CESMAT

MINES ParisTech

ARMINES

Cycle d'Etudes Superieures en Evaluation Economique de Projets Miniers

CESPROMIN

Session 2008-2009

URANIUM PROJECT
PRE-FEASIBILITY OF TORTKUDUK CENTRAL
(KAZAKHSTAN – KATCO)

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Juin 2009
CRBAT090623

CES 2008 RAP/09-03

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FINAL REPORT
Presented by
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CESPROMIN 2008/09

URANIUM PROJECT
Pre-feasibility study of TORTKUDUK Central
(KAZAKHSTAN-KATCO)

Fontainebleau
June 2009
CES 2008 RAP/09-3

SUMMARY

Tortkuduk Central is a part of Muyunkum uranium deposit of the Chu-Sarysu depression, Southern Kazakhstan.
Because of the large extent of deposit & geological characteristics the deposit divided into four sections:

1. Muyunkum South;
2. Tortkuduk South;
3. Tortkuduk North;
4. Tortkuduk Central.

The grade of uranium mineralization is a variable from 0.2 to 1.0 kgU/t.
Based on operating experience of NAC Kazatomprom and work parameters of pilot plant on each site of JV KATCO were defined:

- Method of uranium extraction is In Situ Leaching with working reagent of sulphuric acid;
- Each site is planned for the production of 1000 t U per year.

According to preliminary data reserves estimated at 20 000 tU, with average content of 0.052%. These data were taken for pre-feasibility study of this project. At present, exploration continues and will be finished in two years.

Eluates of Tortkuduk Central will be transported to the Tortkuduk South site's central installation which has complete cycle of processing and production rate of 4000 t U per year.

Evaluated total investment is 72 946 k€. The operating cost is 18.29 €/kgU. The economic evaluations show that the project will provide an Internal Rate of Return of 57%. The Net Present Value is 180 685 k€ and pay back period is 2.28 years.
Sensitivity and risk analysis were performed, that provides information about the project resistance at various situations.

ACKNOWLEDGEMENT

I would like to thank Mr. Arthur de Fautereau, present General Director of JV Katko and Mr. Benoit de Galbert, ex-General Director of JV Katco, who gave me opportunity to study at the course of CESPROMIN.

Also I would like to thank Mr. Olzhas Kairbayev, deputy director of Production Direction, who advised me this course and who provided all necessary materials.

I would like thank my colleagues to Yvgeny Voronin, Yerik MAICHINIV which projects i have used to prepare this project, and for all their advices and recommendations.

Special thanks to Mrs. Isabelle Thenevin responsible of CESPROMIN and prof. Michel Duchene, and all the lecturers who given us perfect and very useful lectures and courses.

My sincere thanks goes to Mrs. Sandrine Motte, secretary of CESPROMIN, who was always willing to help in the solution of everybody's problems, with which any foreigner confronts.

Finally, I'm thankful to all participants of CESPROMIN 08/09 who were my good friends all these nine month.

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INTRODUCTION

This project was developed to present the pre-feasibility study of Tortuduk Central uranium project. The report is based on the technical information and data provided by JV KATKO.

In the first chapter we can see the common notions about uranium and its application, as well as demand and prices for uranium

Uranium industry in Kazakhstan can be found in Chapter 2, as well as reserves of uranium in Kazakhstan and a list of uranium companies in the country.

Description location of TKD Central and geology of the deposit, ore reserve estimation and volume of work of initial exploration estimation are given in Chapter 4, and technical analysis of the project, basic technological solutions, assessment of labour & needs.

Chapter 5 is dedicated to environmental protection and detailed estimation of the environmental impact. This aspect is very important since we have to deal with acid in-situ leaching.

Investment necessities and operating cost are estimated in Chapter 6. Also, there is dealing with economic evaluation of the project. At the end, sensitivity and risk analyses were performed, that provided information about the project resistance for varied situations.

1 General provision

1.1 Nuclear power of the world

Nuclear is not only important but also environmentally less pollutable source of electrical energy. At the moment there are more than 400 nuclear power plants in operation (NPP) all over the world, which produce about 17% of the world's electricity. The share can range from just few percent in some countries up and to 75 % as in France.

Figure 1 - Krško Nuclear Power Plant

The development of nuclear technology had a promising beginning in the 50s. As years went by, the enthusiasm started to diminish. After the Three Mile Island and Chernobyl accidents it even turned into rejection. But nevertheless the percentage of nuclear energy production is constantly increasing as can be clearly seen from the diagram (power and number of the nuclear reactors in the world over the years). The diagram includes reactors that are currently used as well as all the reactors that are still under construction or seriously planned. It is very likely that in the next few years some new nuclear power plants will be constructed which means that the curve will continue to grow even after the year 2015.

