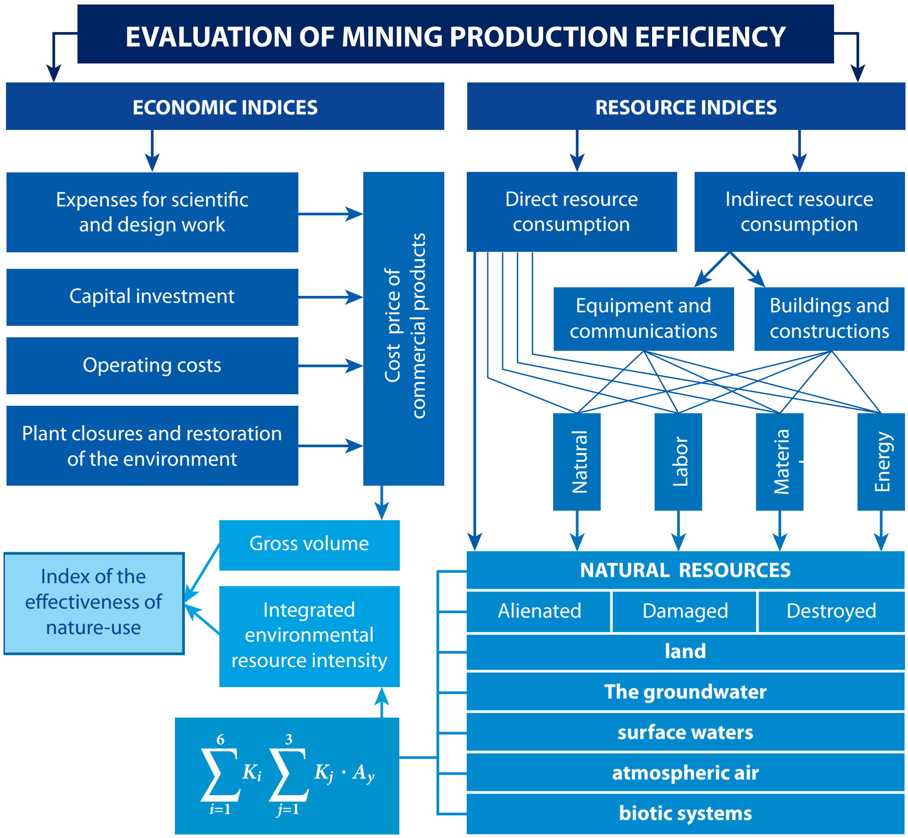

Fig. 3.11. Scheme of environmental assessment of the effectiveness of mining technologies

In determining the environmental resource intensity of mining, the ranking of natural resources plays an important role, i.e. determination of the most important (environment-forming) and less important, for a given territory, natural resources, since different components of the environment have different significance to ensure its stable state and stable state of the society in a given territory.

Reduction to a single index is carried out using the normalization function. This function must be continuous and varies from a certain upper limit (upper score) to a minimum, not limited to the bottom, with a sufficiently large ranking number. Reduction of used or damaged natural resources should be brought into resources that have a well-developed methodology for valuing them.

Such resources may be land resources. In this case, the ranking factor for the upper level is assumed to be unity, and the ranking row is built in relation to the soils.

The approaches used in the environmental assessment of the functioning of mining enterprises are applicable for choosing the method of development, systems for complex mechanization of mining operations, and evaluating other technological solutions.

3.3.2. Solution of environmental problems in the example of the Navoi region

The NMMC with its production activity covers about 100 thousand square kilometers of desert and lowland areas of the Central Kyzylkum. Environmental problems arise due to the presence of dumps of off-grade and off-balance ores in the towns of Uchkuduk and Zarafshan, emissions of harmful substances into the atmosphere, accumulators of toxic industrial wastes of hydrometallurgical production stored in tailings, ore mining in the open pit, drilling and blasting, etc. [27, 28].

The main objects of the NMMC located in the territory of the Navoi region are: Northern Mine Administration (HMP-3, Sulfuric Acid Plant, uranium production), Central Mine Management (HMP-2, Phosphorite Combine), HMP Mine Administration (HMP-1, PA „NMP"), Zarafshan Construction Administration and others.

Hydrometallurgical plant number 1 is located on the site of the city of Navoi. The plant annually develops a "Plan of measures for environmental protection and rational use of natural resources", a quarterly report is drawn up on the implementation of the plan in the following areas: "Protection of water resources", "Protection of atmospheric air", "Protection of land resources", and "Radioactivity".

Air protection. At the HMP-1, the "Standards for maximum permissible emissions of pollutants into the atmospheric air" were developed and approved. According to the "Inventory of sources of pollutant emission to the atmosphere", only 95 emission sources were registered at the HMP, of which

61 were arranged and 34 were not arranged. The main pollutants emitted into the atmospheric air by HMP-1 are inorganic dust – 70.3%, lime dust – 5.06%, ammonia – 8.5%. Control of emitting harmful substances into the atmosphere is carried out monthly according to the schedules agreed with the Navoi Regional Committee for Nature Protection (NRCNP). At the HMP-1, the main sources of emissions of harmful substances are equipped with dust-gas cleaning equipment. Passports for dust removal equipment are issued and registered in NRCNP.

Land protection. On the territory of the HMP-1, 32 items of production and consumption waste with a total weight of about 1,622,617.432 tons per year are generated. The bulk of the waste consists of gold ore processing waste, the solid pulp phase annually is 1,620 thousand tons (according to the waste inventory). Used fluorescent lamps, ferrous scrap metal, non-ferrous scrap metal, used motor oil, water emulsion of compressor oil, industrial oil, used automobile tyres, conveyor belts are recycled. Construction and household waste are transported to the tailing dump maps of HMP-1 for disposal, the annual volume of industrial waste is 1,032 thousand tons, according to the environmental project limit of disposal and generation of waste.

Radiation safety. The structure of HMP-1 includes a tailing dump, a special engineering structure for the burial of HMP-1 production waste. NMMC has developed an "Action Plan for the rehabilitation of the environment in the zone of influence of the tailing dump of the hydrometallurgical plants of NMMC". The tailing dump is located 5 km west of the HMP in the town of Navoi, on the left bank of the Zarafshan River (6 km from the river). It was commissioned in 1964 and was used until 1994 as an accumulator of radioactive waste from uranium production. The area within the dams is 630 hectares, the height of the dams is up to 15 m. For thirty years of operation, 59.7 million tons of the solid pulp phase has been accumulated in the tailing pond in the form of uranium-containing ore crushed to 0.074 mm (80%). The radioactivity of tails is determined by the content of „tails" of uranium in the amount of 50 cu and its decay products (mainly radium). The specific total alpha activity of the tail material averages 9,000 becquerels per kg. Exposure dose varies from 30.0 to 150.0 μSv/hour. The tailing dump was constructed without an impervious screen. The technological solutions filtered into the underground horizons were intercepted by a system of drainage wells and returned to the technological process. In 1994 HMP was redeveloped to extract gold from imported ores. In the same year, the current map No. 6 with a reliable impervious screen was built and put into operation.

Factors of negative impact on the natural environment.

Dusting due to wind erosion of slopes of dams and dry beaches of technological maps.

Release of radioactive radon gas into atmospheric air.

Partial filtration of tail water into groundwater horizons, pollution of groundwater.

Measures as taken to neutralize the negative impact on the environment.

1. Fighting dust by constantly moistening the tail material with the liquid phase of the pulp and process water.

2. Interception of filtered solutions by a drainage well system (24 wells with a capacity of 10 m3 of water per hour).

3. Construction in 1994 of the map No. 6 operated so far with an anti-filtration screen.

4. Permanent control over the halo of groundwater pollution from the filtration of solutions (there are 108 observation wells).

5. Control over the effective doses of radiation to a critical group of the population of the adjacent villages and the town of Navoi.

6. The Institute GIDROINGEO (Uzbekistan) is currently engaged in preparation of "Fulfillment of the prediction of the spread of halos of groundwater pollution due to filtration from the tailing dump of the HMP" report.

An action program for the rehabilitation of the environment in the zone of influence of the HMP tailing dump for the next 10 years.

1. By request of NMMC „Uzgeotehliti" developed „Technical and economic rationale for the environmental rehabilitation of HMP using tailings from the processing of gold ores." The project envisages overlapping with neutral wastes of gold production radioactive wastes from the plant's past activities, that is, their burial by laying 650-700 thousand tons of rock mass per year in the screen. As a result, waste of ore and clay, which practically buried radiation waste, began to flow into the tailing dump. At present, the

radiation background in the tailings storage has practically decreased tenfold and does not cause any concern. The completion of the construction of the anti-radiation screen will take 10-12 years.

2. A schedule has been developed for the monitoring of atmospheric air, groundwater and soil affected by pollution by toxic substances in the zone of influence of the tailing dump. The schedule is coordinated with the local authorities of the State Committee for Nature Protection. Based on the results of observations, an annual report is prepared.

The Northern Mine Administration of NMMC (Uchkuduk district) works in the following areas: mining of gold ores and their processing at the HP (hydrometallurgical production); the extraction of uranium raw materials by the method of underground leaching; sulfuric acid production.

Production activities are conducted in the region with extreme climatic indices - high summer and low winter temperatures, general increased dustiness, and deficiency of water.

The main manmade pollutants are: Hydrometallurgical plant with sulfuric acid production (SAP) and tailing; the mines Vostochny and Daugyztau, where mining operations are carried out by the open method; Geotechnological mine (GTM), where the mining of uranium raw materials is carried out by means of underground leaching; boiler houses „Energy Services" with the production of thermal energy for the needs of the divisions of the Northern Mine Administration.

Hydrometallurgical plant with sulfuric acid production and a tailing pond is the object of continuous monitoring of emissions of inorganic dust, sulfurous anhydride, hydrogen cyanide into the atmosphere; spreading of aqueous solutions, harmful chemicals (cyanides, arsenic, heavy metals) in surface industrial and ground waters, soil pollution in the zone of influence of the tailing pond.

Thanks to environmental protection measures taken, emissions to the atmosphere by 25% of inorganic dust from stationary sources of HMP-3 were reduced. This was facilitated by increasing the efficiency of dust and gas treatment plants (DGTP). Emissions of hydrogen cyanide to the atmosphere do not exceed the MPE standards and make up for each of the 10 sources – 0.376 tons / year.

Discharges of industrial wastewater from sulfuric acid production, according to chemical composition, slightly acidic, sulphate-chloride with mineralization up to 1.5 g/l, are fed to an evaporator card, along the perimeter of which observation wells are drilled. The water-resistant horizon from the penetration of wastewater into groundwater is clay, with a capacity of up to 40 m. Emergency discharges are eliminated with the stripping of the soil, which is transported to the places of authorized storage.

Harmful factors in the zone of influence of the tailings are: the presence of dust from the surface of the tailings, the presence of cyanide compounds, arsenic, and salts of heavy metals in the liquid phase of the pulp. In accordance with the technology of dumping pulp dust from the surface does not occur. The concentration of hydrogen cyanide in the tailing storage area is less than 0.3 mg/m^3. The pulp liquid phase is monitored quarterly through observation wells of the 1st and 2nd belts, drilled around the perimeter of the tailing dam. The depth of the wells ranges from 5 to 20 m. The water-resistant horizon is plastic clay. The zone of manmade irrigation from the western and southern dams occupies an insignificant volume, as evidenced by the presence of dry wells of the 2nd belt drilled at a distance of 250-300 m from the line of the 1st belt. In water samples, cyanides, rhodanides, and arsenic are determined. Arsenic outside the tailings storage basin in the observation wells of the 1st belt was not detected. To monitor the status of groundwater and in the area of the tailings there are observation wells drilled on the Senonian groundwater horizon, located at a depth of 80 m from the surface. According to chemical analysis data, there are no harmful substances - cyanide, rodanide, arsenic – in groundwater.

Industrial waste, in accordance with the permission of the State Committee of Environmental Protection, is stored within the “evaporator card”. The total annual storage volume does not exceed the waste generation standard - 615 tons.

In the production of open-pit mining operations in the mines, there is not only a violation of the earth’s surface, but also emissions of harmful chemicals and dust into the atmosphere during blasting operations. When excavating and moving the ore mass along the mine’s roads, dust suppression is carried out, for which irrigation of both the open pits of the quarries and unpaved roads is carried out.

High inversion of air masses, characteristic for this region, prevents atmospheric pollution in the area of the industrial site of the Northern Mine Administration and settlements.

When a quarry is fully developed, its surface is recultivated, i.e. waste dumps stored on the pit walls are moved to the excavations, and the surface is leveled.

Geotechnological mine – is the source of the formation of radiation-hazardous factors (RHF) associated with soil pollution, equipment by working solutions containing radionuclides. RHF includes: increased gamma radiation, dust in atmospheric air containing particles of alpha nuclides, etc.

According to the radiation monitoring data conducted at the UL sites, in the sanitary protection zone and observation zone (Uchkuduk town and Shalkar settlement), the effective radiation dose of personnel and the public is calculated annually. Exceeding the dose limit is not marked.

Dumps of off-balance ores are surveyed annually. The gamma dose rate and the radon emission flux density are monitored. The presence of a stable and dense crust on the surface of the dumps prevents dusting from surfaces and radon emission. Radiation warning signs are installed on dumps with increased gamma radiation. The bases of the dumps are banked up to prevent the spreading of rainwater swabs from the surface –100 μSv/h to 1,200 μSv/h.

On the sections of the UL, monitoring of contamination of groundwater is carried out at observation wells. A chemical analysis conducted on a quarterly basis indicates no contamination — the concentration of sulfate ions (SO_4^{2-}) is within the background values of 1,000–1,500 mg/l. The lands after the development of the UL sites are being reclaimed. Reclamation of disturbed lands is carried out according to agricultural management. The total activity of rocks in uncultivated areas within the permissible level is 600 Bq/kg, the exposure dose rate does not exceed 25-30 μSv/h. The soils in the plots with the activity of more than 600 Bq/kg are removed and instead filled with clean soil. The removed industrial waste (soil containing an increased number of radionuclides) is stored at the waste disposal site (WDS), for which there is permission of the State Committee of Environmental Protection.

Household and industrial non-toxic waste from the divisions of the Northern Mine Administration and the town of Uchkuduk are stored at the town landfill of solid industrial and household waste. Each year, about UZS 150 million are spent on the maintenance of the "town dump". To improve the ecological state of the environment, an environmental protection plan is annually developed, the implementation of which is monitored by the State Committee of Environmental Protection. The action plan includes sections on the protection of atmospheric air, water and land resources, waste management. The limit allocated for environmental protection measures increases annually.

The launch of the first stage of the biological treatment station at the STP (sewage treatment plant) of Uchkuduk allowed excluding the discharge of household wastewater to the sewage, and using them in the processing technology of gold ores. At present, treated wastewater is supplied by pipeline to HMP-3, and used for irrigation of the green park area of the city.

In the near future, in terms of improving the ecology of the environment, it is planned to use the technology of bacterial leaching, additional build-up of the tailings dam, an increase in the number of vehicles using compressed gas, a possible transfer of Heatpower center to a one-minute emulsion.

The environmental situation in the Zarafshan region. The central mine administration pays great attention to maintaining a normal environmental situation in an industrial region. For these purposes, the current environmental protection plan is developed annually and a prospective plan is also developed. Over UZS 12.0 billion per year is spent on environmental protection measures, and such costs are increasing every year.

The following mining facilities and technologies with the use of hazardous chemicals are in force in the Central Mine Administration: HMP-2 - cyanide (hazard class 1) is used to cyanide ore during gold extraction; Industrial heat water supply and sanitation workshop – chlorine (hazard class 2) is used for disinfecting water; UES EWS (United energy service of external water supply) – chlorine (hazard class 2) is used to disinfect drinking water; Food Combinate – ammonia (hazard class 4) used in refrigeration.

All harmful technologies are equipped with safety systems in order to avoid leakages and emissions of harmful chemicals into the environment. The system of instrumental control over the content of harmful substances has been organized.

In total, the Central Mine Administration has 453 sources, of which 284 are organized. Industrial site maps are available showing emission sources.

The main unorganized sources of emissions to the atmosphere are: source 109 – the tailing pond of stage I, HMP-2 (ore dust); source 110 – tailing pond stage II, HMP-2 (ore dust); source 171 - excavation at the Muruntau mine (ore dust); source 172 – explosive site of the Muruntau mine (ore dust, carbon oxide); 247 source – limestone loading at HMP-2 (limestone dust); source 421 – drum dryer KPC (phosphorite dust); source 425 – installation for production of phosphate concentrate KPC (Kyzylkum Phosphate Complex) (phosphorite dust).

Control over emissions into the atmosphere is carried out by the Laboratory of Environmental Protection of the Central Laboratory of Chemical Technologies and Environmental Protection, which is fully equipped with the necessary equipment and methods. The schedule of monitoring compliance with the regulations of MPE at emission sources and control points at the Central Mine Administration and HMP-2, which reflects the sampling frequency for each source, is annually approved by the Chief Engineer of the Central Mine Administration, coordinated with the Head of Navoi Specialized Inspection of Analytical Control (NSIAC) and sent to NMMC.

There were no emergency and salvo emissions at the enterprise.

In each unit of the Central Mine Administration there are responsible persons for environmental protection who are responsible for ensuring the work in the field of environmental protection and for the timely and accurate preparation of reports. Responsible for the operation of dust removal equipment at HMP-2 are deputy heads of workshops. There are passports and instructions for dust collection equipment.

The reports of the subdivisions are sent to Laboratory of Environmental Protection of the Central Laboratory of Chemical Technologies and Environmental Protection, where they are processed, and the consolidated report is sent to NMMC.

The following operations with the generated waste are carried out at the enterprises of the Central Mineral Management (all data are reflected in the annual reports on toxic and non-toxic waste):

- ferrous and non-ferrous scrap metals, respectively, are delivered centrally at the CMTB of the Central Mining Administration, with subsequent delivery for recycling at Uzvtorchermet JSC and Uzvtortsvetmet JSC;

- waste oils are reused, partially transported to the limestone burning shop as an additive to the fuel;

- waste batteries are delivered to CMTB with the subsequent transfer for recycling;

- used fluorescent lamps are sent to the DU CMRD (demercurization unit of the central mechanical-repair department);

- used tires are placed and stored in the “Stock tires” warehouse of CMTB;

- oil sludge, construction waste, oiled sand (soil), oily rags, substandard salt waste, packaging paper, plastic scrap, rubber waste, broken glass, electrode stubs, brickwork of boilers are taken to the landfill of the HMP-2;

- the magnetic fraction (composition - iron 99.62%, non-magnetic fraction - 0.38%) is stored in a special warehouse;

- overburden rocks, mineralized mass at KPC are stored in warehouses (internal dumps of the quarry and in warehouses of mineralized mass), sludge waste is sent to the sludge storage;

- wood waste is sold for the needs of the population;

- food waste is used for livestock feeding;

- the animal bone after grinding is sent as a feed to the poultry farm in Navoi;
- paper bags are reused for the needs of production; sludge from mining of mercury lamps 2 times a year is taken to tailing pond No. 1 HMP-2;

- waste activated sludge is used as a fertilizer;

- the soil formed during the recultivation of the exploration sites and facilities of the former Vostok mine is taken to the landfill No. 2.

MSW is transported to the landfill of Zarafshan.

The company disposes of the following types of waste: mercury-containing lamps - at the CMRD demercurization unit (DU), partially sorted at landfills of Zarafshan city - paper, polyethylene, glass containers, which are then transferred to specialized enterprises for recycling.

The total area of land allocated by the enterprise for the Zarafshan site is 600.95 hectares, and for the Besapan site is 4,579.39 hectares. 830 hectares are areas occupied by the dumps of the Muruntau mine. 14.4 hectares of land located at the industrial site "Zarafshan" were allocated for disposal of municipal solid waste (MSW), and 56 hectares were allocated at the Centralized landfill site for industrial waste from enterprises located at the Besapan industrial site. The state of the landfills is controlled by the services of the enterprises themselves and the Laboratory of Environmental Protection.

All boiler houses of the industrial site and the town of Zarafshan, as well as limestone kiln of HMP-2, were converted to natural gas, which significantly reduced emissions of harmful substances into the atmosphere.

Work is underway to convert cars to natural gas in all of the motor depot of the Central Mine Administration. For two years, an experiment was conducted to convert heavy-duty dump trucks to liquefied gas. The experiment gave a positive result, however, the transfer of all mining trucks to gas requires significant capital expenditures.

Gas analyzers 121-FA-01 are used to measure air pollution with vehicles with carburetor engines, and gas analyzers "СМОГ" are used with diesel engines. Diagnostic posts are equipped to adjust fuel equipment. Control over the content of CO in the exhaust gases is carried out while servicing and at the release of cars on the line with registration in log file. Quarterly, together with RCS and Ecosan, the operation "Clean Air" is carried out; over 100 vehicles are covered by the inspection. All controls pass state verification according to a schedule. In each carpool there is a person responsible for the state of vehicle toxicity control. There are logbooks of measurement, inspection schedules, toxicity tickets.

The transition of the Muruntau mine to the cyclical flow technology of transporting the rock mass from the pit to the surface significantly limits the use of motor vehicles.

Measures to control emissions of pollutants under adverse meteorological conditions include a reduction in production and the cessation of work on auxiliary production.

An updated inventory of the sources of emissions of harmful substances into the atmosphere was carried out, on the basis of which the volume of maximum permissible emissions (MPE) into the atmosphere for the Central Mineral Administration was compiled. The inventory and the MPE volume were approved by the Chief Engineer of the Central Mine Administration and agreed on at the Republican Committee of Environmental Protection.

Rubber waste generated at HMP-2 is sent to mills for use in the process.

The total water consumption in the Central Mine Administration from surface waters with an established limit of 101.73 million m^3/year averages about 85.0 million m^3/year, and from groundwater with an established limit of 2.42 million m^3/year in average about 2.5 million m^3/year.

In the town of Zarafshan there are treatment facilities for complete biological treatment with a capacity of 49,400 m^3/day (18,030 thousand m^3/year).

1. Mechanical treatment (grids, sand traps, primary radial clarifiers, wet draft chamber);
2. Biological treatment (aerotanks, secondary radial settlers);
3. Disinfection (contact tanks, sludge fields of 6 hectares);
4. Pumping stations;
5. Blower station.

The general condition of the treatment plant is satisfactory. Control over the operation is carried out by the staffed service of engineering and technical workers and service personnel.

At KPC there are sewage treatment plants of complete biological treatment with a capacity of 100 m^3/day (36,500 m^3/year).

According to the work plan, the Hydrogeological Service of the Laboratory of Environmental Protection carries out monthly monitoring of water discharge at hydrometric posts: the town's sewage treatment plants, sewage systems of the town's industrial facilities, the sewer filtration station, the Muruntau quarry and the Muruntau underground mine.

Visual and instrumental examination of drainage routes has established:

1. Discharge OPC (Organophosphorus compound) waters after purification are collected in a storage lake and are used in the technological chain HMP-3 (Uchkuduk town), and during the growing season, partly for irrigation of crops on the farm of the enterprise.

2. Discharge waters of urban industrial facilities, passing OPC, are discharged to the relief (boiler room “3”, a/b No. 9).

3. The drains of the Amudarya city filtration station of a water conduit used for washing the filters and sumps are pumped to the Zarafshan-Besapan conduit and used in process at the HMP-2.

4. Industrial and domestic sewage of the Muruntau mine are fed to the settling tanks in a tray and are used at the mine of GHLP (Gold heap leaching plant) in technology.

5. Manmade waters of the Muruntau mine are discharged into the reservoir lake and then used at the mine of GHLP.

6. Pumped water from drainage wells No: 1; 4; 5 is used for irrigation of greenery in the city of Zarafshan.

7. Domestic wastewater of Muruntau and Solnechny villages are discharged into the relief by a drainage ditch.

In the processing of ores in the technological chain of HMP-2, various chemicals are used, which, reacting with ore substances, form compounds that can contaminate underlying aquifers under certain conditions. In this regard, the company organized monitoring of groundwater around the tailings with the help of hydro-observation wells.

With the help of Central laboratory of labor conditions and EP, hydrogeological observations are carried out on the pollution of groundwater in hydro-observation wells with a depth of 15 to 400 meters in sections: Zarafshan (53 wells), Besapan industrial site (21 wells), the 1st turn tailing dump (76 wells), the 2nd turn tailing dump (134 wells and 4 delves). Water samples are taken from wells to determine the content of harmful chemicals (HCh): cyanides, arsenic, rhodanides, and general chemical analysis. The sampling frequency is: for cyanides – 1 time in 2 months, for arsenic and rodanides – 1 time per quarter, for general chemical analysis - 2 times a year.

Manmade waste of the HMP-2 in the form of pulp are discharged by gravity through the pipelines and stored at the second-level tailing pond, which is a natural intermountain depression, additionally fenced with bulk dams. As a reserve, the tailings of the first stage are periodically operated.

Analysis of the research results and predictions made on the impact on the groundwater quality of map No. 1 of tailing II and map No. 2 of tailing II of HMP-2 for the period up to 2025 allows us to draw the following conclusions about the impossible impact of tailing sites on the nearest natural sources of drinking water:

1. The basins of map No. 1 of tailing II and map No. 2 of tailing II of HMP-2 are situated in natural depressions located next to each other. At the base of the basins lies a complex of low-permeable sediments of considerable thickness, represented mainly by clay. At the same time, the thickness of the clay within the map No. 2 is almost twice as large as in the redistribution of map No. 1 and averages 80 m.

2. The value of the filtration coefficient of Paleogene clay-marl rocks of the foundation of the second-level tailings, obtained from experimental work, varies within the limits of 0.001-0.2 m/day.

3. The main aquifer complexes with areal distribution and susceptible to pollution from filtration of pond waters are Turonian-Lower Eocene and Paleozoic. Due to the block structure of the geological section and the lack of sustained reservoirs between them, they can be considered as a single aquifer. The waters of these complexes on a large area of pressure and outside the zone of influence of the tailings, mainly have mineralization in the calcium composition. Water intakes Taskuduk, Dzhangeldy and Kyzylkak are confined to these aquifer complexes at a considerable distance.

4. In the northern, northwestern, southern, and southeastern directions, the Turonian – Lower Eocene sedimentary water bearing complex due to the deepening of the watering zone is dehydrated (as it moves away from the tailing dam) and the groundwater flow continues only through the Paleozoic rocks. At the same time, in the northeastern, eastern, and southwesterly directions, groundwater flows along watered rocks of the Turonian-Lower Eocene and Paleozoic.

5. The pond waters of the tailings have a dry residue of 6,580 to 7,780 mg/l with a sulphate-chloride, sodium-calcium composition.

6. In hydrodynamic terms, the tailing area II is the meeting place of two natural groundwater flows from the Muruntau Mountains (from the west and northwest) and from the Sangruntau Mountains (from the south-east), the movement of which is further traced to the northeast.

7. Under conditions of backing pond water filtration from tailing II at elevations of about +285 m, a hydraulic mound of polluted groundwater has formed, which spreads along its entire perimeter.

As a result, a zone of groundwater pollution with cyanides, rodanides, arsenic, molybdenum, selenium and other ingredients formed around tailing II, which is controlled and combined by isoline of the total water mineralization of 2 g/l.

8. Along the contour of the isoline of the total mineralization value of 2 g/l, 4 main directions were identified, along which groundwater pollution from tailing II develops. For the United Aquifers Complexes of the Cretaceous and Paleozoic sediments, the maximum length of the formed halos of pollutants within these areas is approximately: northeast (total mineralization – 5 km, cyanide, rhodanides (thiocyanate), arsenic, molybdenum – 1 km, selenium – 0.5 km); western (total mineralization – 6.5 km, arsenic – 3 km, cyanides, thiocyanates – 2.5 km); southern (total mineralization – 4.5 km, arsenic – 3 km, cyanides, thiocyanates – 2 km).

9. The blocky nature of the structure of the studied sediments, with alternating areas close to the surface and deep bedding of Paleozoic age, as well as groundwater levels, caused an unevenness in terms of aquifers confined mainly to Upper Cretaceous and Paleozoic sediments.

Paleocene and Quaternary rocks are watered only in minor areas adjacent to the tailings or sporadically in area for the conditions under consideration with aquifers not sustained in space. Predictive estimates of the development of pollution were carried out using the model of piston displacement, taking into account the processes of longitudinal hydrodynamic dispersion and sorption.

10. Geochemical base formations of tailings are three combined geochemical barriers (absorption, mechanical and evaporative), on which content of pollutant components (arsenic, manganese, nickel, cobalt, titanium, lead, copper) is possible. The nature of the migration of arsenic in the area of the tailings of Stage I indicates that about 100% of the element contained in the liquid phase of the pulp is adsorbed. However, sorption processes require further study.

11. The long-term series of hydrochemical observations of wells allowed them to be analyzed in order to evaluate the main design parameters – the migration speed of individual ingredients, active and effective porosity, hydrodynamic dispersion and sorption coefficients. The most representative were the data on total mineralization, cyanides and rhodanides.

12. Forecast calculations showed that the maximum mixing of the frontal zones formed at the tailings of the II halo is characteristic of total mineralization and at the level of 2 g/l in the north-east direction is 1,650 m, in the north-west – about 600 m, in the south - 800 m.

Interpretation of regime information on cyanides and rhodanides to assess the parameters of migration showed that the speed of their distribution in the aquifer complex should only slightly differ from the rate of development of halos in mineralization.

The contours of halos of pollution on cyanides at the level of the existing concentrations should be close to the contours of halos on mineralization. The position of pollution halos in cyanides and rhodanides indicates a much greater lagging of their fronts from the front in mineralization in certain areas.

The development of arsenic, molybdenum, and selenium halos at the level of prevailing concentrations occurs at rates substantially lower than that of cyanide and rhodanide. As a result, the length of their halos is much less than for the above components.

13. None of the pollution haloes formed at the tailings of II halo threatens nearby water intake facilities – Taskuduk, Dzhangeldy, Kyzylkak. All of them are located at a distance of two or more times the maximum possible length of halos. They are located in independent hydrodynamic systems that are not related to the system within which the tailing dump is located.

All water intake facilities have independent supply areas, therefore the ingress of polluted water to areas of fresh water deposits and operating water intakes is practically excluded.

14. The operation of Map No. 2 of the tailings II entails the formation of halos of pollution from it in the north, northeast, west and south directions. Predictive estimates using calculated parameters obtained by interpreting routine observations within the halos of pollution in map No. 1 of tailing II show that over the period of operation of map No. 2 of tailing II, that is from 2012 to 2025 – these halos can reach total mineralization, respectively

1,650, 250 and 660 m. For cyanides and rhodanides – by 1400, 250 and 610 m. The length of the aureole in arsenic, molybdenum and selenium will be even smaller.

All halos from map No. 2 of the tailings II by the end of the forecast period, due to insignificance, will be inside the halo of pollution according to the total mineralization formed by 2018 at map No. 1 of the tailings II. They will not pose a threat to nearby water intake facilities.

15. Placing map No. 2 of tailings II within the territory already contaminated as a result of filtration from map No. 1 of tailings II will lead to significantly less environmental consequences as compared to the effects of pollution of a new, free of load and ecologically clean geological environment.

16. The projected magnitude of the influence of map No. 2 of the tailings II on groundwater, which do not entail significant negative consequences, allows filling its bowl up to 2015 without construction of impervious structures.

Radiation control at the Central Mine Administration and Zarafshan region is carried out according to the schedule of radiation monitoring, approved by the chief engineer of the Central Mine Administration and agreed with the head of the NSIAC (Navoi Specialized Inspectorate for Analytical Control).

The frequency of the surveyed objects depends on the degree of danger of the work being done. Thus, in the Central Laboratory of gamma-activation analysis (CL GAA), dosimetry monitoring is carried out monthly, since its work is directly related to sources of ionizing radiation. Measurements are carried out on all major types of radiation: gamma, beta, alpha. Measurements do not exceed the established levels.

The measurements carried out on the territory adjacent to the CL GAA show that its work does not affect the environment, the values for gamma radiation do not exceed the background values and are 15-18 μSv/h.

At industrial sites where there are no sources of ionizing radiation, measurements are taken 1 time per quarter. These are HMP-2, KFC, GEP-3(geological exploration party) and other units. No cases exceeding the permissible values of radioactive radiation at these facilities were observed.

Once a year, a gamma survey of the entire territory of Zarafshan, the industrial site of Zarafshan and nearby villages: Tamdy, Muruntau, Solnechny, Aktakyr, Rakhat, Sarymai, Kyzyl-kuduk is held. These values of measurements in these areas do not exceed the background levels and are 10-15 μSv/hour.

Special attention in terms of dosimetric control is given to kindergartens and schools. Measurements are held 1 time per quarter. Not only the premises where children and service personnel are located are thoroughly checked, as well as basements, walking areas, sandboxes.

In the premises where children spend time, measurements are made for the presence of radioactive gas radon-222. The measurement results do not exceed the limit levels and are less than 40 Bq/m^3. Since radon is currently receiving a great deal of attention in terms of radiation monitoring, the laboratory of CLMLC (the central laboratory monitoring labor conditions) and EP carried out measurements of apartments located on the first floors, the results do not exceed the established levels and are less than 40 Bq/m^3, for gamma radiation the results do not exceed background values and compose 10-12 μSv/hour.

The O'zGEORANGTEXLITI Research and Design Institute of Geotechnology (Tashkent) conducted a research project „Assessment and Forecast of the Radiation Situation at the Kyzylkum Phosphorite Combine".

Land reclamation works are conducted on the territory of the former Vostok mine. The work on this site is under constant dosimetry monitoring. The samples taken from the reclamation sites were analyzed at the Navoi Central Research Laboratory. The results showed that the specific activity of the samples did not exceed the established levels, 7,400 Bq/kg, according to (SRR) Sanitary rules and regulations No. 0193-06, therefore this waste was attributed to non-radioactive, the work has been completed in 2014.

On the reclaimed maps No. 1, 2 of the tailing ponds of the 1st stage, 80 thousand haloxylon saplings were planted and 800 kg of their seeds were sown on an area of about 260 hectares with the cost of UZS 5.0 million. At the mine number 3 UL of the former mine Vostok, haloxylon seedlings in the amount of 81 thousand were planted on an area of 163 ha with the cost of UZS 8.0 million.

For more stringent and representative control of the development of the situation in the further development of pollution in the course of joint operation of Map No. 1 and Map No. 2 of tailing II, it is necessary to provide for the expansion of the observational network along all the directions of halo formation considered above, as well as other additional more advanced research and monitoring methods.

„NMP“ Production Association is located on the site of Navoi. In “NMP”, an “Action Plan for Environmental Protection and Rational Use of Natural Resources” is developed annually.

„NMP“ developed and approved „Standards of maximum permissible emissions of pollutants into the air“.

According to the “Inventory of sources of pollutant emissions into the atmosphere”, only 246 emission sources were registered at the NMP, of which 139 are organized. The main pollutants emitted into the atmosphere by “NMP” are abrasive and metallic dust, inorganic dust, carbon monoxide and nitrogen dioxide.

Monitoring of emissions of harmful substances into the atmosphere is carried out monthly according to the schedules agreed with Navoi Regional Committee for Nature Protection (NRCNP). In the PA „NMP“ the main sources of emissions are equipped with dust-gas cleaning equipment.

Passports for dust removal equipment are issued and registered in the NRCNP.

A total of 23,123.8 tons of production waste are generated annually at PA “NMP”, with a standard of waste generation per year of 30,778.4 tons. Of these, 23 are toxic waste with a toxicity class ranging from 1 to 4. Such production wastes of the NMP, such as waste from burning burnt land, construction waste, electric furnace slag, refractory waste, wood dust, cast iron, abrasive and metal, flux slag is used to create a radon screen on the tailings pond.

Scrap metal is recycled for smelting molds. Oil products are delivered in full to the tank farm for recycling. Non-toxic waste is disposed to the dump of domestic waste. Used fluorescent lamps are transferred to demercurization. Used cars are taken as secondary raw materials.

Protection of water resources. All water supply is centralized, the water is supplied from UES (United energy service) of NMMC. Wastewater is discharged into the municipal sewage system and 240 thousand m^3 of industrial wastewater from the foundry and electroplating plants are transferred to the HMP-1 technology, which eliminates the ingress of harmful substances into water bodies.

Navoi site. According to the environmental services of the region, Navoi-city is the most disadvantaged in terms of harmful substances available in the air compared with the cities of Bukhara, Samarkand, Zarafshan. This is due to the increased content of nitrogen dioxide, ammonia, natural dust and phenol.

Every year, the Laboratory for Environmental Protection and Radiation Dosimetric Monitoring (LEP&RDM) under Navoi Central Research Laboratory of NMMC, conducts radiation dosimetric studies at nine observation sites on the territory of the city of Navoi and the nearby settlements. It should be noted that the average annual values of the annual effective dose rate are significantly lower than the permissible level for residential premises and areas within the observation zone where people reside (category B of 0.3 mSv/year).

In connection with the active environmental protection measures, the intensity of the background radiation tends to decrease.

The results of a sociological study. The village of Durmen, which is the closest settlement to the tailing dump, was examined during on site visit. The exposure dose rate is at the level of 11.85 μSv/h, which practically does not differ from the city background level. Measurements are taken monthly, with informing the local population.

Summing up the state of environmental protection measures in the divisions of the Combine, it should be noted that in recent years a fairly clear environmental policy has been formed and the principles of continuous improvement of environmental protection have been established in accordance with all national environmental requirements.

This is facilitated by the implementation of the "Plan of Measures for the Implementation of the Program of Actions for the Protection of the Environment of NMMC until 2025", aimed mainly at introducing new economical and environmentally friendly technologies for the extraction and processing of mineral resources. A number of new decisions made by the experts of the plant deserve attention:

1. Extraction of uranium ore from underground mines and quarries by traditional methods for the mining industry was replaced by the method of underground leaching. Improving the methods of uranium extraction, the plant developed and introduced into production a low-reactive technology, in which the intensity of the leaching process and its efficiency is provided not by sulfuric acid, as before, but by the oxygen of the air fed into the ore formation.

The advantage of this new technology is that in the process of extracting uranium, the total mineralization, the composition and content of chemical components in groundwater remain virtually unchanged. In addition, it allows not to carry out costly rehabilitation of the ore-bearing formation after mining.

2. The combine began to introduce into production a more environmentally friendly technology for bacterial leaching of gold from refractory sulfide ores, which will completely eliminate emissions of arsenic into the atmosphere.

3. Reconstruction and expansion of the Kyzylkum phosphate complex was carried out with the aim of introducing a new technology of wet concentration of products and separation of aggressive chlorine, which led to a significant reduction in the impact of phosphate production on the environment.

4. The plant has developed and introduced a new, economical method for the disposal of radioactive waste. The bottom line is that for the disposal of radioactive waste from the plant's past activities, inert wastes from the HMP for the processing of gold ores are used.

5. The reconstruction and technical re-equipment of the sulfuric acid production of the Northern Mine Administration, the gas cleaning system of the Zarafshan HMP-2 is being carried out.

Technological environmental measures conducted at NMMC have positive tendencies to improve the environmental situation, and the main ones are:

- the transition from uranium mining by traditional mountain methods to underground minireagent leaching;
- rehabilitation of landfills for radioactive waste;
- introduction of a cyclical and continuous technology of transportation of the mining mass from the quarry to the surface at the mine Muruntau;
- processing of the magnetic fraction generated in the process of redistribution of gold ore at HMP-2;
- creation of circulating water supply systems; reclamation of mining sites;
- the use of bacterial sulfide oxidation technology for sulfide ore processing at HMP-3 and others.

The accumulated experience deserves approval and study with the aim of introducing it in other branches of industrial production not only in the region, but also in the republic.

Navoiazot OJSC. Navoiazot OJSC has 800 recorded emission sources, of which 771 are organized and 29 are unorganized.

The main sources of fugitive emissions to the atmosphere are equipment installed in open areas and shelves; sludge collectors and averagers; bitumen welders and welding units.

In total, harmful substances emitted into the atmosphere from the workshops and production facilities of the enterprise are 43 types. Of these, ammonia, nitrous oxide and dioxide, carbon monoxide, ammonium nitrate, etc. are the most influential and hazardous to public health and the environment. The company has developed an action program for the protection of the environment for the coming years, the implementation of which will lead to a reduction in various harmful emissions.

Navoi Thermal Power Plant (NTPP). Sources of harmful emissions at Navoi Thermal Power Station are 6 chimneys. The project does not envisage the cleaning of flue gases.

Kyzylkumcement JSC. There are 156 emission sources in Kyzylkumcement, of which 82 are organized and 77 are equipped.

The total number of treatment plants is 99 pieces, the gas cleaned is 5,438.2 thousand m^3/hour. Due to the implementation of measures, a reduction in emissions of 30 tons was achieved. Reduction of emissions is associated with the improvement of humidification systems in the mining industry, the Milling workshop, raw materials and charging shops, an increase in the evaporative capacity of the humidification columns in the Aspiration workshop, current and major repairs of the aspiration equipment, and reconstruction of cement silos.

General recommendations:

1. As a result of a large-scale technological revolution, the transition to industrialization, the use of progressive methods of obtaining products and improving their quality, the load on the biosphere increases adequately. Therefore, when planning environmental protection measures, it is necessary to conduct purposeful work to reduce the level of environmental pollution by harmful substances.

2. Reducing the load on the sewage treatment facilities of Navoiazot OJSC sewage of the city of Navoi can reduce water consumption in the city.

3. Air pollution in the city is significantly affected by the place of accumulation and burial of domestic waste, therefore it is necessary to envisage the creation of a mini-plant in the region for processing domestic wastes not only of the city, but also of nearby settlements, which is economically and environmentally friendly.

4. In some densely populated areas of the region, sewage facilities do not have sewage treatment facilities, or do not work (Kyzyltepa, Nurota, Karmana and others), which leads to environmental pollution. It is necessary to organize the work of sewage treatment plants in these cities at the level of modern requirements.

5. In small towns, educational institutions, out-of-town children‘s camps, newly created joint ventures where central sewage is not available, it is expedient to install small treatment facilities.

All ongoing environmental activities in the Navoi region are intended to implement the Decree of the President of the Republic of Uzbekistan “Concept of environment protection development in the Republic of Uzbekistan till 2030”.

CHAPTER IV

Construction of the algorithm of the choice of the strategy of development of the integrated resource of the natural-industrial system

The analysis of the status of the aggregated resources of the Kyzylkum region enables us to make the fundamental conclusions as follows.

1. The region is a typical region with a resource economy, the social and economic development of which is determined by the residual reserves of basic deposits of gold, uranium and phosphate rock, as well as the possibility of diversifying the mining and processing industry by raw type.

2. The situation in the region is developing in such a way that after 2030 the social and economic situation in it can deteriorate significantly, which is associated with the development of reserves of the main gold and uranium deposits. The situation becomes more complicated by the fact that the structure-forming enterprise (NMMC):

- forms the main part of the regional and substantial part of the state budget;
- gives a significant part of foreign exchange earnings in the republic;
- occupies a decisive position in the labor market;
- is the main keeper of the social sphere.

Such a dominant position of NMMC in the regional economy means that a decrease in the output of mineral products will inevitably affect the social and economic situation not only of the region, but also of the republic as a whole. Therefore, the strategic goal of the regional and state industrial policy in this case is to prevent the degradation of the region.

3. The main direction to prevent the degradation of the region is diversification of production by type of raw materials with involvement in processing gold-bearing rock from overburden dumps, extraction of associated elements, development of silver deposits, small gold deposits, uranium-vanadium deposits in black shales, deposits of combustible shale as a source of metal-containing products, etc.

4. Achieving this goal requires the development of a strategy for the development of a region, aided by the state ownership of the base enterprise (NMMC). The strategy should include the following main tasks:

4.1. To ensure the extension of the life of the processing complexes through the involvement in the production of waste mining of gold and phosphate ores on the basis of incentive preferences in the form of tax incentives. Develop for this the relevant regulatory documents.

4.2. To ensure the development of new deposits, including deposits of unconventional mineral raw materials (uranium-vanadium, oil shale, etc.). Intensify geological exploration in this direction.

4.3. Create a system for the transformation of scientific knowledge into innovative technologies for the development of deposits with complex mining and geological conditions (for example, deposits of combustible shale), processing of mining waste, extraction of associated elements.

4.4. To prevent, through the implementation of a policy of rational deterrence, the growth of the population of cities with mono-production, in the first place, Zarafshan and Uchkuduk. Reduce the number of personnel of the base enterprise through the transfer of part of the functions to subcontracting and outsourcing organizations and attracting small and medium businesses to the development of new deposits.

4.1. Creating methods and means of compensating the influence of complicating factors on the development of the region

4.1.1. Development of economic methods for managing geo-resource potential of deposits

Opportunities to improve the economic performance of mining to expand the boundaries of development and reduce the condition of the mineral in the depths only due to technological measures are limited. For this purpose, it is advisable to use other areas, based, in particular, on the peculiarities of the formation of the cost of production and production development fund.

The peculiarity of the formation of the cost of production is based on existing regulatory documents, according to which all current expenses for the development of balance reserves of ore are included in its composition. This approach in deposits of complex structure results that overburden operations include not just work on the removal of waste rock, but also work on the associated extraction of substandard mineral. This mineral will be involved in processing at a certain stage of deposit development, but it is stored in warehouses with zero cost. Such a well-established use of substandard mineral accumulated in warehouses is a kind of mechanism for the redistribution of the cost of ore mining over time, which should be used when planning the development of the deposit.

Another manifestation of the formation of the cost of production is its relationship with the stripping ratio, which, in turn, depends not only on the volume of stripping work, but also on the number of recoverable balance reserves. Moreover, since these reserves are directly related to the condition for mineral resources, it is possible to adjust the stripping ratio and, consequently, the cost of ore mining, by changing them.

The production development fund maintains the production capacity of the mining and processing complex at a given level. With a lack of this fund, the company is unable to carry out the production program, so it must have a fully justified amount. Its formation depends on the tax policy of the state, and on the economic performance of the mining and processing complex.

A significant part of the cost of ore mining is the unit cost of stripping, characterized by overburden, which directly depends on the depth of the deposit and the amount of salable ore in its contours (Fig. 4.1). It is proposed to use these relationships to control the cost of production. The essence of such a proposal is that the increase in the cost of production as the depth of the deposit increases is offset by a decrease in the overburden ratio due to an increase in the quantity of commercial ore because of a decrease in the cut-off grade. The prerequisites for such compensation are a direct linear relationship between the cost of ore mining and stripping coefficient; inverse parabolic interrelation of the amount of commercial ore with cut-off grade; structural features of the deposit with a characteristic distribution of gold content in horizontal and vertical sections. In particular, studies have found that with a deposit depth of 200, 400 and 600 m to maintain the cost of production at ~

4.5-5.0 g/ton of cut-off grade from 2.0 g/ton, should be reduced, respectively, to 1.5 g/ton, 1.0 g/ton and 0.5 g/ton (Fig. 4.1, a). As a result, the stripping ratio will decrease from 1.8 to 0.5 m^3/t (Fig. 4.1, b).

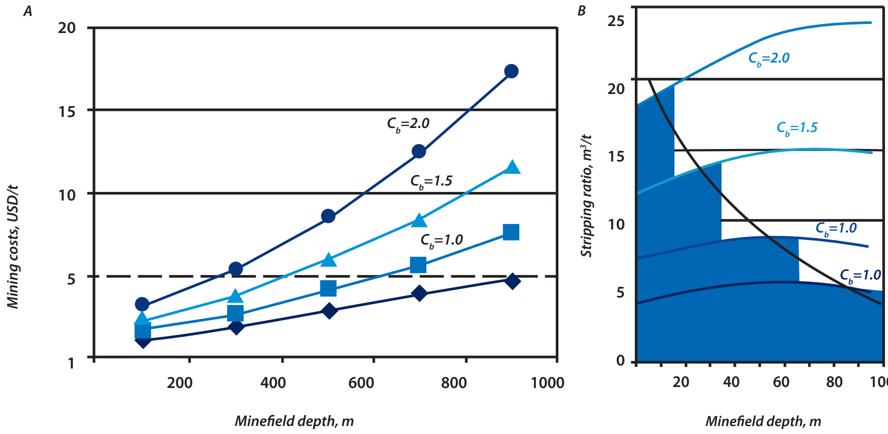

Fig. 4.1. Dependence of production costs and overburden ratio on the deposit depth. (– – – allowable cost)

With the open-cast mining of deposits of complex structure, the compensating effect in managing the cost of production is enhanced as follows. In the process of mining, off-balance ore is extracted from the subsoil, the amount of which increases as the boundaries of the deposit expand and become involved in the development of marginal deposits. Over time, the output of the deposit decreases, and compensation for this decrease occurs from off-balance ore from zero-value warehouses. As a result, there is a decrease in production costs for ore supplied for processing.

When this occurs, a kind of redistribution of mining costs between periods with favorable and unfavorable conditions for mining. The consequence of these actions is a cyclical decrease in the content in the processed ore. At the same time, a situation arises when ore mass is extracted from the subsoil in the form of overburden, the content of which is equal to or slightly lower than the content in off-balance ore shipped from the warehouse for processing. Consequently, it is advisable to convert such ore mass extracted from the deposit into the category of commercial ore, reducing the cut-off grade and, accordingly, increasing the balance reserves. The increase in ore reserves at different side contents is presented in fig. 4.2. Then compensation for growth in production costs will also occur by reducing the stripping factor. The presence of an inverse parabolic relationship between cut-off grade and ore reserves enhances the compensating effect. As a result, production costs will be reduced, development of the deposit will continue, and after a while the compensating cycle will be repeated, but with a decrease in the content in the ore mass involved in processing.

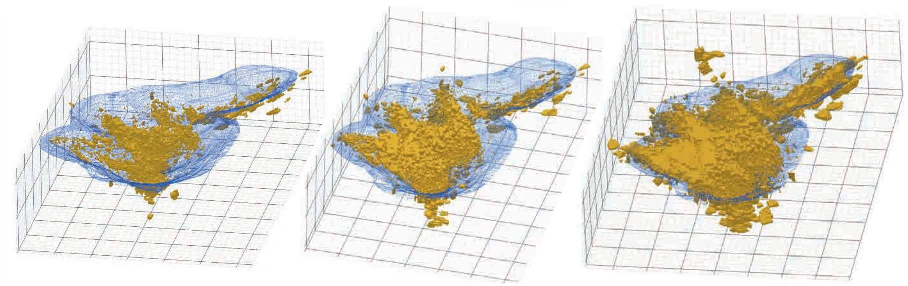

Fig. 4.2. Increase in ore reserves at different cut-off grade

The Fig. 4.3 shows the dependence of the change in ore reserves in the Muruntau deposit at different gold grade levels. Thus, with open-cast mining of steeply dipping deposits of complex structure, it is inevitable that off-balance ore is involved in processing, the content of which will naturally decrease as the depth of the deposit increases. At the same time, such involvement will occur cyclically according to the scheme "Determination of operating conditions for mineral resources – storing off-balance ore – decrease in deposit productivity – compensation for decline in off-balance ore productivity from warehouses – correction of mineral reserves – increase in reserves – decrease in stripping ratio – continuation of mine operation".

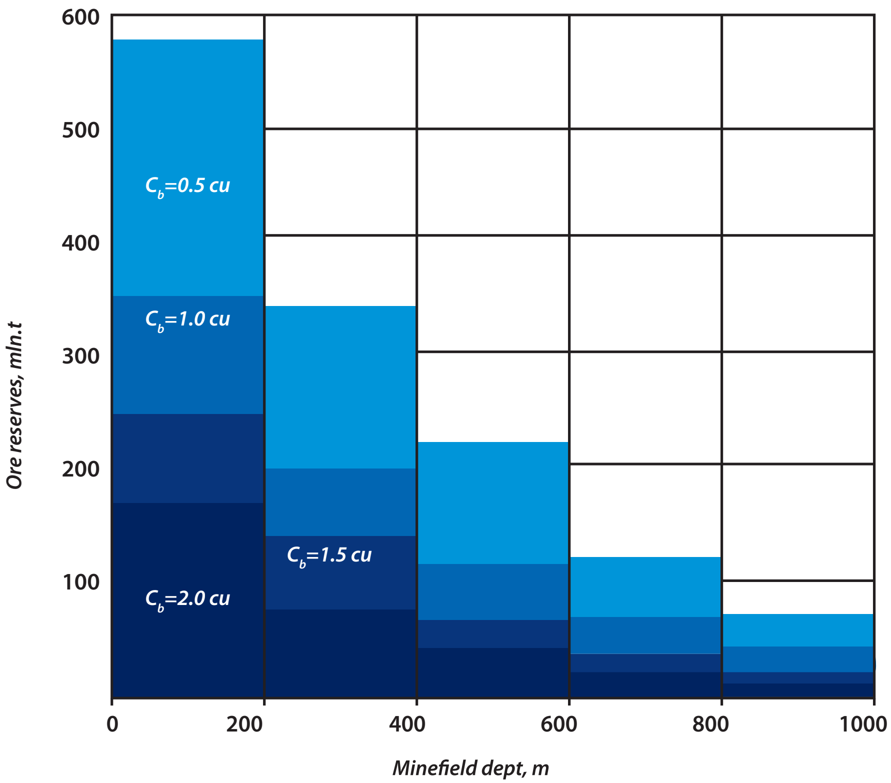

Fig. 4.3. The distribution of ore reserves in the depth of the Muruntau deposit

The share of income remaining at the disposal of the enterprise and being a fund for the development of production should be sufficient to maintain its capacity. This fund decreases as production costs increase due to an increase in the depth of the deposit. As a result, the moment will come when the company will not be able to maintain its production capacity and will cease to exist. Nevertheless, it can be kept at the required level with the help of another compensation tool - discounts from the fee for the use of subsoil. This tool is widely used in world practice to stimulate the development of mineral deposits in difficult mining and geological conditions or of reduced quality when the state purposefully reduces payments for the use of subsoil with the condition that due to this the company will increase the share of income allocated for production development.

In this case, the value of such discounts it is advisable to establish differentially, linking them with an increase in the cost of obtaining finished products as the content in the processed ore decreases. In this case, the discounts compensate for the effect of lower grades in the processed ore on the production development fund. The use of such a compensating instrument provides for the following procedure: establishing the dependence of production costs on getting finished products on the depth of the deposit for different cut-off grade; determination of the minimum size of the production development fund: development of a schedule of discounts on payments for the use of subsoil; adjustment of production costs schedule with reference to the depth of the deposit; using the resulting graph to determine the limiting characteristics of the mined ore (Fig. 4.4).

Naturally, after this, the question arises about the limits of the deposit, the answer to which can be obtained with great reservations. Nevertheless, the following option seems to be logically justified, which presupposes the maintenance of open-cast mining until the production costs for obtaining the product are equal to the income from its sale.

This situation is justified at the stage of completion of stocks in the last 8-10 years, when the cost of maintaining the capacity of the enterprise is practically not required. For this stage in the calculations, it is advisable to take a zero amount of payments for the use of subsoil.

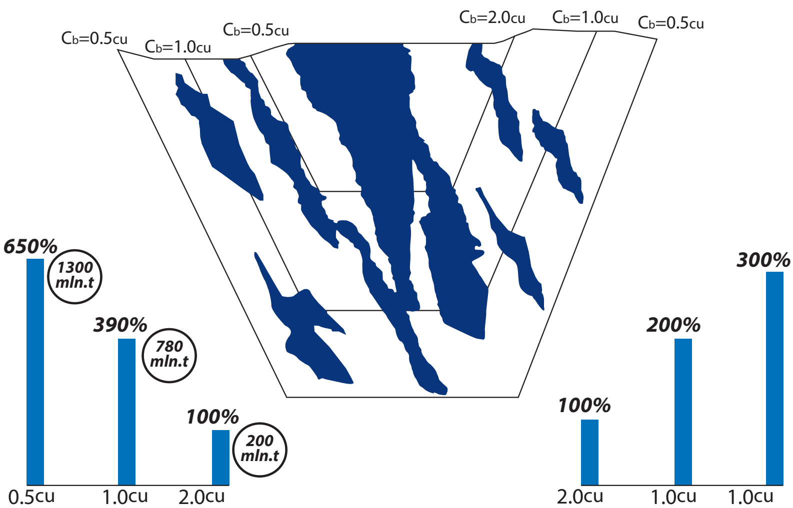

Fig. 4.4. Schematic boundaries of the deposit, ore and gold reserves at different side contents (tax rate 15%)

Then the use of a revised schedule of production costs (Fig. 4.5) allows you to determine the maximum cut-off grade in commercial ore at the last stage of the deposit (the interval of depths is 900 – 1000 m).

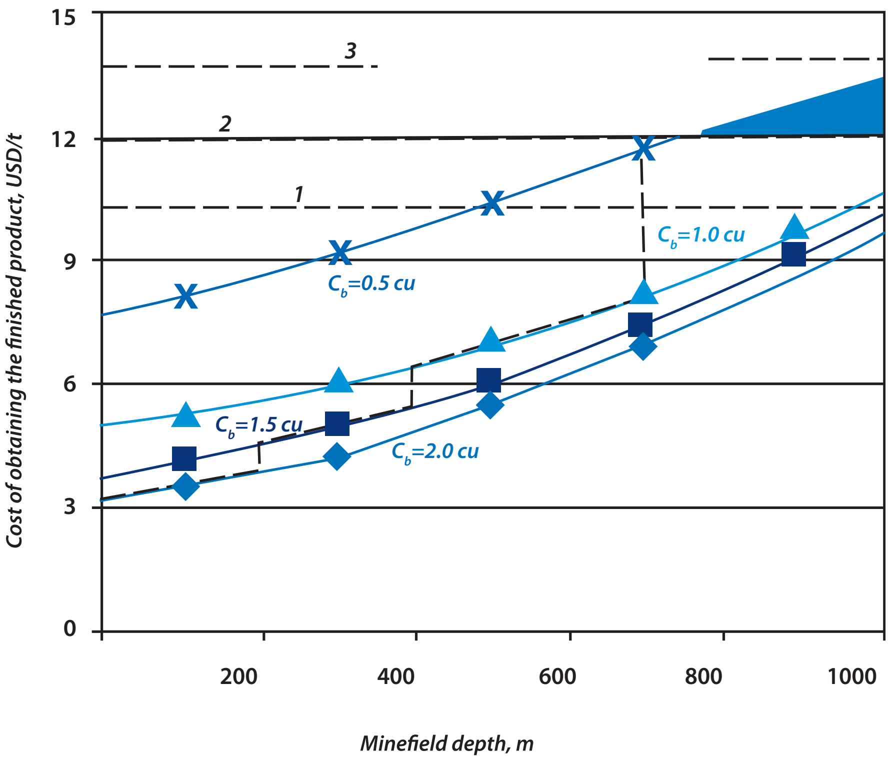

Fig. 4.5. The dependence of the cost of obtaining finished products from the depth of the quarry with different cut-off grade (– – – stages of transition from one content to others; 1, 2, 3 - marginal costs of obtaining finished products at the price of gold 310, 360 and 420 USD/oz.)

In particular, for the Muruntau deposit, it has been established that, at a gold price of USD 1,200/oz, this content is 0.5 g/ton, and the corresponding average grade in the mined ore is 1.4 g/tone. With such ore parameters, practically all (97%) ore mass extracted in the process of deposit development can be processed.

For the established maximum grade in the ore and a deposit depth of 1000 m, its boundaries are determined. In this case, the design parameters of the board are calculated taking into account the decrease in the stock of its stability with increasing depth of development. As a result, the volume of the rock mass in the deposit contour is 510 million m^3, the volume of ore with a cut-off grade of 1.0 g/ton – 560 million tons, and 0.5 g/ton – 1,070 mln. tons, which is by 2 and 2.5 times more, respectively, compared to the fourth stage deposit.

Thus, increasing the efficiency of using geo-resource potential by expanding the boundaries of open-cast mining and lowering the conditions for mineral resources in the subsoil suggests solving such issues as managing the cost of production and the production development fund.

A mining company, unlike other industrial complexes, is a natural-technological complex, the effectiveness of which depends on the choice of the main parameters of technological schemes and the correct direction of development of mining operations. A quarry, being an open pit mine, is developed over the time and space as the deposit‘s reserves are depleted. Its size and surface configuration change, the number of ledges increases, and the scheme of transport communications becomes more complicated, which characterizes a dynamically developing object.

Usually, in a newly developed field, mining operations are moved through the deposit in order to achieve maximum extraction of the minerals at the minimum cost of overburdening. With the transition to the next stages of development of the deposit, the main task of the calendar planning will be to ensure that during the stopping of mining operations at the previous stage, and the stripping and extraction of reserves in the next stage.

Today, most mining companies in the post-Soviet space are moving from the old mining planning system, which meant development of feasibility studies and subsequent design work by the industrial institute, to modern planning systems with using specialized software products. At the same time, the calendar plan of the old planning system had a number of unrecorded criteria that led to the risk of that the project indicators would not be achieved in the future.

Therefore, the main task in the transition to modern planning systems is to create a detailed and reliable block model of the deposit.

The calendar planning consists of stages of reviewing the long-term, medium-term, and short-term planning periods. The long-term calendar plan is a strategic calendar plan and defines the period of the entire life of the deposit.

Currently, the Muruntau mine is being depleted in the design contours of the IV stream and work has begun on stripping the reserves of the V stream. For the period of 2014-2016, the works on the study of perspective development of Muruntau deposit by reducing cut-off grade and involvement of reserves below the design limits of the IV stream of the mine, while pit depth of the V stream is 1,000 meters.

The transport scheme of the current state of the mine forms a link between the cargo flows of the bottom of the PPK, DPP, warehouse, dump with the 5 capital trenches of internal laying.

The research carried out with aim to optimize the main processes in the design of the V steam quarry allowed us to determine the economic feasibility and technical feasibility of bringing its production capacity to 50 million tons per year. With this, inherent characters of deep career dictate and complicate the process variables, as the increasing transportation distance, increased attention to the sustainability of the wall of the blasting works, the choice is increased the angle of the working wall, enhance speed bating of technological areas, reducing the width of working platforms, multi-horizons, the system of averaging of ore. All these parameters should be considered taking into account the control parameters of the directive values, the safety of mining operations, in which the NPV will be the maximum. Also, economists put forward a priority in planning for the constancy of production costs and the immutability of production volumes. But the subsoil cannot be such. At the same time, it is required to take a factor in the calculations of the design capacity of ore production in order to ensure the number of grades of the extracted ore with subsequent charge and feed of the same quality and quantity of ore to the processing (Fig. 4.6, Table 4.1).

The existing level of organization of mining operations and the achieved rates of mine development within the IV stream were analyzed. Calculations and comparison of the parameters of the speed of excavation with the actual indicators for production and technological zones (PTZ) were carried out based on the method of A. I. Arsentyev.

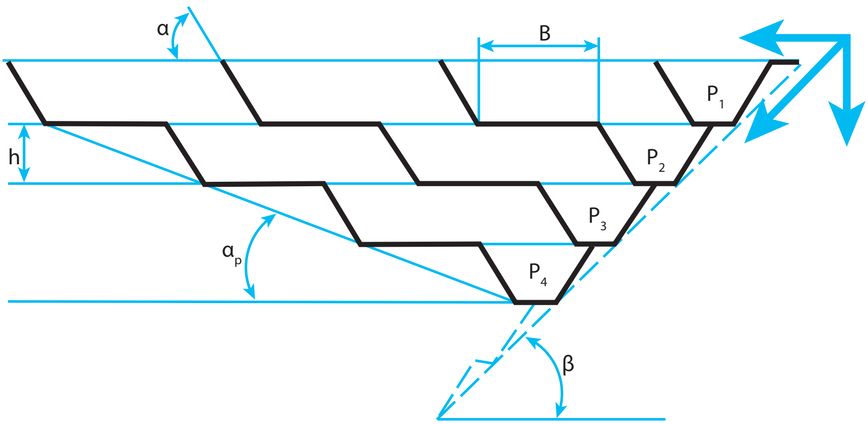

Fig. 4.6. Scheme of development of mining operations with a single-wall deep-hole development system

Table 4.1

Analysis of actual parameters of mining operations at the Muruntau mine

Name of indicators	Unit of measure	Designed	Actual in 2017					Actual in 2017				
			PTZ-1	PTZ-2	PTZ-3	PTZ-4	PTZ-6	PTZ-2	PTZ-3	PTZ-4	PTZ-5	PTZ-6
Width of a working platform	m	60	87	80	86	91	75	60	66	75	175	67
Work front stretch	m	900	200	940	830	870	1,300	740	1,250	1,190	560	1,600
Number of parallel blocks	Pcs	1	1	2	1	1	4	1	1	1	1	3
Angle of slope of the working side (working area)	degree	36	46	43	36	36	6	31	36	40	5	12
Rate of mine deepening per year	m	90	45	75	60	60	75	45	60	60	15	75
Maximum possible ore productivity of mine	million tons	50	0.9	6.7	3.6	0.6	10.2	3.2	5.5	1.2	0.9	20.2
			22					31				
Mine performance by rock mass	million m^3	75	0.7	4.0	3.0	3.2	25.1	1.9	3.9	4.2	2.0	38.0
			36					50				

The Fig. 4.7. shows the actual operation of the mining complex for the period of 2017 and 2018. With this, in 2017, the maximum speed of excavation was achieved for PTZ-2 due to a smaller work site, and for PTZ-6 due to a smaller work site and a large concentration of mining equipment. In 2018, the rate of excavation for PTZ-2 decreased due to the appearance of tight conditions and the completion of mining operations at this section in the 3rd quarter. The high parameters of the working wall angle are explained by the fact that the walls of this production and technological zone have reached the maximum design position. For PTZ-6, the angle of the working wall was 6 degrees in 2017 due to intensive stripping of reserves and front work at the lower levels, and as for PTZ-5, 5 degrees was achieved due to the fact that the end of 2018 it was started stripping operations at the design pit contour of V stream, the equipment of which comes from production on stage.

Drawing conclusions from the analysis, we can say that the rate of deepening has not yet reached the maximum values, namely, it is possible to increase the rate of deepening by maintaining the minimum width of the working site and increasing the angle of the working wall, which will ensure a lowering in mining operations by 90 - 120 m per year.

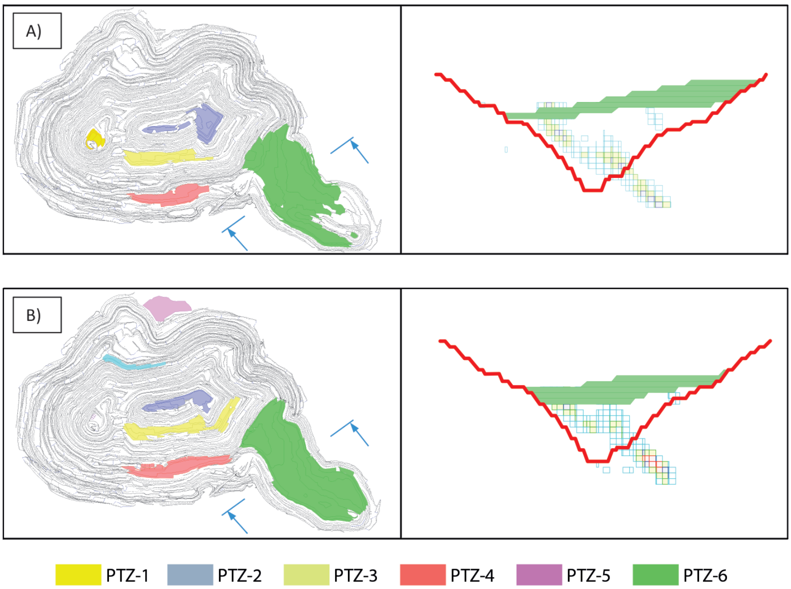

Fig. 4.7. Actual directions of mining operations in the Muruntau mine: A) in 2017; B) in 2018

Based on the optimization the mine shell built with the given initial data on economic and geo-technical conditions, the draft mine was made in the final contour, which provides a combined stripping scheme (Fig. 4.8). At the same time, the sloping trunks of the CFT-ore will be implemented in three stages with concentration horizons for receiving ore, at the horizons of +390 m, -90 m, and -210 m respectively. The first stage of construction is expected to be completed in 7 years. Therefore, until the completion of the penetrating of inclined shafts, mining operations must ensure the stripping of the concentration horizon +390 m for the subsequent penetrating of the shafts and installation of the CFT-ore. A properly planned network schedule for the construction of the CFT-ore complex must strictly comply with the calendar plan for development of mining operations of the mine. Late mining operations will lead to late start-up of the complex and, in some sense, loss of profit.

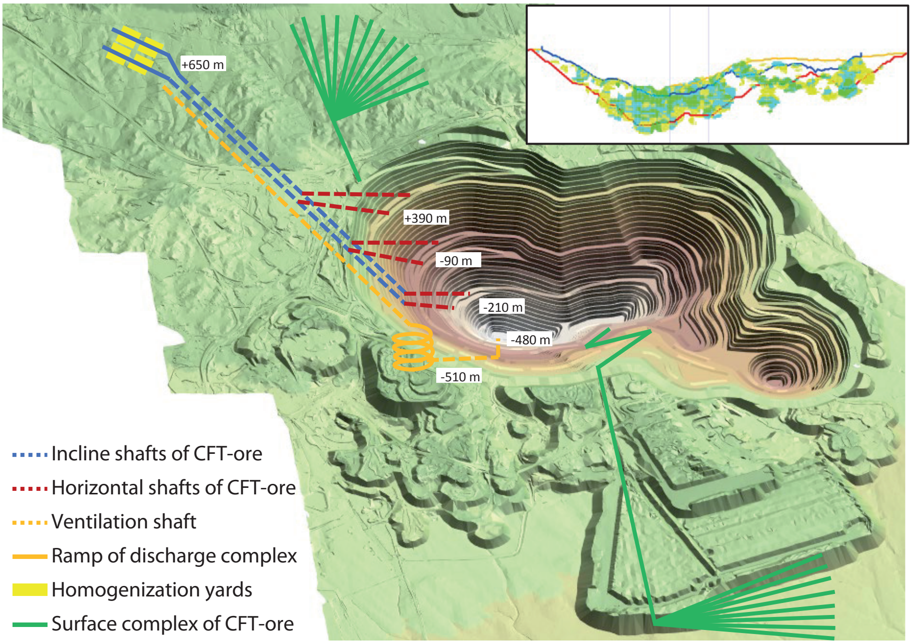

Fig. 4.8. Situational plan and design solutions for development of the Muruntau mine within the V stream

The efficiency of mining companies is determined by the correct choice of the direction of development of mining operations. The process of mining and extraction of enclosing and covering rocks is characterized by two main directions of development of mining operations: in depth, characterized by the direction of the deepening, and in the horizontal direction. To maintain the production capacity of the quarry at the proper level, intensive development of works in both directions is necessary. The rationally chosen direction of the work zone excavation allows you to minimize the cost of developing a mine.

The general theoretical basis of the work was the papers of leading scientists in the field of open pit mining, rational use of natural resources of the quarry field, determining the rational direction of mining development: E.F. Sheshko, M.I. Agashkov, N.V. Melnikov, V.V. Rzhevsky, K.N. Trubetsky, A.I. Arsentyev, Yu. I. Anistratov, S.D. Korobov, and others. But this scientific field was less covered in the automated software systems compared to the studies of foreign researchers: Demian Greggeri, Boleslav Tolvinsky, J.B. Taylor, H. Learch, I.F. Grossman.

With the use of specialized software, several options were worked out for the development of the quarry space with the specified target parameters of production, the stripping factor and recovery of the final finished product with the consolidation of the NPV indicator.

The development of a mine in the contours of the V stream is accompanied by stopping of mining operations in the contours of the IV stream. At the same time, the sequence of processing the V stream consists in timely stripping of reserves that provide the need for processing. Thus, due to the lower stripping rate on the North wall, the stripping of the North wall reserves is ensured at the initial stage, followed by the stripping of the South wall. At the same time, the stripping of the Eastern wall begins on 12^{th} year after the stripping of reserves, which are sufficient for rhythmically supply the processing complex with ore. This situation resolves positively the strategy two times by ensuring the operation of the High Angle Conveyor (HAC-270 located on the Eastern wall for a long time.

The development of mining operations in the South-East, which section is located on the Myutenbay deposit (PTZ-6) will takes 18 year for development of mining operations at the mine. This situation is explained by the fact that PTZ-6 has a large overburden factor in comparison with other production and technological zones.

The Fig. 4.9 shows the heavy decline in ore extraction in the contours of IV stream and the increase in productivity in contours of V stream, with achieving the design rates on 9th year of the operation in the contours of V stream only.

At the same time, the 3rd year of operation of the mine is the most responsible period, when the volumes of extracted ore in the V stream will be equal to the volumes of production in the IV stream. Implementation clear and detailed plans of mining operations require organizational units and activities.

Nevertheless, in 38 years, the mine will be depleted. However, taking into account market conditions, after the payback period, it will be necessary to consider the possibility of engaging of stockpiles in the development, which will be the sixth stage of development.

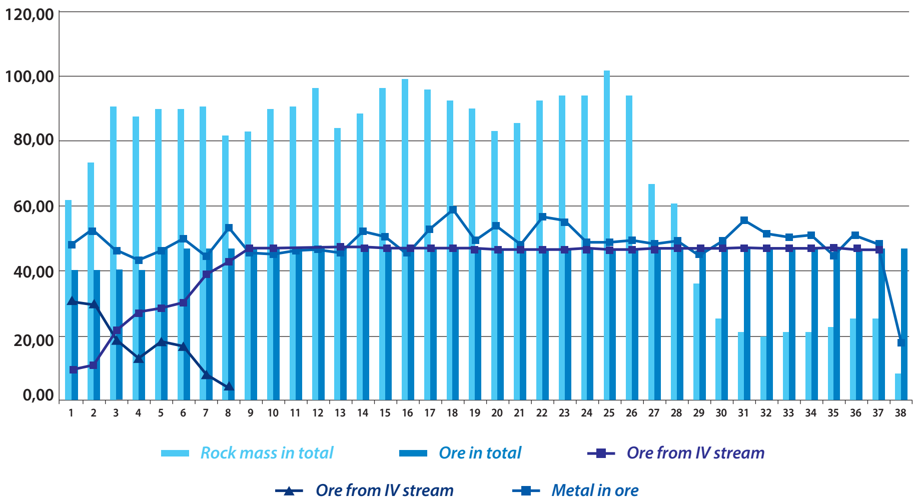

Fig. 4.9. Calendar schedule of mining operations with interfacing of mining operations in the contours of the IV and V streams

4.1.2. The state-investor system: Balancing interests and interaction mechanism for regional development

The transition of the economy to the market nature of the relationship has led to the emergence of a new actively operating entity - an investor, who potentially expresses readiness on certain conditions to take part in solving the tasks outlined by the state with their financial resources. Moreover, the investor and the state are interested in such cooperation, which leads to the formation of the "state-investor" system. The operation of this system during the development of subsoil has some peculiarities related to the limited mineral resources and a number of other natural, social and economic conditions of the deposits being explored. These features generate a difference in the interests of the participants in the system, and in order to find a balance between them, these interests must be treated with understanding. At the same time, the basis of this understanding lies in the nature of the origin of interests, the analysis of which during the development of the subsoil is advisable to start with a balance of mineral resources.

Compiling a balance of mineral resources is one of the unsolved problems of subsoil use. The current balances of such an appointment are mainly informative functions, whereas it is advisable for them to assign the functions of a regulatory document. To this end, in law, it is advisable to introduce the development of the state balance of reproduction and consumption of mineral resources into the practice of planning the social and economic development of individual regions and the country as a whole (Fig. 4.9).

Determining the use of mineral resources and the general interests of the state in subsoil use allows us to proceed to their specification and the formation of priorities in the development of deposits (Fig. 4.10), which is characterized by a unique compatibility of social and economic, climatic, political and market conditions. Therefore, depending on the complex of these conditions, the main objective function of the state in the development of subsoil resources should be specified with the definition of an individual objective function applicable to a given deposit and region.

Thus, for example, the most attractive investment attractiveness will have priorities associated with maximizing tax revenues and increasing export potential, and the least - with a reduction in social and economic tensions and man-made pressures on the environment. At the same time, the state has a fairly wide range of investments to choose from, which may have a different nature of origin: state, foreign and domestic private, personal and socially-oriented capital. However, it should be noted that not only the identified priorities affect the choice of investment policy, but also the nature of investments affects the efficiency of using the resource potential of the deposits, which is associated with different levels of minimum acceptable efficiency of using investment resources.

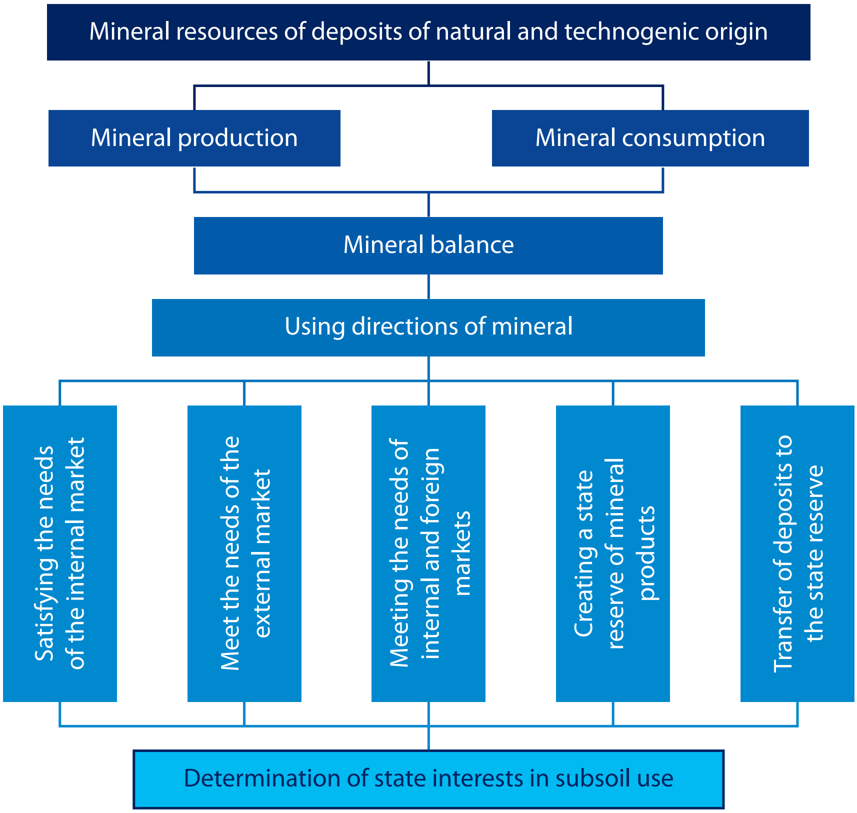

Fig. 4.10. Diagram of ways to use the mineral resources of deposits

Thus, the formation of state interests in subsoil use allows us to determine the directions of use of mineral resources and priorities in the development of deposits, most relevant to specific requirements, business models, problems and opportunities for the development of a particular deposit. However, this solution is one-sided, since it does not take into account the interests of another participant in the state-investor system, namely the interests of the investor, whose contribution to the development of deposits can be both financial and intellectual resources (Fig. 4.11).

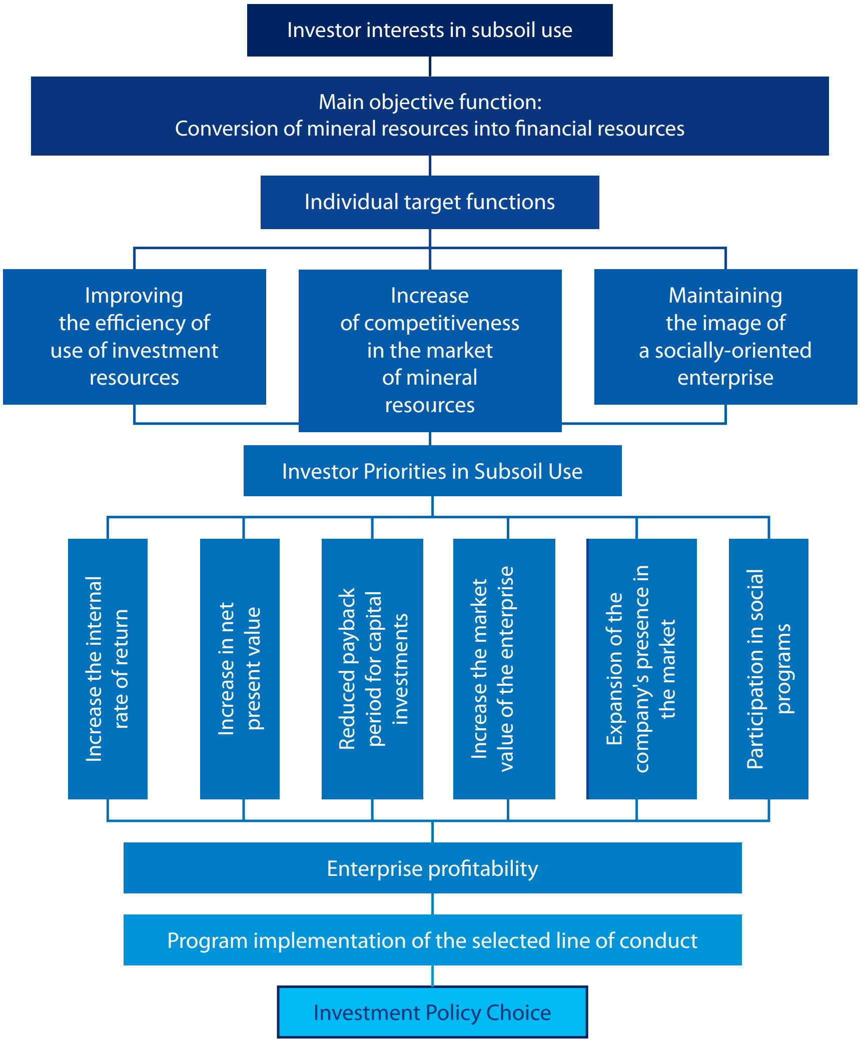

Fig. 4.11. Scheme of formation of state interests and priorities in the subsoil use

The interests of the investor in subsoil use include a much smaller number of issues than the interests of the state. This is due to the fact that the main objective function of the investor is only an integral part of the main objective function of the state and is formulated as “Converting mineral resources into financial resources” (Fig. 4.10).

The main objective function of an investor may include several individual objective functions reflecting his interests in a particular case. Moreover, each such individual objective function corresponds to the investor’s well-defined priorities in the development of deposits:

- more efficient use of investment resources → an increase in the internal rate of return and net present value while reducing the payback period for capital investments;
- improving competitiveness in the market of mineral resources → increasing the market value (capitalization) of an enterprise and expanding its presence in the market of mineral resources;
- maintaining the image of a socially-oriented enterprise → participation in social programs of the region.

In any case, the investor is not a sponsor, so all his interests, with some variations, will inevitably be aimed at ensuring the profitability of the enterprise he needs. Any investor will always adhere to such a line of conduct, which even with obvious at first glance non-productive expenses, in particular, social orientation, will ultimately have a positive impact on the profitability of the enterprise. Naturally, the implementation of such a line of conduct will require the development of an appropriate investment policy, which would determine the conditions for attracting investment in the development of a particular field.

The considered scheme of formation of interests of the investor in the subsoil use allows to conclude that regardless of specific requirements, business models, problems and development opportunities of a particular field, the investor will adhere to the main priority - to ensure the required profitability of the enterprise with the implementation of the main objective function of mineral conversion. raw material resources for financial purposes.

Comparison of the formation of interests of the state and the investor in the subsoil use suggests that:

- the interests of the state and the investor coincide in the economic efficiency area of development of the subsoil, but for the investor such a coincidence of interests is limited to the minimum acceptable level of efficiency in the use of investment resources;

- the interests of the state and the investor do not coincide in the area of full utilization of the resource potential of the deposits, solving social and economic and environmental problems, because they reduce the efficiency of the use of investment resources, but allow the state to realize priority directions in the development of subsoil resources;

- the investor, due to the nature of his origin, cannot allow a decrease in the efficiency of the use of his investment resources; therefore, his ability to maneuver his interests is limited by the minimum acceptable level of profitability from the development of the subsoil;

- the state has more room to maneuver its own interests, since in its activities it may allow the deterioration of the financial result in favor of another positive effect from the development of the subsoil;

- compromise solutions between the interests of the state and the investor should be sought across the entire spectrum of state interests, while ensuring an indispensable condition for attracting investment in the development of deposits - the minimum acceptable level of efficiency in the use of investment resources (Fig. 4.12).

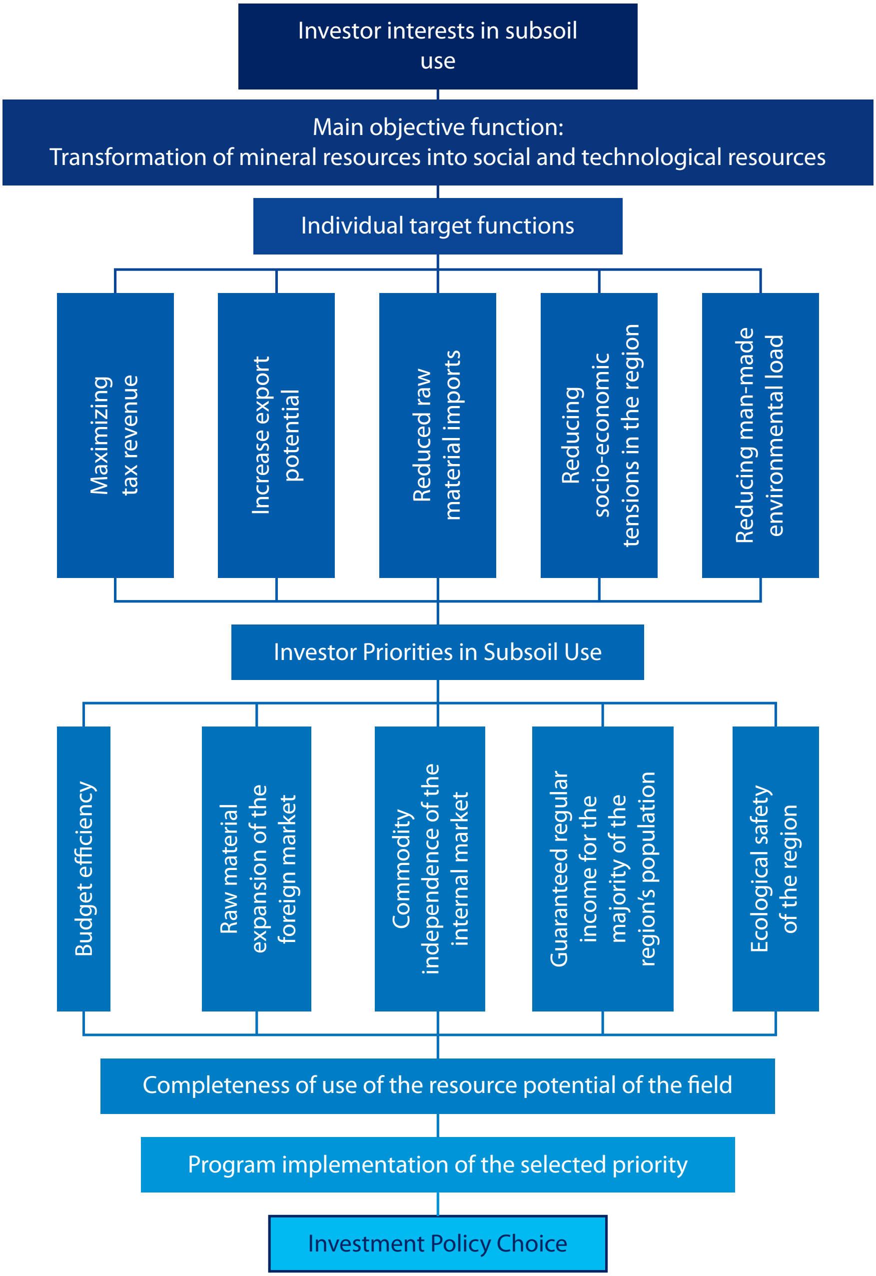

Fig. 4.12. The scheme of formation of interests and priorities of the investor in the subsoil use

Thus, the main issue in building relationships in the "state-investor" system is the search for compromise solutions, which make sure that each participant will receive in due time and within the stipulated volume:

- state – taxes and confidence in the rational use of the resource potential of deposits;
- investor – profit, determining independently where, when and how much to extract mineral.

As an example of finding a compromise solution between the state and the investor, the materials presented in, can be considered, which are based on the obtained functional dependencies of the initial parameters (ore reserves, average grade, capital investments and specific operating costs) and integral indicators (output of marketable products, net present value, budget efficiency and internal rate of return) from cut-off grade. In the search for compromise solutions, it is impossible not to take into account the fact that the mineral resource complex plays a decisive role in the economy of many states, which should protect it from poor-quality exploitation and other negative phenomena.

Consequently, the state needs to create such an economic and legal environment in which the investor is guaranteed non-interference of the state in its economic activity, and the state receives effective levers to protect its property - the resources of the subsoil. At the same time, the state should focus the investor on the implementation of its priority directions in the development of mineral resources, at the same time defining economic and legal regulation measures ensuring the investor's fulfillment of these priorities. In this case, measures of economic and legal regulation may include: encouraging investors to develop fields with a poor content of useful components in complex geological and natural-climatic conditions; penalties, suspension or termination of the license for the right of mining for violation of its conditions, etc.

4.1.3. Impact of the nature of investments on the full use of the resource potential of deposits

The impact of the nature of investments on the completeness of the use of the resource potential of the deposits is traced through a change in the mechanism of influence on decision-making in subsoil use, which is associated with the inclusion of a private investor in this area - an investor with private capital. At the same time, the investor's activity is estimated by practically the only criterion - the efficiency of capital investment, which should not fall below a certain level. It is a comparison with this level of actual or projected return on invested capital that allows an investor to decide on participation or waiver of investments. At the same time, the refusal of investments at the operating facility will lead to the termination of the development of the field, which may not coincide with the interests of the state and will require a search for a compromise or other corrective solution. It is from this point of view that the impact of the nature of investments on the full use of the resource potential of deposits is considered.

By nature, investments can be divided into public, private and mixed. At the same time, regardless of the nature of the origin of the investment, the income from the sale of the mineral product is conventionally divided into four parts: production costs, reflecting the consumption of financial resources for the mineral product; profit, representing the difference between the market price of the mineral product and production costs for its receipt; tax payments, which are part of the profits allocated to replenish the state budget; development fund, representing a portion of the profits directed to the renewal of fixed assets.

In practice, the mechanism of income distribution is much more complicated, since it includes many elements that depend and are independent of the conditions of localization of the deposit, the characteristics of the mineral, technical and economic indicators of subsurface development, government priorities, etc. However, the considered simplified scheme of income distribution without excessive quantitative detailing allows us more clearly present the essence of the influence of the nature of the origin of investments on the full use of subsoil resources.

At the same time, the fundamental difference between investments of different nature of origin lies in the fact that the part of profit remaining after tax payments is used at the discretion of the state only (the first option), transformed into dividends that are sent only to the investor (the second option) or are shared between the state and the investor (third option). Comparison of these three options for the distribution of profits and allows assessing the impact of the nature of the origin of the investment on the full use of the resource potential of the deposits, which is illustrated in a simplified form (Fig. 4.9. This figure schematically shows the growth of the market price of mineral products and the increase in production costs over time due to the deterioration of the conditions of development of the field, as well as the amount of tax payments and profits remaining at the disposal of investors (dividends). The difference between the intensity of growth in the price of products and the increase in production costs causes a natural decrease in profits, and, consequently, the income of investors from invested capital. It is in this natural reduction of investors‘ incomes that the essence of the influence of the nature of investments on the full use of the resource potential of deposits lies.

With the implementation of the first option with public investment (Fig. 4.13, a, the development of the field could theoretically be terminated if the market price of products and production costs are equal (point 1. The reserves, which can be extracted from the depths, will be taken as 100%. However, in practice, tax payments lead to a shift in the equality of price and costs to point 2, and the allocation of funds from profits to the development fund – to point 3. As a result, the area of price ratios between points 3 becomes the area of unprofitable work of the enterprise, and recoverable reserves are reduced to 70%. In this case, to correct the situation, the company refuses to update production assets and continues to develop the field, producing a residual resource of equipment. Then the zone of unprofitable price ratios will decrease to the interval between points 2-1. However, the investor-state, in accordance with its priorities, may partially or fully support the development fund by reducing tax payments.

As a result, the variation in the period of development of the residual resource of equipment and the size of tax payments, the state can theoretically combine points 3 and 2 with point 1, thereby ensuring the extraction of 100% of reserves. This zone between points 3-1, in which government support is required to continue the activities of a mining enterprise, we will call it the "Zone of Preferences".

The main disadvantage of the first investment option is that the state must fully secure the investment of the object, and the main advantage - the income from the investments (Dividends-1) remains completely at the disposal of the state. At the same time, the state may reject all or part of dividends and tax payments, directing the released resources to the continued development of the field.

When implementing the second option with private investment (Fig. 4.13, b), the market economy mechanism comes into effect, according to which the investor expects to receive income from the investment. Unlike the public investment option, a private equity investor cannot even partially waive dividends. As a result, the zone of unprofitable price ratios will expand to point 4, corresponding to the minimum reasonable value of income from investments (points 4-5). At the same time, the actions of the investor in relation to the development fund will be similar to the actions of the investor with public investments, but the recoverable reserves are reduced to 60%, and the "Zone of Preferences" is expanding. Therefore, it will take more effort from the state to maintain its priorities compared to the first option.

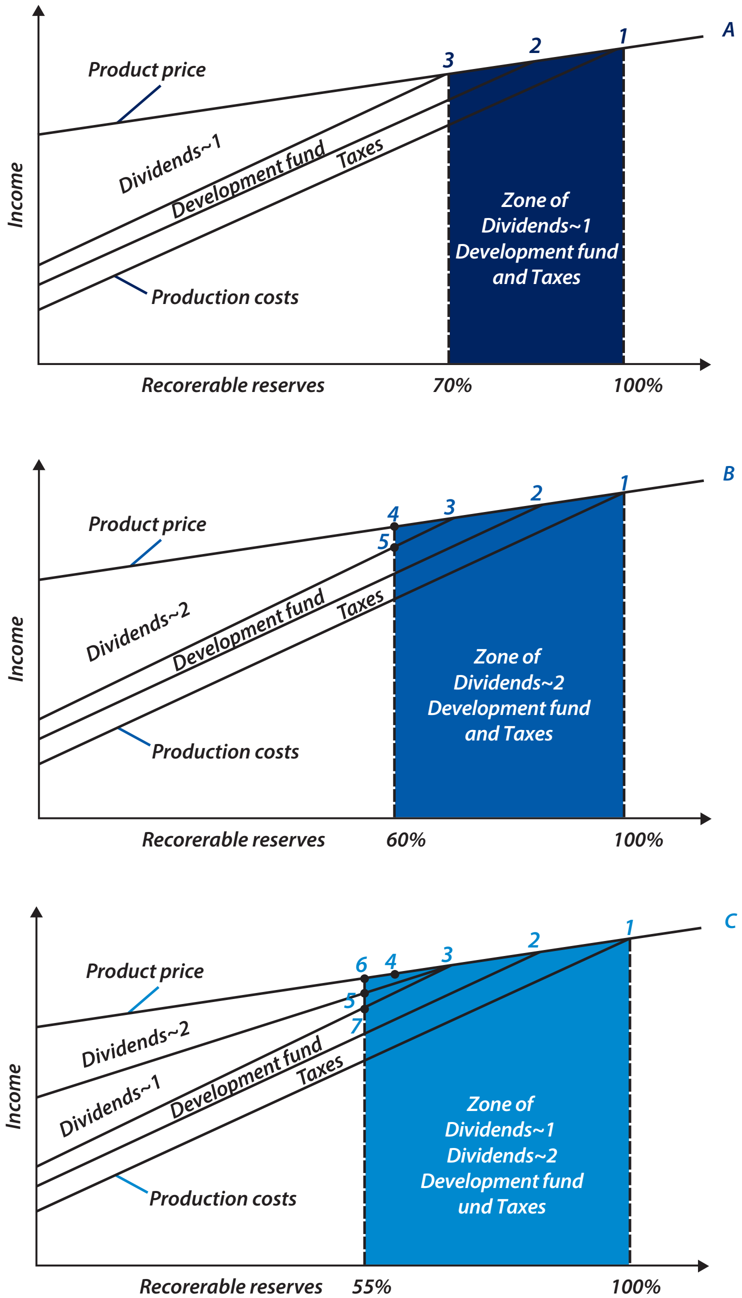

Fig. 4.13. Simplified income distribution schemes for public (a), private (b) and mixed (c) investments

The main disadvantage of the second investment option is that the state is not directly involved in the distribution of profits, which remains completely at the disposal of the investor with private capital (Dividends-2), and the main advantage is that the state does not invest in the object and can use them for other priority directions. At the same time, the state retains the right to withdraw part of the profits in the form of mining rent at a favorable stage of field development, as well as completely or partially refuse tax payments when development of the field goes to the final stage.

The third option with mixed investments (Fig. 4.13 c) is an option in which government investments are partially replaced by investments of a different nature of origin. This option is characterized by the advantages and disadvantages of options with public and private investments, and its main feature is the need to divide profits between investors into parts Dividends-2 and Dividends-1. Therefore, the moment when the income of the investor with private capital Dividends-2 decreases to the minimum acceptable level (points 6 - 5) comes earlier (point 6) compared with the second (point 4) and, especially, the first (point 3) option. As a result, recoverable reserves are still decreasing (to 55%), and the "Zone of Preferences" is expanding further, which will require the state to increase its efforts compared to not only the first option, but also the second option.

Thus, the full or partial replacement of public investment with investments of a different nature of origin inevitably entails a decrease in recoverable reserves, the compensation of which requires government intervention with granting preferences to a private investor based on a search for a compromise solution. The adoption of such decisions is significantly influenced by the fact that based on large deposits social-industrial complexes are formed, covering, depending on the scale of the object, from several dozen people to the population of entire regions. Such complexes have the opposite effect on decisions, stimulating the state to make efforts to maintain the natural-industrial system in balance. In particular, the state, instead of a decision to halt the development of the field, may decide to continue it, taking as a priority the preservation of a sustainable social and economic situation in the region. From such reasoning, it can be concluded that the basic function of states in the development of the mineral resource complex is the creation of favorable conditions for investment activity, direct participation in investments and indirect impact through the disclosure of the prospects for the mineral products market.

The Fig. 4.14 shows schematically the actions of the state directly involved in the development of the field with its capital after the ratio of the price of products and production costs reaches a value that does not provide the minimum acceptable income to an investor with private capital (point A).

After reaching point „A“, the development of the deposit can either be stopped or continued, but on condition that:

- application of preferences from the state in favor of a private investor;
- transition from mixed investments to public investments using preferences in favor of the state enterprise.

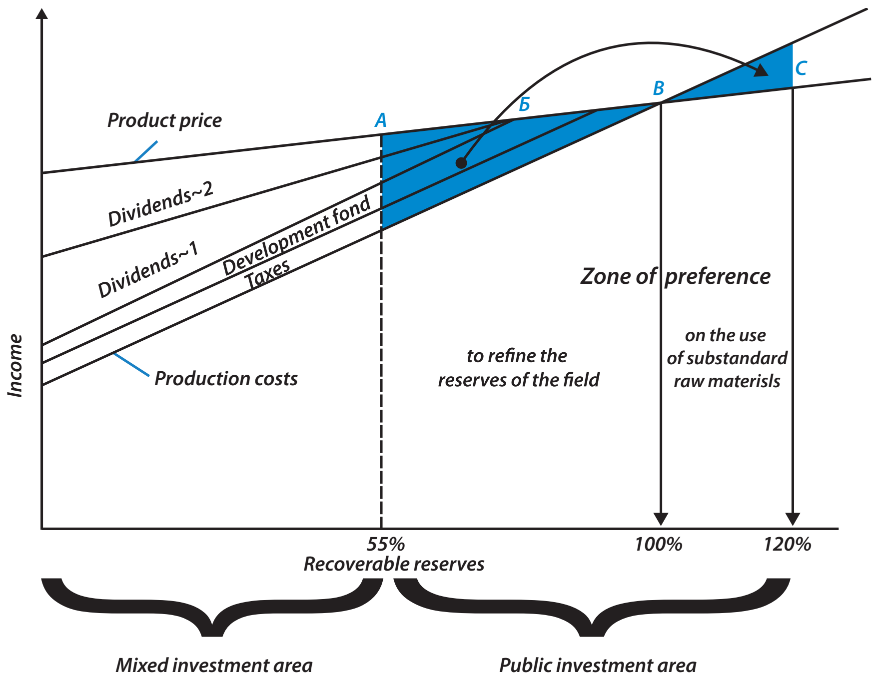

Fig. 4.14. Simplified income distribution scheme highlighting mixed and public investment areas

Both situations have the right to exist. But in the first case, the state should abandon its dividends, thus prolonging the participation of an investor with private capital in the development of the field and expanding its area of participation to point "B". Then the situation evolves according to scenario 2, described earlier. In the second case, the investor's participation in the development of the field ends at point "A", and the situation continues to evolve under option 1. At the same time, preferences in favor of the state-owned enterprise on the A-B-C site can allow not only to refine the field's reserves, but also funds for the involvement in the processing of waste mining (points B-C). Such a redistribution of funds will only increase the use of the resource potential of the field. However, in a particular case, the adoption of a decision depends on the priorities of the state.

Thus, the combination of direct participation of state capital in investments with the creation of favorable conditions for investment activities through preferences in favor of the state enterprise ensures the fullest development of the resource potential of the deposits.

As an example of the positive influence of preferences on the development of the subsoil in fig. 4.15 shows the graphs of the dependence of the recoverable ore reserves on the tax rate.

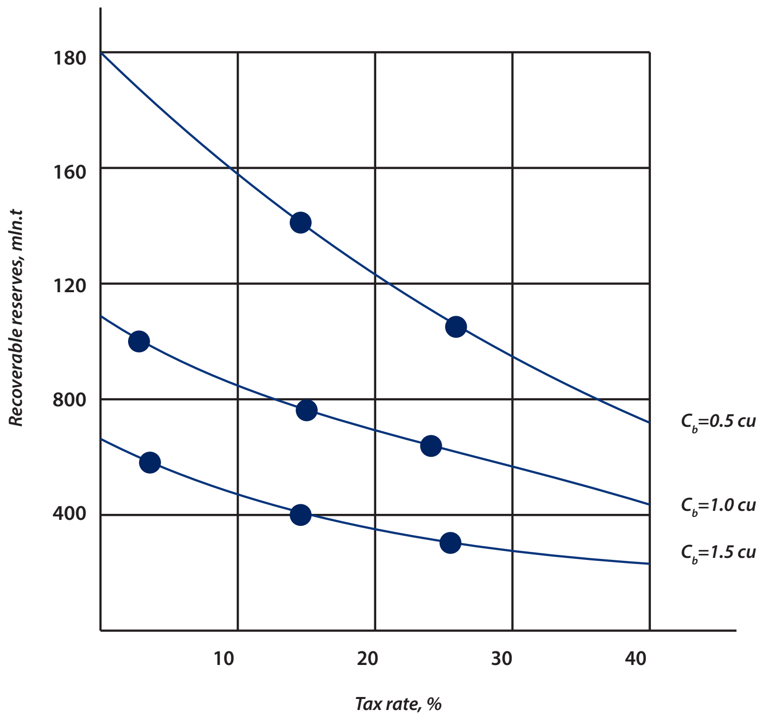

Fig. 4.15. Dependencies of recoverable ore reserves on the value of the tax rate at different cut-off grade

Analysis of the graphs obtained shows that the tax rate as an instrument of economic and legal regulation of the relations between the subsoil user and the state significantly affects the recoverable reserves and, accordingly, the terms of mining operations. Therefore, the practical application of this tool should be approached very carefully.

The indirect influence of the state on the development of the mineral-raw complex is manifested through prognostic functions, the tool of which is the development of intersectoral balances of production and consumption of mineral products (Fig. 4.16), which allows to determine the direction of investment activity in the subsoil use. However, it should be noted that the result that corresponds to state interests would be achieved only if the intersectoral balance is transformed from a statistical document into a regulatory document, the status of which will be fixed by law. At the same time, in the field of investments, the main task of the inter-sectoral balance is the awakening of the interest of potential investors to a specific area or object of subsoil use, and the main task of the state is to choose the nature of investments for them. The basis of this choice can serve as the status of the deposit (Fig. 4.17), determined by its importance to the economy (local, regional, strategic and special significance).

Deposits of local significance are being developed to meet local needs for mineral raw materials, which require minimal preparation for use. The beginning and termination of the development of such deposits occurs depending on the specific situation in the local market of mineral raw materials. Therefore, for their development it is advisable to attract only private investment, the reliability of which is not significant, and is determined by the viability of the investor. The state in this case is to monitor compliance with the license for the development of the field and regulatory acts in subsoil use.

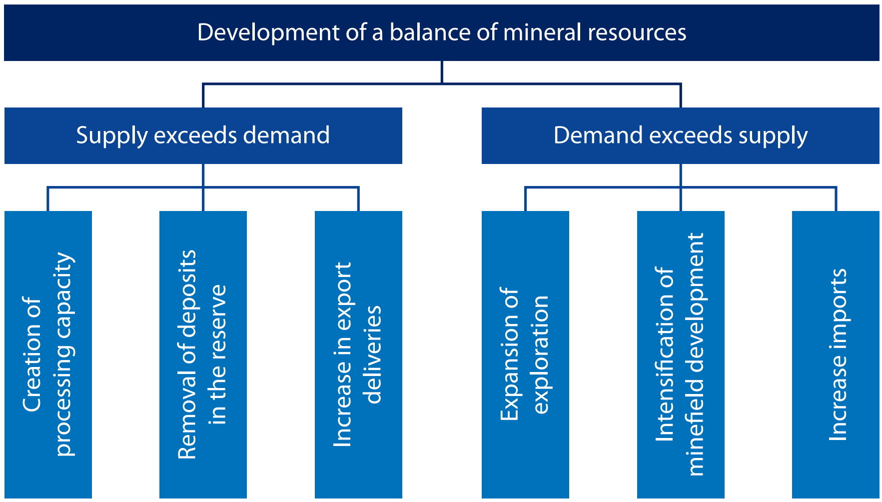

Fig. 4.16. Scheme for determining the areas of investment activity of the subsoil user

When developing deposits of regional significance, preference is given to private or mixed investments depending on the budget deficit at the regional level. The state in this case is to monitor compliance with the tax revenue regime, as well as the willingness to continue development of the field without an investor with private capital.

The deposits of strategic importance are being developed in accordance with state priorities, solving the tasks of the state program of social and economic development. In this case, preference should be given to state or, in extreme cases, mixed investments, which is determined by the budget deficit and the availability of credit resources. The state in this case remains to monitor the implementation of the production program in accordance with the identified priorities in the development of the field, as well as the willingness to continue the development of the deposit without an investor with private capital.

The deposits of special importance should include deposits, the mineral raw materials of which are not used on the territory of the state and can only be exported. The development of such deposits provides the state budget with additional foreign currency funds, and the choice of the nature of investments (mixed or private) is determined by the availability of budget funds. In this case, the state is left with control over the fulfillment of the export delivery regime, and it is advisable to develop the field on a contract basis without transferring the ownership of the extracted raw materials to the enterprise developing the field.

The considered method of choosing the nature of investments depending on the status of the deposit allows to mitigate the situation if compromises between investors and the non-owner (state) are violated, which leads to a drop in production, conflicts of social and economic nature, outflow of investments up to a change in the nature of their origin. There are enough examples of such a change in the nature of the origin of investments in the practice of subsoil use.

In particular, in the JV Zarafshan-Newmont (Uzbekistan) with investments of mixed ownership (50%/50%), created for heap leaching of gold from Muruntau deposit stocks, the established situation caused the private investor to leave the founders. As a result, the state investor was forced to continue the development of reserves on its own in the conditions of violation of the existing system of financing and material supply, as well as the departure of heap leaching specialists.

Thus, the analysis of the impact of the nature of investments on the efficiency of development of the resource potential of the fields allows us to draw the following conclusions.

1. Public investments have the greatest potential for the development of subsoil resources, the full or partial replacement of which by investments of a different nature of origin (private, mixed) inevitably entails a decrease in recoverable reserves. Compensation of such a reduction requires government intervention with the provision of preferences to a private investor based on the search for a compromise solution.

2. The reasonable choice of the nature of the investment, depending on the status of a field of local, regional, strategic or special significance, can mitigate the situation if compromise decisions between investors and the non-donor (state), on the basis of which the field is developed, are violated with possible production decline, social-economic conflicts character, outflow of investments up to the change of the nature of their origin.

The choice of the nature of investments depending on the status of the field, a partial or complete change of the nature of the origin of investments, as well as the definition of the area and preferential regime are the process of managing investment activities aimed at implementing state priorities in the development of deposits.

Deposit Status	Type of ownership	Special purpose	Conditions for attracting private investment	State Functions	Special conditions
Local meaning	Private	Satisfying local raw material needs	Investor's value	Monitoring compliance with regulatory requirements	Spontaneous nature of the activity
Regional meaning	Private or mixed	Social and economic development of the region	Budget deficit	Monitoring compliance with the agreed tax revenue regime	Willingness of the state to "take the baton"
Strategic importance	State or mixed	Implementation of the state development program	Lack of budget funds and the degree of availability of credit resources	Monitoring the implementation of the production program	
Special meaning	Mixed or private	Receipt of additional foreign currency	Lack of budget funds for the development of the field	Monitoring the implementation of export deliveries	The use of resources on a contract basis

RESOURCE DEVELOPMENT STRATEGY

Fig. 4.17. Scheme of the investment regime in the development of mineral resources

4.2. Methodology for development of strategies for the development of mineral resources

The currently existing economic-mathematical models allow describing the social and economic processes in the region with varying degrees of detail. In terms of the depth and scope of the forecast tasks, three types of such models can be distinguished (Table 4.2):

- models of indicative planning;
- models of forward planning;
- strategic forecasting models.

Table 4.2

Basic characteristics of building models of regional development

Model type	**Time depth modeling**	**Basis for building a model**	**Criterion for assessing the quality of the model**
Operational Planning Model	1 ÷ 3	Actual indicators taking into account the trend of changes in the implementation of project decisions	The degree of compliance with actual and planned indicators
Tactical planning model	from 3 ÷ 5	Developed projects with a forecast of the consequences of the decisions taken	Degree of compliance with planned and project indicators
Strategic Forecasting Model	10 ÷ 15 and more	Forecast of changes in the basic characteristics of the integral resource	Degree of compliance with design and forecast indicators

The strategic forecasting model has significant differences from the planning models, namely, that:

- the depth of forecasting is substantially greater than the depth of planning;
- relies on steady in the long period changes in the basic parameters of social and economic development, while planning is based on relatively clear characteristics of the design decisions;
- when forecasting, as a rule, time limits are limited to several control points (after 5÷10 years), while planning is important for detailed dynamics of indicators, therefore, these points are much more;

- some of the forecast conditions may be based on expert estimates and quite reliably formulated in terms of the type “better - worse”, “more - less” or “faster - slower”;

- the basis for building predictive models are the basic actual and design characteristics of the operational and tactical planning of the development of objects, which are complemented by the forecast of their changes, and the generality of time intervals (Fig. 4.18) determines the possibility of their simultaneous development and mutual adjustment of planned and forecast models.

Fig. 4.18. Diagram of total time intervals for planned and forecast models

The listed differences of strategic forecasts:

- show that the main substantive role in predictive modeling is played by expert assessments performed by a group of experts on industry, regional and functional areas, and the planning and design experts support these estimates by calculation;
- determine the basic requirements for the methodological toolkit of forecast calculations for regional development, which is based on information and institutional models of the regions.

The information model of the region is aimed at the systemic description of the information field providing the initial data for:

- estimates of the initial state of the region;
- identify sustainable changes in the topological structures of the region;
- development of regional development strategies;
- determine the main parameters of the development of the region.

The institutional model of the region is a modified model of the region's development, providing:

- assessment of priorities in regional social and economic policy;
- illustration of the influence of factors on the choice and feasibility of strategic decisions;
- justification of the conditions for achieving the desired parameters of the development of the region;
- the ability to control the implementation process of the developed strategy.

The main methodological result of the joint analysis of the informational and institutional models is the concept, which is basically based on a comparison of two characteristic boundary variants of the regional development strategy (Figure 4.19):

- a pessimistic option, when the influence of negative factors is not compensated by the developed solutions;
- an optimistic option, when the influence of negative factors is compensated for by the developed solutions.

Moreover, each strategy variant may contain several development scenarios for a region with different directions for the use of investment resources. In particular, such areas in the commodity regions include:

- traditional investments in the reconstruction and modernization of the production infrastructure;
- implementation of projects for the development of mineral resources;
- the development of high-tech production in the mineral industry.

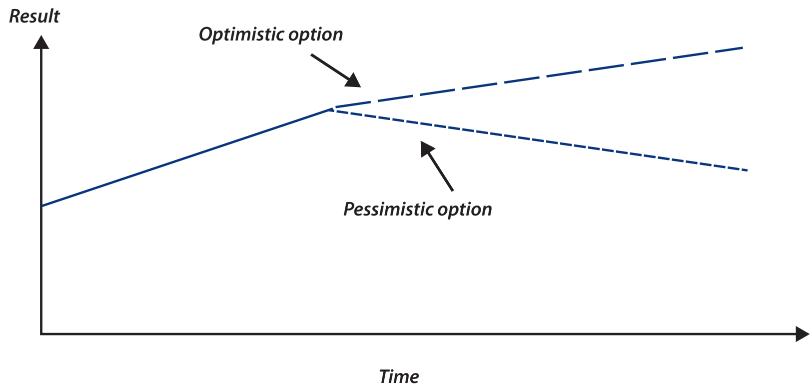

Fig. 4.19. Scheme of boundary options for strategic development of the region

The listed areas of investment activity are present in various combinations and proportions in all forecast scenarios for the development of a region.

The result of the development of boundary scenarios with different directions of investment activity are dynamic macroeconomic models that simulate the development of the region with the possibility of calculating the main parameters-indicators of its integral resource: production in physical and monetary terms, population employment, the need for investment, capital investment efficiency, and resource consumption.

The Fig. 4.20 shows three scenarios for the development of a “gold” complex based on the Muruntau deposit.

The pessimistic scenario provides for the termination of the development of resources of the deposit simultaneously with the end of mining in the deposit. At the same time, gold production will cease in 2030 - 2035 with a reduction in the number from 21 to 15 - 17 thousand people.

The optimistic scenario provides for the development of contour plot sections of the deposit by the open-cast and underground way, as well as the processing of heap leaching „tailings“ and overburden from dumps. In this case, the gold output will decrease to 25%, but the enterprise will work until 2060 - 2065 with a reduction in the number from 21 to 10 - 12 thousand people.

Naturally, an intermediate version of the scenario is also possible, involving the processing of only the “tailings” of the heap leaching after the end of mining in the deposit.

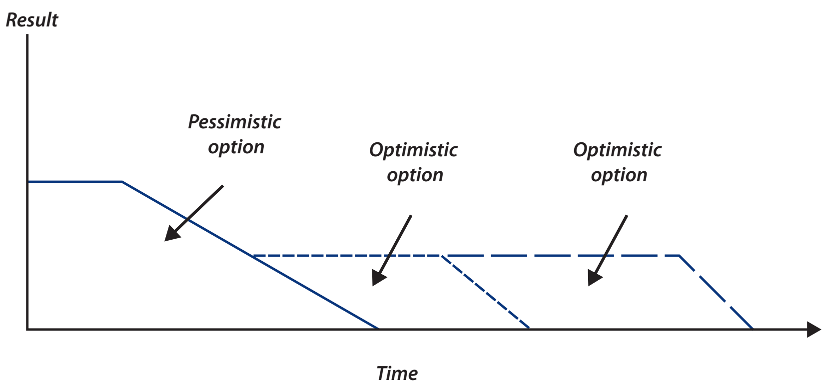

Fig. 4.20. Schemes of scenarios for the development of a “gold” complex based on the Muruntau deposit

Predictive model of regional development can be presented in mathematical, analytical or verbal form. In relation to the Kyzylkum region, it is advisable to present such a model in a combined analytical and verbal way, reflecting the essence of the main managerial and technological decisions with the calculation of basic indicators at the control points of the time scale. At the same time, the document should not be excessively large. This approach is determined by the following considerations.

Fundamental decisions on the social and economic development of the region should be prepared by the structure-forming industrial complex, passing an initial discussion with the approval of the leadership of the region and be approved by the leadership of the republic. This should be preceded by an understanding of the real state of affairs and awareness at all managerial levels of the need and the possibility of making decisions about the further development of the region, taking into account the interaction of various social and economic and political-economic interests. Such an understanding should take into account the action of the "redistributive conflict" and the market efficiency of economic activity. And if market efficiency does not require, the "redistributive conflict" requires additional explanations.

"Redistributive conflict" occurs in any economic system, since it is caused by a shortage of resources. Therefore, to resolve such a conflict between economic entities requires the intervention of the state through its authorities. However, regional authorities are not always aware that the problems they face are caused by the redistributive conflict that has arisen. At the same time, the top management in government bodies in its own way understands the ways of implementing the objective function before it, while in decision-making, as a rule, at first glance there is no objective logic and economic expediency. However, in fact, the objective logic in the actions of top management is still built, but indirectly. As a result, decisions made by top management are far from always based on the recommendations of experts, since it can focus on other priorities and the possibilities of their implementation. Therefore, when preparing a regional development strategy, excessive specification of indicators is not even desirable, since it requires the development of special software. In such a situation, it would be logical for the group of experts to prepare a report on the development strategy of the region, which, after the presentation and discussion of the top management, should make corrective decisions. In the course of such a presentation, redistributive conflicts will be resolved, since the main means of such a resolution is budget planning, during which resources are allocated in accordance with established priorities and through which objective logic is followed in the actions of top management.

Thus, for the Kyzylkum region, the structure-forming industrial complexes of which are state-owned enterprises, it is advisable to build a forecasting model of the region's strategic development in an analytical and verbal way, and to ensure priority directions in its social and economic development through budget planning in resource allocation. To this end, the model of the region's strategic development should go through a presentation and discussion with top management with the subsequent introduction of corrective decisions into it.

4.3. Development of small-scale and manmade gold deposits in the difficult environmental conditions of the central Kyzylkum

Analysis of the operation of the mining and processing complexes of the NMMC with an assessment of the potential of transport, water and energy and other resources shows the presence of incompletely realized opportunities for expanding the mineral resource base by engaging in the development of small-scale gold deposits. With appropriate development of efficient technological schemes of mining and equipment, in the future it is possible to partially compensate for the decrease in ore extraction at large deposits by choosing the most optimal options for wide involvement in commercial operation of small-scale deposits located in the zone of influence of large mining and processing complexes (Zarafshan, Uchkuduk, Zarmitan, Amantau, Navoi).

Traditional methods of designing and planning open mining, based on the consideration of each field as an independent mining and geological object, give such a significant distortion of the final result that often calculations show the inexpediency of developing small-scale deposits as such. In this regard, it is recommended that the organization of the processing of gold-bearing raw materials of small-scale deposits because of already existing large ore-processing complexes as base plants.

The degree of processing of mined ores can be determined because of the technological type of ore, the distance to the mining-processing complexes, the availability of transport communications, electricity, water, etc. At the same time, depending on the listed factors, both base ore and semi-finished products of various kinds - gold-laden sorbents, concentrate of gravity concentration, etc. - will be supplied to the base plant. Involvement in the development of small-scale deposits using simplified forms of organization of the pile and processing of gold-bearing raw materials at the base factories will allow receiving additional amount of gold, contributing to the replenishment of the gold reserves of Uzbekistan.

Let us consider in more detail the organization of the development of small-scale gold deposits on the example of the Zarafshan mining processing complex as a base plant (center). According to the existing classifications, objects with reserves of up to 10 tons of metal belong to small-scale deposits of primary gold. It should be noted here that a number of selected objects in terms of gold reserves could be attributed to the average, characterized by a gradation of metal reserves for ore deposits up to 50 tons, respectively. of the processing complex can be attributed deposits Besapantau, Triad, Aristantau, Balpantau, Tamdybulak, located within a radius of 1 to 70 km from the base plant HMP-2, man-made („tails recycling heap leaching and „stripping" Muruntau), as well as in the long term ore located behind the contour of the combined career „Muruntau- Myutenbay" and subject to the development of open-cast and underground. The systematization of small-scale gold deposits on the example of Zarafshan mining processing complex (MPC) as a base plant is presented in Table 4.3, the layout of small-scale deposits in the area of the HMP-2 plant is shown in the Fig. 4.21.

The basis of the new approach is the well-proven method of zoning the working space of Muruntau deposit into natural-technological zones. At the same time, each natural-technological zone of this object can be considered as an independent field by the volume of mining rock, the amount of recoverable metal and its reserves in the subsoil, the mining equipment used and the schemes for opening the working space, remoteness from each other and processing. The deposit is divided into natural-technological zones, and zones - into excavation blocks, carried out according to the general functional purpose: stripping operations, mining works with passing and main production, target works (carrying out opening workings, creating sites for intra-deposit stocks, etc.). At the same time, work in the zones and on the blocks is performed cyclically, stopping sequentially and resuming. Changing the priority and significance of natural-technological zones over time requires periodic adjustment of their development plans, and the presence of heterogeneous cargo flows requires coordinated mining operations. To solve these problems in Muruntau deposit, the method of continuous design and planning of mining operations is used. All small-scale and manmade deposits that are in their location and material composition of ores for processing at the large Zarafshan mining complex, are proposed to be considered as a kind of natural-technological zone of the Muruntau deposit. Work in natural-technological zones is carried out without the involvement of additional equipment and personnel. Released equipment and personnel are attracted from other, less priority at the moment, natural-technological zones.

Table 4.3

Systematization of small-scale gold deposits on the example of Zarafshan MPC as a base plant

Deposit	**Geological reserves of total ore, mln. tons**	**Oxidized ore**	**Free gold**	
		open-cast mining, ore, mt	**open-cast mining, ore, mt**	**underground mining, ore, mt**
Muruntau	490.1		393.5	96.6
Myutenbay	79.9		53.3	26.6
Besapantau	25.3		25.3	
Boylik	0.4		0.4	
Reserve fields				
Triada	5.6			5.6
Aristantau	3.7	3.7		
Balpantau	31.8		31.8	
Tamdybulak	1.5		1.5	

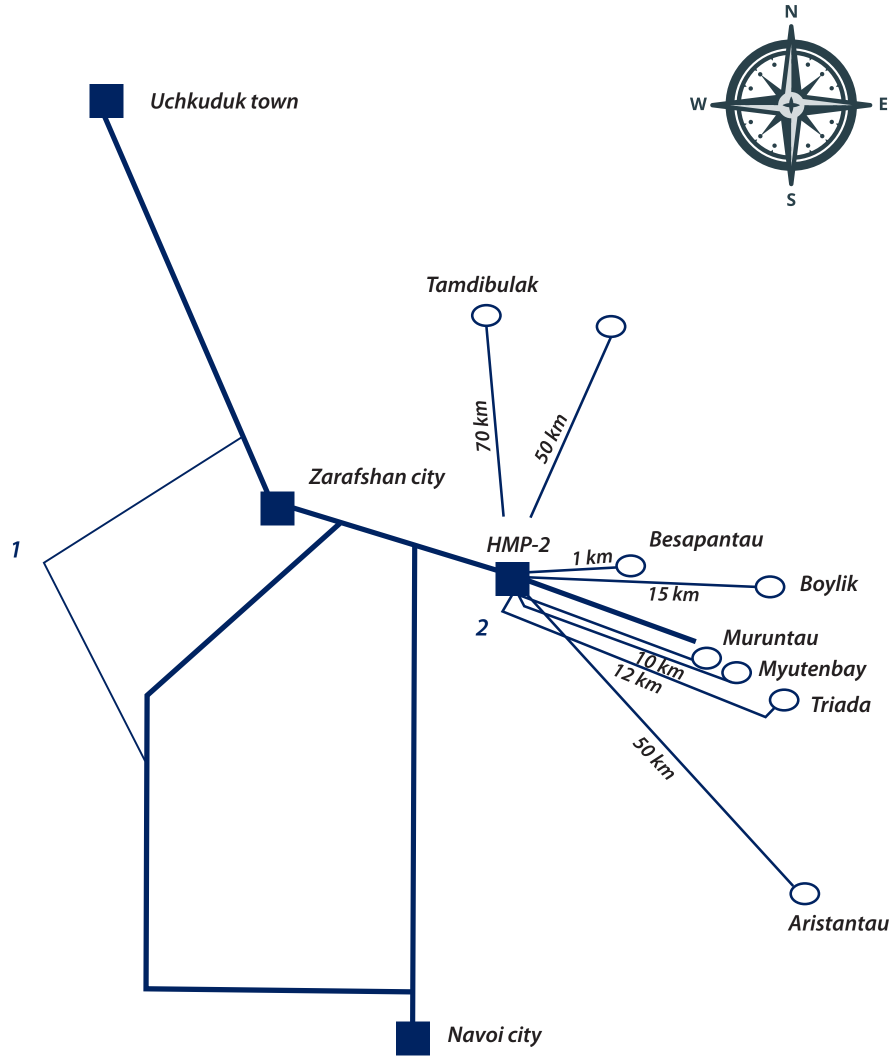

Fig. 4.21. The layout of small-scale deposits in the areaof the base plant HMP-2: 1 - existing transport lines; 2 - the base plant (center)

It is obvious that the moment of commissioning of a new small-scale or manmade deposit should be a balance between the technical and economic indicators of its development and those of the worst (at this point in time) natural-technological zone of the Muruntau deposit (basic version). At the same time, natural-technological zones (stages) of mining should be distinguished on the small-scale and manmade deposits accepted on the balance, as well as on the Muruntau open-cast mine. For the main criterion for the development of natural-technological zones, we will consider the maximization of gold production for the whole Zarafshan mining and processing complex.

Let us consider an example. To select the most rational natural-technological zone for the development of small-scale and manmade deposits, we determine the economic efficiency of several options for mining activities and types of transport in comparison with the baseline used in a career at this stage of development.

The technical and economic indicators of each subsequent option are influenced by the previous pattern of the direction of mining, and the effectiveness of the proposed options depends on the technical and economic indicators of the basic scheme at the time of the introduction of a new one. Variants of the direction of mining, proposed at the next stage of development of small-scale and man-made gold deposits, differ in the period of mining production and the time of their commissioning. Mining operations are carried out at different depths of deposits; therefore, at the moment of transition to each proposed option, the directions of work will be different technical and economic indicators. When the transition period changes, the costs of the proposed option of work direction also change, which affects the total costs of the field development for a certain period.

For example, with the base case (1), the annual cost of developing the rock mass increases continuously, which is the case when using motor vehicles. There are two variants of the opening (2, 3) that can be put into operation in t_1 and t_2 years. During the construction periods (t_1-t_2) and (t'_1-t_2) the costs for them consist of the costs of the base case and the costs of building a new one. After commissioning, the cost of options has decreased. Suppose that the construction costs of both options are the same, but earlier commissioning of the first proposed option has reduced operating costs compared with the second one in the period (t_1-t_2). If even the costs of the second option in the period (t_1-T_k) turn out to be less than the first (but in mining practice this does not occur because of their decrease), then, taking into account the time factor, they may not cover the effect obtained by the first option in the period (t_1-t_2).

When the effectiveness of these options for the reduced costs is compared, the second option may be better if it has a difference in the reduced costs compared with the base one. In this case, the effect obtained by the first variant in the period (t_1-t_2) will not be taken into account. However, when summing up the operating and capital costs over the years of operation and construction, this effect will be visible.

To evaluate the two proposed options, you need to take the time to consider them from the start of construction of the first (t'_1) to a year when all three options exhaust themselves (approximately 7-10 years after the second is commissioned).

Prior to the construction of the first option, the indicators of the proposed options are the same as the baseline, so these years should not be considered. The costs of the options are:

$$Z_6 = \sum_{t_1^1}^{T_k}(S_{6i} + K_{6i}) \tag{1}$$

$$Z_1 = \sum_{t_1^1}^{t_1}(S_{6i} + K_{6i}) + \sum_{t_1^1}^{t_1} K_{1i} + \sum_{t_1}^{T_k}(S_{1i} + K_{1i}) \tag{2}$$

$$Z_2 = \sum_{t_2^1}^{t_2}(S_{6i} + K_{6i}) + \sum_{t_2^1}^{t_2} K_{1i} + \sum_{t_2}^{T_k}(S_{2i} + K_{2i}) \tag{3}$$

where t_2^1, t_1 – are the years of the beginning and end of the creation of objects according to the first proposed variant of opening; t_2^1, t_1 – the years of the beginning and the end of the creation of objects according to the second proposed variant of opening; S_{6i},K_{6i} operational and capital costs in the base case in the 1st year; S_{1i}, K_{1i}, S_{2i}, K_{2i} – operational and capital costs during the operation of the first and second proposed opening options in the i-th year.

The proposed options must meet the conditions:

$$Z_1 < Z_6, Z_2 < Z_6 \tag{4}$$

The effectiveness of the first option compared with the second will be:

$$Э = Z_2 - Z_1 \tag{5}$$

By substituting all the values, we get:

$$Э = \sum_{t_1^1}^{T_k} Z_b + \left(\left(\sum_{t_2^{\prime}}^{t_2} K_{2i} - \sum_{t_1^{\prime}}^{t_1} K_{1i}\right) + \sum_{t_2}^{T_k}(Z_2 - Z_1) - \sum_{t_1}^{t_2} Z_{1i}\right) \tag{6}$$

The development of small-scale and manmade deposits in modern conditions is possible only with the provision of quick payback of capital investments at the lowest cost. For the Zarafshan mining and processing complex, as a base center, the development of small-scale deposits is proposed to be carried out according to a parallel-sequential scheme of mining the group of fields with natural-technological zones (Fig. 4.22), thus achieving the maximum profitability index at minimum discounted costs.

It is provided the cyclical involvement in the processing of mineral raw materials with consistently declining content and the use of additional production cycles for the selection of natural and manmade resources of the enriched part of the mineral. Thus, with a compact arrangement of small-scale and manmade deposits and a relatively uniform qualitative composition of ores, it is possible to use both joint and sequential development options. In the first case, ore mined simultaneously on several natural-technology zones of deposits is transported and processed at the base plant, in the second case, the deposits are alternately drawn into exploitation using modular mobile concentrating plants and transporting the concentrate to the base processing plant. The minimum payback period with minimum costs can be achieved by involving in the priority development of those fields for the development of which requires a smaller amount of mining and capital works. The desired result is achieved by the development of natural resource zones with the lowest overburden coefficient and the maximum content of the useful component with obtaining the highest recoverable value.

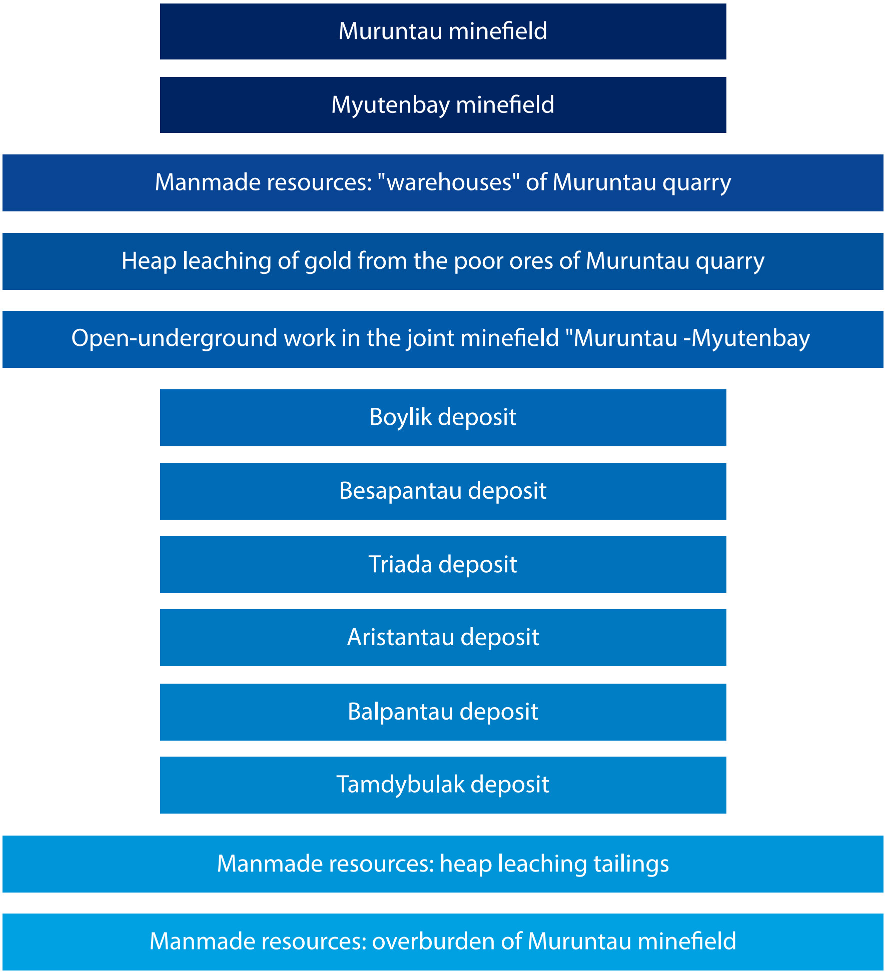

Fig. 4.22. Parallel-sequential scheme of mining a group of deposits on the example of the Zarafshan mining and processing complex as a base center

Let us consider the solution of the transport problem. On the territory, which is a base for the Zarafshan mining complex, the N^{th} number of explored small-scale deposits is located. The quality and content of the valuable component in the ore for different deposits is different with an average grade within $1 \div 10C_b$, the development of which is supposed to be carried out in an open way. It is planned to organize their work in such a way that it is possible to conduct the most efficient exploitation of deposits.

For this purpose, there are two main options for conducting work related to the extraction, transportation and processing of ore at the plant:

a) the mined ore from the deposit is fully delivered to the plant without preliminary processing on site, and depending on the average gold grade, ϱ_c will be consumed a UZS, and gold extraction will amount to β_c;

b) the mined ore is pre-processed in place by heap leaching, after which the processed concentrate is delivered to the plant, depending on the average gold content ϱ_k, α_k UZS will be spent, and gold extraction will be equal to β_k

The average gold grade in the ore ϱc and in the concentrate ϱk are among the main factors determining the efficient operation of the base plant. If the content of ore entering the plant is less than the established one, then the final product will become more expensive. Otherwise, it will be cheaper, which will lead to savings. According to the technological data, the following relationships should be observed:

$\beta_с > \beta_к$, $\alpha_с > \alpha_к$ и $\varrho_с > \varrho_k$

The transportation of the extracted ore mass is organized according to the above options as follows. For the first option (a), the sum of costs for transporting a ton of ore from the i-th small-scale deposit to the j-th hydrometallurgical plant will be C_{ij}^{c} . UZS In the second option (b), the sum of the costs of moving the enriched ore in the form of concentrate from the i-th deposit to the j-th plant will be equal to C_{ij}^{k}. UZS. Usually $C_{ij}^{k} \geq C_{ij}^{c}$, however, due to the fact that the concentrate by volume is much less than the amount of the original ore, the cost of transporting the concentrated product as a whole may be less, i.e. $C_{ij}^{k} < C_{ij}^{c}$. In addition to the cost of transporting the ore mass, there are costs associated with the process of enrichment of ore in place by heap leaching. These costs consist of two parts: e_i^T costs associated only with the technological process of heap leaching of ore, and e_i^n - costs associated with the loss of useful components during heap leaching. It was noted above that $\beta_с > \beta_к$, from here it is possible to determine the difference $\beta_n = \beta_с - \beta_к$. This difference represents the percentage loss of minerals in two ways of organizing work: the transportation of all ore and during its processing, as well as the transportation of concentrate with its further processing. If the metal content in the ore at the i-th deposit is ϱ_i, then after the enrichment, the metal content will be equal to $\varrho_i \times O_i$, where O_i is the enrichment factor of the ore, which sets the increase in the metal content during the enrichment. This coefficient is usually determined depending on the average $\varrho_к$ in the plant to which the concentrate is sent. For conversion to 1 ton of ore, the O_i indicator can be disregarded. Thus, if the market price of one gram of gold is equal to the value of θ UZS, then the amount associated with metal losses e_i^n will be equal to:

$$e_i^n = \theta \times \varrho_i \times \beta_n \qquad (7)$$

How many times the gold content in the concentrate will increase, the total amount of the concentrate relative to the ore being processed will decrease so many times. If NT ore is processed, the amount of concentrate obtained will be equal to N_T/O_{ti}.

To calculate the amount of costs per ton of ore associated with the enrichment and transportation of ore from the i-th deposit to the j-th plant, you can derive the formula in the following form:

$$C_{ij}^o = e_i^T + e_i^n + C_{ij}^k / O_i \qquad (8)$$

The cost of the entire process of processing tons of ore without prior enrichment will be equal:

$$d_{ij}^c = C_{ij}^c + \alpha \qquad (9)$$

The cost of the entire process with pre-processing is calculated by the formula:

$$d_{ij}^k = C_{ij}^k / O_i + e_i^T + e_i^n + \alpha_k (1+\beta_n)/O_i \qquad (10)$$

Now it is possible to solve the question of the expediency of applying the technological process according to options (a) or (b): if $d_{ij}^c < d_{ij}^k$, then it is advisable to apply the technological process (a); if $d_{ij}^c \geq d_{ij}^k$, then process (b). Using this criterion, you can evaluate each field and find the minimum cost of transporting ore or concentrate C_{ij}, which constitute the elements of the price matrix to solve the linear programming transport problem.

$$C_{ij} = \begin{cases} d_{ij}^{c} < d_{ij}^{k} C_{ij}^{c} \\ d_{ij}^{c} \geq d_{ij}^{k} C_{ij}^{o} \end{cases} \tag{11}$$

If the quantity x_{ij} denotes the amount of ore moved from the i-th deposit to the j-th plant, then the following restrictions can be introduced for these variables:

$$\sum_{1=i}^{N} x_{ij} \leq M_j^3, j = 1, 2, 3 \tag{12}$$

$$\sum_{1=i}^{3} x_{ij} \leq M_j^M, i = 1, 2, \dots, N \tag{13}$$

where: M_j^3 power of each j-th plant; M_j^M – production capacity of the i-th career.

Total costs are determined by the following formula:

$$Z = \sum_{i=1}^{N} \sum_{j=1}^{3} C_{ij} \cdot x_{ij} + \alpha_c U^c + \alpha_k U^k \cdot (1 + \beta_n)/O_i \tag{14}$$

where: U^c - the amount of ore processed according to option (a), t;

U^k- the amount of ore processed according to option (b), t.

The following equalities must be fulfilled:

$$\sum_{i=1}^{N} \sum_{j=1}^{3} x_{ij} = U^c + U^k \tag{15}$$

which are balance criteria for solving the transportation problem.

Thus, it is required to find the values of the indicators x_{ij} satisfying the criteria (12), (13) and (15) and giving the minimum values for the objective function (14).

The program of calculations on a computer, compiled on the basis of the above methodology, made it possible to choose the best option for the development of small-scale deposits. The source data includes the distances from the deposits to the base plant, the content in the ore and concentrate, extraction at the plant and in the deposits during the heap leaching, costs of removing metal from the ore at the plant and processing the concentrate, the cost of heap leaching during the process and loss of for under extraction of gold with this method.

Because of the calculations, the distributions of small-scale deposits were determined according to their development options. For options that differ in the difference in the extraction of gold, respectively, in the conditions of the plant and on the open pit during the heap leaching process, extreme indicators were taken during the extraction of the metal. In the first case, this difference is 15%, in the second, 40%. That is, at 95% gold recovery at the plant, in the deposit in the first case 70% is extracted, and in the second - 55%. The third option was also calculated using new principles for ore processing on site. At the same time, the difference in extraction at the plant and in the field is reduced to 0%. This option is characterized by the fact that ores of small-scale deposits are processed on-site by simplified or incomplete technological schemes.

Consequently, for small-scale deposits of Besapantau, Boylik, Triada, it is necessary to apply a technological process (a) that involves the transportation of all the mined ore to the base plant, that is, the ore from the deposit is delivered to HMP-2 without prior processing in full. With a decrease in the difference between the degree of extraction at the plant and in the deposit, the number of small-scale deposits of Balpantau, Tamdybulak, Aristantau increases, the ore of which is more profitable to be processed into a concentrate using the heap leaching method (б).

As an example, consider the option of engaging in the development of a small-scale Boylik deposit. The field is developed by the same industrial-experimental deposit, which is regarded as a kind of natural-technological zone of the Muruntau deposit. Equipment and personnel drawn from other, lower-priority, natural-technology zones of the Muruntau deposit carry out the mining of the Boylik deposit.

The volumes of rock mass to be excavated are 1,720 thousand m^3, ore – 620 thousand tons. The maximum depth of the Boylik experimental-industrial deposit is 70 m, the width and length of the deposit are 200 m and 380 m, respectively. The Fig. 4.23 shows the final form of career Boylik. The parameters of the development system are: the height of the (working) ledge is 10 m, the slope angle of the working ledge is 70°, the slope angles of the deposit sides are 35-55°, the width of the safety berms is 10 m. A development transport system with overburden movement of the overburden to distance 1 km. The distance of ore transportation to the temporary storage of balance ores from the Boylik deposit is 4 km. From the warehouse all the mined ore is shipped to the railway transport and sent to the base plant.

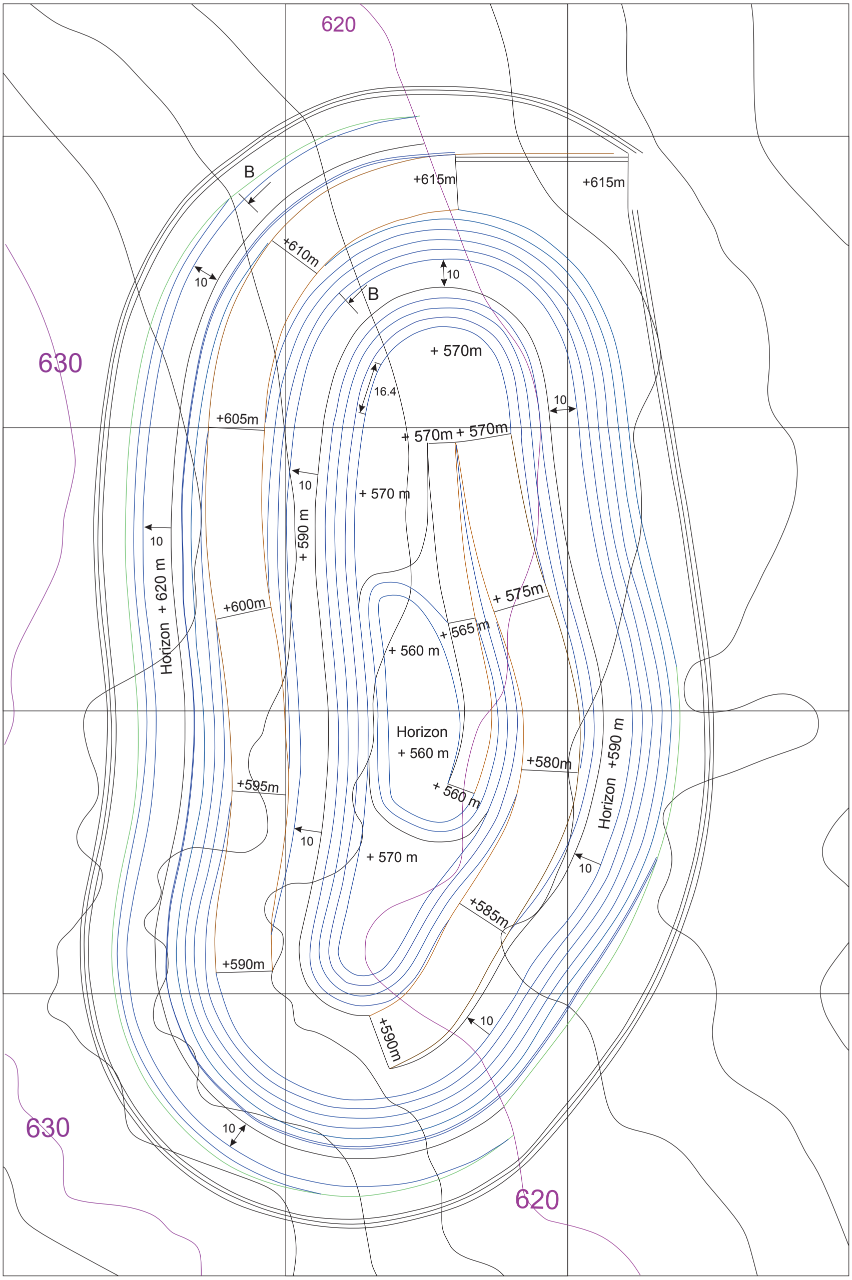

Fig. 4.23. The final form of Boylik deposit

When the difference in the extraction of 40% on any of the objects it is inappropriate to use the heap leaching method. The difference in the extraction of 0% can be achieved with modern technologies to improve the heap leaching method or new principles for on-site processing of ore using simplified or incomplete flow diagrams. With a decrease in the difference in the extraction of gold at the base plant and at the place of occurrence, the distance at which it is advantageous to transport the concentrate rather than the ore mass to the base plant is reduced. With an increase in the metal content in the deposit, the border increases when the ore is delivered to the base plant as a concentrated product.

Justification of the construction sites of modular mobile concentrating factories within the zones of influence of the base factories is methodological in nature and does not have a goal of strictly binding to geographical points due to the mobile nature of the modules. In order to substantiate the locations for the construction of mobile modules, in addition to the characteristics of the small-scale deposits themselves, data on the location of power lines and water lines, transport arteries and residential settlements containing a certain labor resources are used in the structure of NMMC mining allotments..

Thus, within the zones of influence of the base plant HMP-2, the construction of mobile modules in the area of the Tamdybulak deposit was recommended for crushing ore and preparing concentrate from small-scale deposits of Tamdybulak and Balpantau, which are an additional raw material base of the Muruntau deposit. The variety of technological properties of ores in small-scale and manufactured gold deposits necessitates the use of compact processing complexes with broad technological capabilities. It should be borne in mind that in the development of gold deposits, in addition to commercial ore sent to the base plant for processing, a significant amount of off-balance ore remains, the processing of which at the base plant is not economically feasible. Such ore should be processed to semi-finished products directly in the mining area, using for this purpose modular units and complete technological lines.

In general, the developed mathematical model allows you to choose the most optimal of the options for the development of small-scale gold deposits, differing in the method of processing the mined ore. The following options are offered:

- fully mined ore from the deposit is delivered to the plant without preliminary processing on site;

- the mined ore is pre-processed in place by heap leaching, after which the processed concentrate is delivered to the plant;

- after ore, the ore is sent to the nearest intermediate modules, where it is processed according to incomplete technological schemes, then the resulting concentrate is delivered to the plant.

As a result of the calculations, the technical and economic parameters of the development of small-scale deposits are determined, the distribution of small-scale deposits by their development options, the dependence of the distance between the base plant and the deposits on the metal content in them for different values of the difference in gold extraction at the plant and in the deposit.

Thus, the main criteria for the development of small-scale and manmade gold deposits located in the zone of influence of large mining processing complexes are determined by the price factors for the metal and the mining and technological conditions of their mining.

The total economic effect is achieved taking into account the profitability of the transport of ore or concentrate to the base processing plant. The result is the further growth of the republic's gold potential, the extension of the period of stable operation of the NMMC mining processing complexes with their adaptation to new economic conditions.

4.4. Prospects for the growth of stocks of metals in exploited deposits

In recent years, the comprehensive measures have been taken to develop the mineral resource base, which is one of the main directions to ensure sustainable development of the country's regions, as well as to improve the management and control system in the field of geological study, use and protection of mineral resources.

With this, the current state of this area requires cardinal measures to increase the efficiency of the formation and implementation of targeted programs for development and reproduction of the mineral resource base, taking into account an increase in the search reserve, in order to identify new promising areas and mineral deposits intended for development of the building materials industry, electrical engineering industry, as well as simplifying licensing procedures for search and extraction of mineral feedstock, creating favorable conditions for attracting investment.

Exploration of the deposit and its geological study is a long, continuous process, starting with the discovery of the deposit and ending when it is fully developed only. It is known that all the identified occurrences of minerals are studied sequentially, passing the stages of prospecting for mineral deposits, evaluation and exploration. Their further study is carried out at the stages of additional exploration and operational exploration under the conditions of the existing mining enterprise. For the purpose of rational and economical exploration (geological prospecting) for solid minerals in the republic, the following sequence of their implementation has been adopted by stages.

1. Regional geological studies of the territory of the Republic of Uzbekistan.
2. Geological survey of 1: 50,000 scale (1: 25,000).
3. Searches.
4. Evaluation.
5. Exploration
6. Additional exploration.
7. Operational exploring.

Stages are separate stages of the exploration cycle, aimed at solving specific problems, based on the degree of study of the object and goals, differ in the degree of detail of the study. The statement, as a rule, of each next stage of geological exploration is determined by the results of the work performed. The obtained information of the completed stage in terms of completeness and degree of reliability should be sufficient to solve the problems of geological and feasibility study of the feasibility of the work of the next stage. From the moment when the field begins to be exploited, the specificity of geological exploration changes significantly. The range of issues solved at the previous stages of study is expanding, and geological studies are becoming more in-depth and detailed. There is a need to clarify information about proven reserves and the reliability of exploration, identifying additional mineral resources, improving and improving the technology of field development and mineral processing.

The listed tasks can be combined into three groups:

- clarification of information about proven reserves as they are opened, prepared and tested;
- identification and assessment of new mineral reserves in the area of mining allotment for the expansion of the mineral resource base of the existing enterprise and the extension of its existence;
- detailed information on the geological structure of the deposit and the composition of the mineral for quality control and completeness of mining and for assisting the mining enterprise to improve the technology of deposit development and ore processing.

To address these problems, mining and exploration are carried out directly by mining enterprises at the fields, which are carried out on explored and not developed industry, as well as on the developed fields within the mining allotment of enterprises.

Additional exploration of a previously explored deposit is carried out if it is necessary to study it further before being involved in development, in connection with obtaining new data on the possible scale of the deposit, to develop or improve the existing technology for processing mineral raw materials, to further study hydrogeological, engineering-geological and other conditions for developing the object and choosing rational methods of working it out.

The tasks of additional exploration of the developed deposit are as follows:

- sequential clarification in conjunction with the plans for the development of mining operations of the geological structure, mining technical conditions of the deposit and the quality of mineral resources on insufficiently studied areas of the deposit (flanks, deep horizons, isolated mineral bodies) with the transfer of C_1 and C_2 reserves to higher categories;
- additional study of the material composition and properties of the mineral (including geological and technological mapping) in cases of clarifying the directions of its use, revising the requirements of standards or technical conditions for the quality of the extracted raw materials and technological schemes for its processing;

- exploration of the flanks of the field and of individual sections to replenish spent reserves or expand the raw material base of the operating enterprise for the extraction of mineral resources.

Mining operations during operation are carried out according to the degree of knowledge only in blocks provided with reserves of category B. Stocks of category C_1 can be allocated at the priority mining sites. The sites possessing reserves of category C_2 are similar to the exploration of new objects, since the ore bodies of such sites are very poorly studied and some of them may turn out to be partially or completely non-industrial.

In terms of the complexity of the geological structure, the gold deposits are subdivided into I, II, III and IV groups, different from each other in changes in capacity and internal structure, morphology, quality and quantity of the main useful components, coefficient of variation of linear reserves, etc. Almost every currently developed gold ore of III - IV groups of complexity have differences between the estimated and actual reserves due to the complexity of their geological structure, high spatial variability of mineralization parameters.

As it is known, during exploration of gold deposits, ore bodies are studied on a grid of up to 40 x 40 m, ore and gold reserves are calculated, data of technological, hydrogeological, engineering and geological studies are specified, a conclusion is made on the readiness of the deposit for industrial development. The picture changes drastically during the industrial development of deposits when the ore bodies are transferred from a network of 40 x 40 m (exploration) to a network of 3.5 x 3.5 – 7 x 7 m (operational exploring). It is often required to perform a larger amount of drilling of exploration wells (with a corresponding increase in the volume of testing and analytical work) to clarify the boundaries of the ore bodies and to determine the average gold content during exploration, bypassing the stage of exploration. Timely additional exploration solves many production problems associated with mining, processing, planning and design. The more precisely the reserves at the stages of exploration and additional exploration are determined, the fewer mistakes are made in designing operational works, determining the annual productivity of metal production, profitability, the lifetime of an enterprise and other technical and economic indexes.

The explored and exploited reserves (Kokpatas, Muruntau, Charmitan, Marzhanbulak, etc.) were compared using the example of the exploited deposits of Uzbekistan from various gold ore formations and types of ore deposits, in particular, the difference in the average gold content in the upper horizons of the Muruntau deposit was 24% [20]. Quantitative discrepancies in the reserves of oxidized ores at the Kokpatas deposit, determined by comparing exploration results (considering re-calculation of stocks of HMP) and exploitation by sites, are explained by more complex patterns of industrial gold mineralization localization: inconsistency in gold content, thickness of deposits and linear reserves both along strike and fall; changeable morphological outlines of industrial clusters (more complex than they appear at the exploration stage); a higher degree of variability of the statistical parameters of mineralization than at the exploration stage; confined to industrial ores only at certain hypsometric levels of the mine. There are discrepancies in the parameters of the average gold content in the deposits of Ajibugut and the ores of the Ziadin and Mardzhanbulak fields. The ore bodies of the Daugyztau deposit are well-explored, but poorly (unreliable) studied. Due to the fact that the exploration was not accompanied by a sufficient number of technological tests for different types of ores. Due to insufficient study of geotechnological types and types of ores of the Daugyztau deposit during exploration, a sharp drop was recorded in the value of the continuous extraction of gold from oxidized ores with a high content of carbonaceous-bitumen (fat to the touch) black shale using the flotation-biox-sorption technology using HMP-3 plant. The operative geological and technological mapping at the supplementary exploration stage at the pilot site allowed identifying four natural types of ores and restoring the expected gold recovery during the processing of mixed and primary gold sulphide ores from the Daugyztau deposit.

Since 2011, NMMC has been entrusted with the task of conducting the search, evaluation and exploration of precious metals and uranium, i.e. reproduction of the mineral resource base of these metals, with the organization of the Scientific and Production Center (SPC) “Geology of precious metals and uranium” as part of the combine [23], which is currently exploration expedition (EE of NNMC). The State Committee for Geology of the Republic of Uzbekistan has been assigned with the task of identifying prospective areas for gold and uranium with forecast resources of category P1 and P2, conducting geological exploration for hydro-mineral resources, solid non-metallic minerals, ferrous metals, as well as comprehensive geological surveys of scale 1: 50,000, 1: 25,000 (Fig. 4.24).

The transition to a new level of exploration of geological exploration is focused on enhancing the economic efficiency of work and ensuring the implementation of the annual state program of exploration for the increase in gold and uranium reserves. The main objectives of the exploration expedition in carrying out the program of exploration are:

- ensuring the fulfillment of the state order for the increase in gold and uranium reserves in order to replenish the resource base of the existing mining and processing enterprises of the plant;

- further strengthening and expansion of the mineral and raw material base of gold and uranium of existing enterprises on the basis of the preparation of new facilities for the growth of reserves for the future;

- conducting prospecting and appraisal work in promising areas located remotely from the existing infrastructure in order to create a mineral resource base for the construction of new mining enterprises.

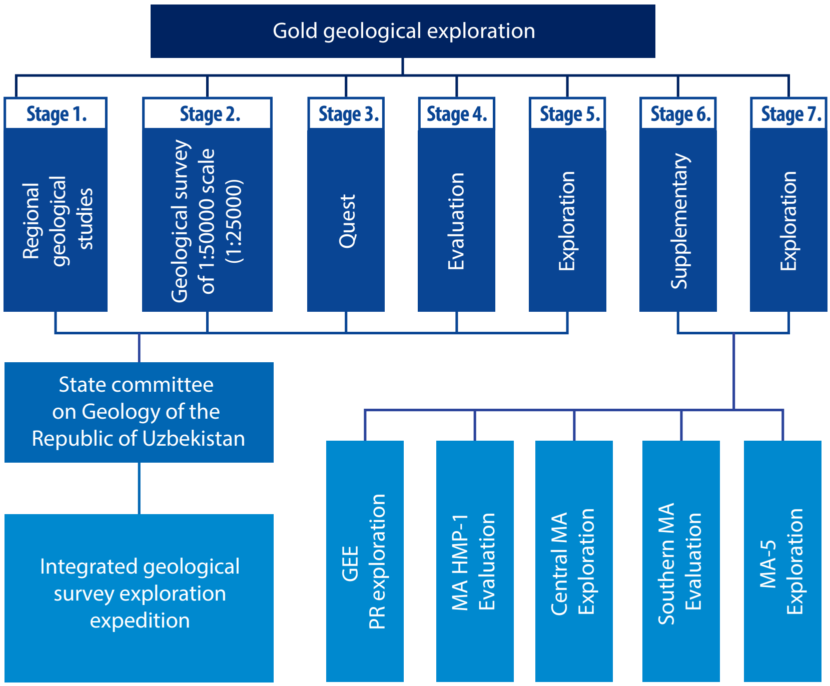

Fig. 4.24. Structural diagram of the distribution of geological exploration in stages between the State Committee on Geology of the Republic of Uzbekistan and the Navoi MMC

The positive fact is that the annual program of exploration of SPC is based on the analysis of the state of the mineral resource base and the assessment of the forecast resources of the main types of minerals, the availability of industrial reserves of the mining and processing divisions of NMMC, taking into account the main criteria for selecting objects included in the program, justifying the direction stages of regional, geological surveying, appraisal and exploration of ferrous and non-ferrous metals, gold, uranium, groundwater and other types of minerals. In addition, the priority areas of research, experimental and methodological work, technological research of ores, geological and economic research and other works on the geological study of the subsoil; achieving the required level of growth in gold, uranium and other mineral resources at new facilities, taking into account annual redemptions, financing of geological exploration both from the state and own funds of NMMC.

According to the Decree No. PP-4401, dated 23.07.2019. „On measures to further improvement of the geological study of the subsoil and the implementation of the state program for the development and reproduction of the mineral resource base for 2020-2021", the summary parameters of the growth of forecast resources and mineral reserves in the context of the geological and economic regions of the Republic are given in Table 4.4.

Table 4.4

Summary parameters of growth of forecast resources and mineral reserves in the context of geological and economic regions

No.	Description of mineral resource	Unit of measure	Growth of forecast resources ($P_1 + P_2$)		Forecast of growth of reserves ($C_1 + C_2$)	
			2020	2021	2020	2021
1.	Gold	ton	150	300	40	40
2.	Silver	ton	150	300	123	127
3.	Tungsten	thousand tons	5	5.5	4	4.5
4.	Rare metals and rare-earth elements	thousand tons	4.6	5	0.5	1
5.	Uranium	ton	8,000	12,000	3,000	3,000
6.	Copper	thousand tons	148	155	40	41
7.	Lead	thousand tons	38	47.5	27.2	29.5
8.	Zinc	thousand tons	43	47.5	23	24.1
9.	Nickel-cobalt	thousand tons	2	3	-	-
10.	Non-metallic minerals:					
	quartz raw materials	thousand tons	-	-	200	250
	basalt raw materials	thousand tons	-	-	270	300
	coal	thousand tons	-	-	8,000	9,000
	larch	thousand tons	-	-	6	6
	inert materials (gabbro, granite)	million tons	-	-	10	10
	sand and gravel mixtures	million tons	-	-	4	4
	phosphorites	million tons	-	-	5	6
	limestone	million tons	-	-	45	55
including by geological and economic regions:						
I	**KYZYLKUM GEOLOGICAL AND ECONOMIC REGION**					
1.	Gold	ton	92.5	150	18.5	18
2.	Silver	ton	150	300	50	50
3.	Rare metals and rare-earth elements	thousand tons	3.1	5	0.5	1
4.	Uranium	ton	4,500	5,000	2,100	1,450
5.	Copper	thousand tons	25	30	-	-

Continuation of table 4.4

II	**SAMARKAND GEOLOGICAL AND ECONOMIC REGION**					
1.	Gold	ton	51.5	130	15	12
2.	Uranium	ton	3,500	7,000	900	1,550
3.	Lead	thousand tons	-	10	-	-
4.	Zinc	thousand tons	-	10	-	-
III	**TASHKENT GEOLOGICAL AND ECONOMIC REGION**					
1.	Gold	ton	6	20	3.5	4.5
2.	Copper	thousand tons	123	125	30	30
3.	Lead	thousand tons	17	17.5	9.2	9.5
4.	Zinc	thousand tons	16	16.5	1	1.1
5.	Silver	ton	-	-	73	77
IV	**SOUTH UZBEKISTAN GEOLOGICAL AND ECONOMIC REGION**					
1.	Gold	ton	-	-	3	5.5
2.	Tungsten	thousand tons	5	5.5	4	4.5
3.	Rare metals and rare-earth elements	thousand tons	1.5	-	-	-
4.	Lead	thousand tons	21	20	18	20
5.	Zinc	thousand tons	27	21	22	23
V	**USTYURT GEOLOGICAL AND ECONOMIC REGION**					
1.	Copper	thousand tons	-	-	10	12
2.	Nickel-cobalt	thousand tons	2	3	-	-

At the same time, the exploration expedition of NMMC does not resolve the task of replenishing depleted reserves of gold deposits, such as Kokpatas, Daugyztau, Adzhibugut, Muruntau, Myutenbay, ore bodies of the Ziadin deposit, and deposits of the Zarmitan gold ore zone in the contour of land allotments. An analysis of the early stages of geological exploration shows that outside of a fairly well-studied part of these deposits (on the flanks, deep horizons, in the interstitial space) there are often poorly studied and "blind" bodies. Earlier, these ore bodies were studied by the own forces of the structural mining divisions of the NMMC at the exploration stage.

Thus, timely measures taken will significantly prolong the development of deposits at the expense of additionally increased reserves at the exploration stage and will significantly increase the accuracy of establishing the numerical values of the geological industrial parameters of the deposits and specific ore bodies that determine its configuration, occurrence conditions, and mineral characteristics and industrial overall rating.

4.5. Building an algorithm for selecting a regional development strategy

The success of strategic planning with the presentation, discussion and corrective decisions of the top management expert prepared version of the strategy, is largely predetermined by the chosen methodology of its formation and management.

For the Kyzylkum region, it is quite enough to base the formation of a development strategy on the method of options with expert estimates, interpolation and iteration of the characteristics of activities of objects and subjects of a regional scale, later adding it with direct design calculations.

The basis for managing the implementation of the strategic plan can be the international standard ISO-9001, which provides for:

- analysis of the situation;
- the formation of social and economic policies with the definition of the mission, priorities and development goals;
- development of solutions to achieve the goals;
- implementation of decisions;
- analysis of the results of the implementation of decisions taken;
- making corrective decisions;
- implementation of corrective decisions, etc. cyclically to achieve the goal.

Strategic planning of the development of a region can be represented as the next set (algorithm) of cyclical actions (Fig. 4.25). In general, the development strategy of the region will be enlarged in the form of three main blocks (Fig. 4.26):

- preparatory, when the collection and analysis of source data;
- analytical, when the main strategic decisions are developed;
- fixing, when decisions are recorded in the program document of the top management.

If we proceed to the specifics of the Kyzylkum region, the work on the preparatory unit will inevitably lead to the following conclusions.

1. The only source of raw materials that is capable of reserves, but not of quality, is sufficient to fully load the existing production facilities with a minimum reduction of jobs and the production of highly liquid products, are mining and processing wastes, from which manmade deposits are formed.

2. The "gold" chain should be freed from the cost burden it suffers from the effects of phosphate rock production, the social sphere, the provision of unusual services, etc.

3. The deposits of any minerals that are potentially suitable for the production of products in demand in the external or domestic market should be evaluated in terms of expediency of development; decisions must be made on them, determining the ways and terms of such mastering.

The first two conclusions are quite understandable (the technology is known, mining and processing complexes exist, personnel are available, non-specific loads are determined in advance, etc.), and the third conclusion requires additional explanations related to the implementation of the action program in accordance with the developed algorithms (Fig. 4.27, 4.28).

It should be borne in mind that the algorithms systematically designate the main directions, following which, specifying, refining and complementing them, the group of experts will be able to work out rational decisions on strategic development as a whole region, and its constituent elements. Such an approach is most important for making decisions on fields whose development is aimed at compensating for a decrease in the integral resource of a region.

We should start with the fact that a group of experts is being formed, which, for well-known deposits, should formulate a development goal corresponding to the social and economic policy, priorities and the main objective function of the region's strategic development (Fig. 4.28).

It then determines the status of the field and the appropriate nature of the investment (public, private, foreign, or national, mixed). After this, an organizational scheme for the development of the field, including the receipt and sale of mineral products, is being worked out in general terms. Next, a report is prepared to the top management, which clarifies the key points and makes a decision on the organizational chart of the field development.

After that, a specific investor is selected, who, together with the expert group, clarifies the procedure and conditions for financing, the technological scheme for the development of the deposit, the production and sale of mineral products. Next, the design begins and the project implementation is organized.

We will consider the organization of the development of a new field in the Kyzylkum region using the example of the Rudnoye uranium-vanadium deposit (Fig. 4.27), which is located 55 - 60 km south-west of the city of Zarafshan and is associated with carbonaceous-silicon (“black”) shale, widespread in Kyzylkum region. It is known that such slates are a kind of accumulator, primarily of vanadium, uranium, rare earths and molybdenum.

Collection of baseline data on the resource potential of the region
Development of the schedule for the development of balance reserves of basic deposits
Expert determination of the impact of the development of reserves of basic deposits on employment, foreign exchange earnings, budget formation and the social sphere
The formulation of socio-economic policy, the definition of priorities and objectives of the strategic development of the region with the assessment of basic indicators in the dynamics
Identifying the main ways to achieve goals in the strategic development of the region
The first discussion of the report on the strategic development of the region among top management
Refinement of the socio-economic policy, priorities, goals and basic indicators of the strategic development of the region over time
Making and specifying corrective decisions to achieve the clarified goals and basic indicators of the regional strategic development
Addition of corrective decisions by enlarged design calculations
The second discussion of the report on the strategic development of the region among top management
Making a software decision

Fig. 4.25. General algorithm of strategic development of the region

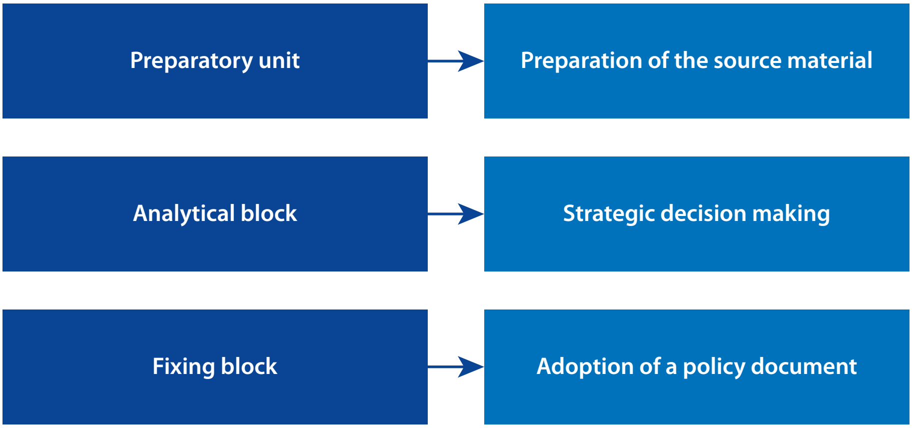

Fig. 4.26. A flowchart of a regional development strategy

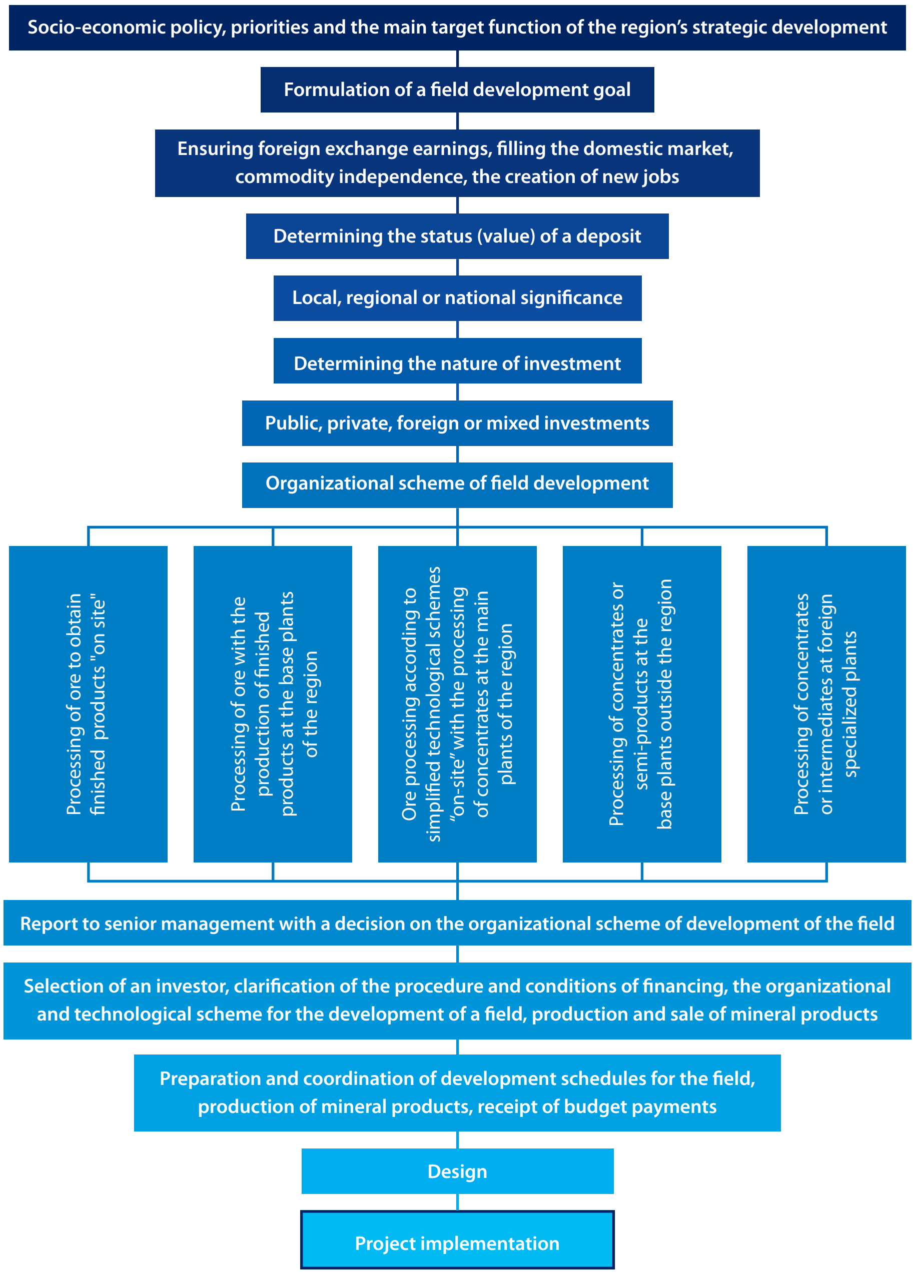

Fig. 4.27. Scheme of the organization of development of a new field in the region

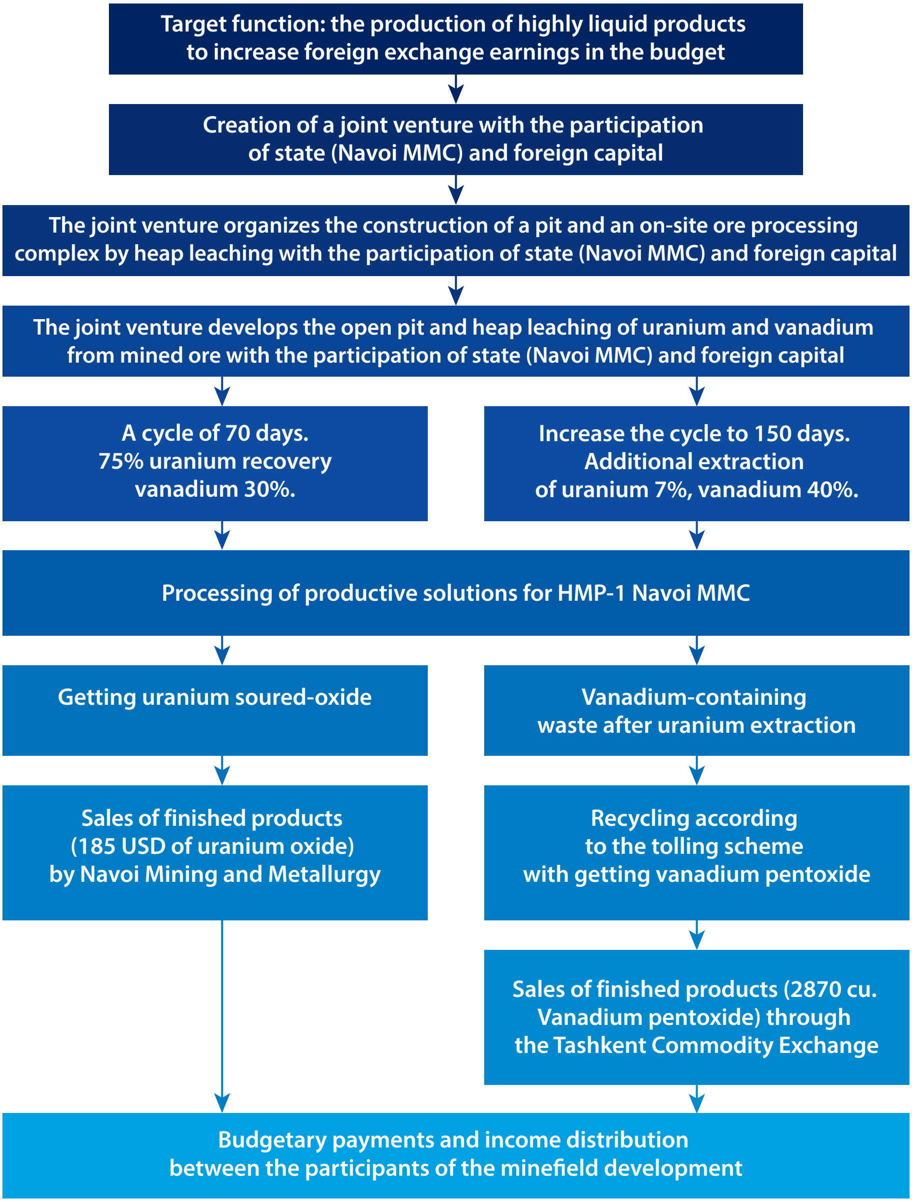

Fig. 4.28. Organizational scheme for the development of the Rudnoye deposit with the production of finished products

Market research of uranium and vanadium. Mineral products from ores of the Rudnoye deposit - uranium in nitrous oxide and vanadium anhydride are highly liquid products on the world market. For example, the domestic production of uranium in Russia is below the level of consumption. Currently, there is the only producer of industrial quantities of uranium in Russia: JSC Priargun Mining and Chemical Combine in the city of Krasno-Kamensk (Chita Region). There are currently three different markets in the world in which uranium products are sold: the United States, the West European market and the market of Southeast Asia. World uranium production is no more than 65% of consumption, and the current deficit is covered by warehouse reserves (primarily Russia). The reduction of stocks inevitably affects the growth of the price of uranium, which is currently happening.

Vanadium is alloying metal and mainly used in the iron and steel industry, consuming about 85% of the total vanadium production. Vanadium alloyed steels are characterized by improved quality and are widely used in transport, engineering, gas pipe manufacturing, and others. Special alloys containing vanadium are used in nuclear, space, and aviation technology.

The main commercial products on the world and domestic markets for vanadium are: technical vanadium pentoxide (V_2O_5), vanadium-containing slags, ferrovanadium, and chemically pure vanadium pentoxide.

The volume of world production (in terms of technical pentoxide) in 1998-2000 was about 40 thousand tons. The main producers were South Africa, Russia and China. The main consumers are the countries of Western Europe, Japan and the USA.

The relatively new uses of vanadium include its use in the energy sector for the production of chemical energy sources and powerful batteries, as well as catalysts, including to neutralize the exhaust gases of motor vehicles.

In addition, it is promising its use in the pharmaceutical industry, in particular, for the production of drugs that replace insulin, etc.

The consumption of vanadium for these purposes is increasing, and this requires chemically pure pentoxide, the production of which so far is no more than 10% of the total. For example, the creation of industrial energy storage batteries (up to 30 MW) developed in Japan requires about 180 tons of pentoxide per 1 MW of power. Industrial production of such batteries can increase the need for chemically pure pentoxide by many times.

Despite the long-term supply of the world industry with titanium magnetite vanadium ore resources, the development of new vanadium ore deposits of enhanced quality is currently being considered abroad.

For example, in the United States in 1998, the Rome mine was commissioned to mine uranium-vanadium ores (obviously, for the sake of obtaining vanadium, since uranium mining, with the exception of underground leaching, has been discontinued in the United States for several years).

In Russia, in the early 1990s, the production of chemically pure vanadium pentoxide was carried out at the Novosibirsk plant of rare metals and the Berezniki titanium-magnesium plant. At present, this product is not produced in Russia, and the current need for it is estimated at 2000 tons, and its growth to the level of 4000 tons is quite probable. At the same time, the global demand for chemically pure vanadium pentoxide may be no less than 10 - 15 thousand tons in the future.

Traditional applications of vanadium anhydride are the production of master alloys used in the casting of titanium alloys, and the smelting of ferrovanadium.

The uranium-vanadium ore deposit Rudnoye, located in the Kyzylkum region, is not inferior, but even surpasses most of the indicated objects in terms of V_2O_5 content (0.9% versus 0.3-0.5%), but the chemical vanadium anhydride obtained from its ores composition is the most suitable product for the production of chemically pure pentoxide (Fig. 4.28).

Analysis of the geographic and economic characteristics of the region. The Rudnoye deposit is located in the Auminzatau Mountains of Central Kyzylkum, 60 km southwest of the city of Zarafshan. The nearest settlements are the villages – Aschi, Shuktubai, Daugyztau, Karakata railway station and junction number 141, connected with the deposit by unpaved roads operating all year round. The distance from junction 141 to the Rudnoye deposit in a straight line is 30 km, along the railway line from junction 141 to the city of Navoi, where the uranium ore processing plant is located, is 195 km. 60 km to the northeast of the field is the city of Zarafshan. In settlements there is an excess of able-bodied population.

8 km to the north of the field, the Amudarya-Zarafshan water pipeline and the power transmission line - 220kV. There are no sources of drinking water in the area.

The terrain is weakly hilly. The absolute elevations in the area of the field reach 500 m, the relative elevation of the elevations is up to 50 m.

The ore-bearing zones of the deposit have a paleoplacer and lenticular forms with an unseasoned thickness, oriented along the long axis in the north-west direction. Geologically, the field is represented by the alternation of horizons of carbon-siliceous shales, complicated by tectonic faults. Ore is a carbonaceous siliceous, phyllite, carbonaceous shale, which are unevenly deposited uranium, vanadium and, to a lesser extent, molybdenum mineralization. The length of the ore zones varies from 100 to 560 m, width – from 40 to 290 m. The thickness of the ore deposits varies from 1 to 20 m, the depth – from 15 to 180 m.

The ores of the Rudnoye deposit, in addition to uranium, contain vanadium and molybdenum. The content of vanadium pentoxide in the balance reserves varies from 0.5 to 2.8% and averages 1.12%, and in off-balance reserves - 0.8%. The most important feature in the distribution of uranium and vanadium minerals is their association with the crushing of ore-bearing rocks. Compressive strength of ore is 40-50 MPA, host rocks – 8 - 12 MPa. The field is poorly watered. The groundwater mirror lies below the contour of explored industrial ore bodies. Water inflows into the quarry are possible only on the lower horizons in the amount of up to 5 m^3/h.

Thus, the analysis of the initial data allows drawing the following conclusions.

Uranium and vanadium, which are the main useful elements of the "black" shale, are not used in the industry of Uzbekistan. However, in the conditions of the development of reserves of basic deposits, this field can become a real source of foreign exchange earnings in the Republic, supplying highly liquid mineral products (uranium, vanadium, rare-earth elements) to the external market.

This direction should be taken as the main target function of the development of the Rudnoye deposit, not forgetting, however, its social significance.

A factor contributing to the revitalization of the Rudnoye deposit is the region's favorable infrastructure - the presence of roads, a conduit, a transmission line, settlements with an excess of workforce, and a hydrometallurgical plant for uranium ores processing.

In terms of ore, uranium and vanadium reserves, the Rudnoye deposit may be assigned a regional status. Since the financial resources of the region's primary mining and processing enterprise (NMMC) are involved in the diversification of gold production, it is advisable to organize the development of the Rudnoye deposit on the basis of mixed investments with state and foreign capital, bearing in mind that a foreign investor's contribution will be the contribution of the state enterprise (NMMC) – raw materials, technology for processing uranium-vanadium ore and services for the sale of uranium products.

The situation is somewhat different with obtaining vanadium pentoxide, since there are no production facilities for processing vanadium raw materials in the republic, and building a special complex for these purposes is an expensive undertaking. In this situation, the most appropriate option is the option of processing vanadium-containing waste with production of vanadium pentoxide.

The assessment indicates a favorable economic environment for the development of the Rudnoye deposit and allows us to conclude that the development of deposits of this type can have a significant impact on the maintenance of the integral resource of the Kyzylkum region.

Conclusion

Natural resource potential is one of the most important factors in the economic development of the region and the country as a whole. The direction and scale of development and distribution of productive forces, primarily resource-intensive industries, depend on the state and availability of natural resources.

In modern conditions, the importance of rational use of natural resource potential is increasing, which allows reducing the material consumption of products, ensuring the growth of labor productivity and increasing the efficiency of the regional economy.

Environmental management is inextricably linked with the entire system of social and economic management of society, if by managing society we understand the process of impact on public life and the environment in order to improve development and preserve their quality parameters.

World experience clearly demonstrates that two ways can be distinguished in achieving a high level of economic development.

The first way is resource-using development. Most regions possessing natural resources are developing along this path. The basis of high macroeconomic indicators lays large-scale consumption of natural capital in the course of economic activity: the extraction of mineral resources, environmental pollution by uncontrolled emissions of harmful substances, etc. „Easy" income from the extraction of natural raw materials and its exports in conditions of high world prices does not stimulate the development of the processing sector of the industry in the regions.

The high profitability of raw materials production, due to the rental nature of environmental management, diverts the resources of labor and capital, which reduces innovation activity in other sectors of the economy. Such development is not capable of ensuring the true welfare of the population. The "decumulation" of resources in the process of current economic activity leaves no room for further development of economic systems. The extremely unstable nature of such a development path is reflected in the fact that a significant degradation of the natural environment in the absence of intellectual resources and modern technologies will lead to a complete "collapse" of economic systems in such regions. High profits of the environmental sector are not the key to the growth of the regional economy and social welfare.

The second possible path of development is innovative development. The basis of the economic growth of such regions is the achievement of scientific and technological progress and innovative development based on the formation of regional innovation systems (RIS), innovation clusters. Even in the absence of a rental component in the incomes of the processing industries, the share of value added in the volume of industrial production in these regions is from 30 to 40%. At the same time, the GRP created in the process of industrial production in these regions is more evenly distributed among the population of the regions. This development is sustainable, since it does not just "leave" resources, but also creates new ones, laying the groundwork for the development of subsequent generations.

The growth of the welfare of the region is an objective characteristic of its development. The implementation of regional development is aimed at updating and generating socio-technological knowledge as a resource for regional development. The task of ensuring the rational use of natural resource potential is becoming one of the most important, and its successful solution affects the development of the economy and the strengthening of social stability in resource-producing regions.

As the experience of solving problems of regional development in different countries shows, the specific model chosen for the development and implementation of regional policies depends on many factors. Even developed countries vary greatly in the severity of regional problems, in the level of territorial disproportions and political culture with its attitude to the "permissible inequality" of territories, and in the methods of state intervention in regional processes.

The specificity of geo-economic interests also influences the choice of the institutional structure, since it gives rise to cooperative ties and strategic partnerships of various territories and states.

The issue of regional development solves the problem of activating and describing disparate initiatives, then transforming them into projects and programs of activities and, thus, creates the basis for the implementation of large-scale regional projects. In this case, using relatively small means it is possible to obtain a super-total synergistic effect of regional development.

The research results presented in this monograph covered the issues of conceptual approach in the innovation strategy of the Kyzylkum region using a systematic solution of integral resource in the example of NMMC activities as the main region-forming factor.

The studies have shown that at present excellent prerequisites have been created for the sustainable innovative development of the Kyzylkum region.

These prerequisites are:

1. Developed sectoral structure of industrial production in the region, uniting such industries as mining, metallurgical, chemical, geological exploration, mechanical engineering, machine-tool construction, construction, jewelry, agricultural.

2. Existing excellent opportunities for creating innovative clusters: mining, including non-metallic materials; chemical industries; construction and others.

3. Modernization, technical and technological re-equipment and new investment projects implemented at NMMC.

4. The existing strategy for the development of raw materials of the Central Kyzylkum mining province.

5. Increasing the production of import-substituting products.

6. The quality of labor resources.

7. Announcement that Navoi region is a free economic zone is based on the rich mineral and raw material base of the region, a promising geographic location, and significant transport and logistics potential.

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