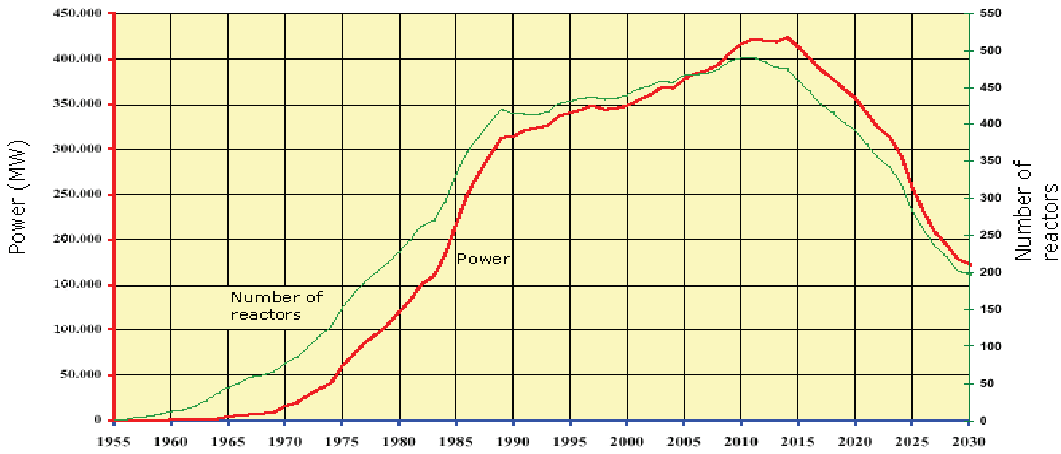
1.2 Basic facts about Nuclear Power Plants in the World

Table 1 - Basic facts about Nuclear Power Plants in the World

Number of operating NPPs in August 2008	439
First NPP	Obninsk. Russia. 1954
Most powerful NPP	Chooz. France. 1500 MW Ignalina. Lithuania. 1500 MW
Share of nuclear energy in world energy production	15%
Nuclear energy produced in 2006	2.658 TWh
Number of years of operation to January 2008	10.677
Number of countries with operating NPPs	30
Number of NPPs under construction (August 2008)	35
Number of NPPs that started operation in year 2007	3
Number of shut down NPPs	119
Number of decommissioned NPPs	17

1.3 Power and Number of Nuclear Reactors in the World

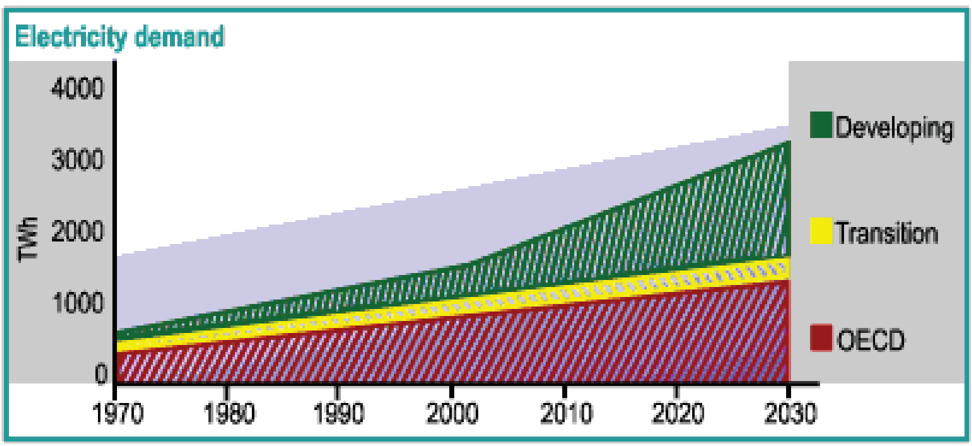
Figure 2 - Power and Number of Nuclear Reactors in the World



The diagram includes reactors that are currently used as well as all the reactors that are still under construction or seriously planned. It is very likely that in the next few years some new nuclear power plants will be constructed which means that the curve will continue growing even after the year 2015.

1.4 World primary energy consumption growth

Figure 3 - World primary energy consumption growth



Source: OECD/IEA World Energy Outlook 2004.

Nuclear power generation is an established part of the world's electricity mix providing over 17% of world electricity (cf. coal 40%. oil 10%. natural gas 15% and hydro & other 16%). It is especially suitable for large-scale continuous electricity demand which requires reliability (i.e. base-load).

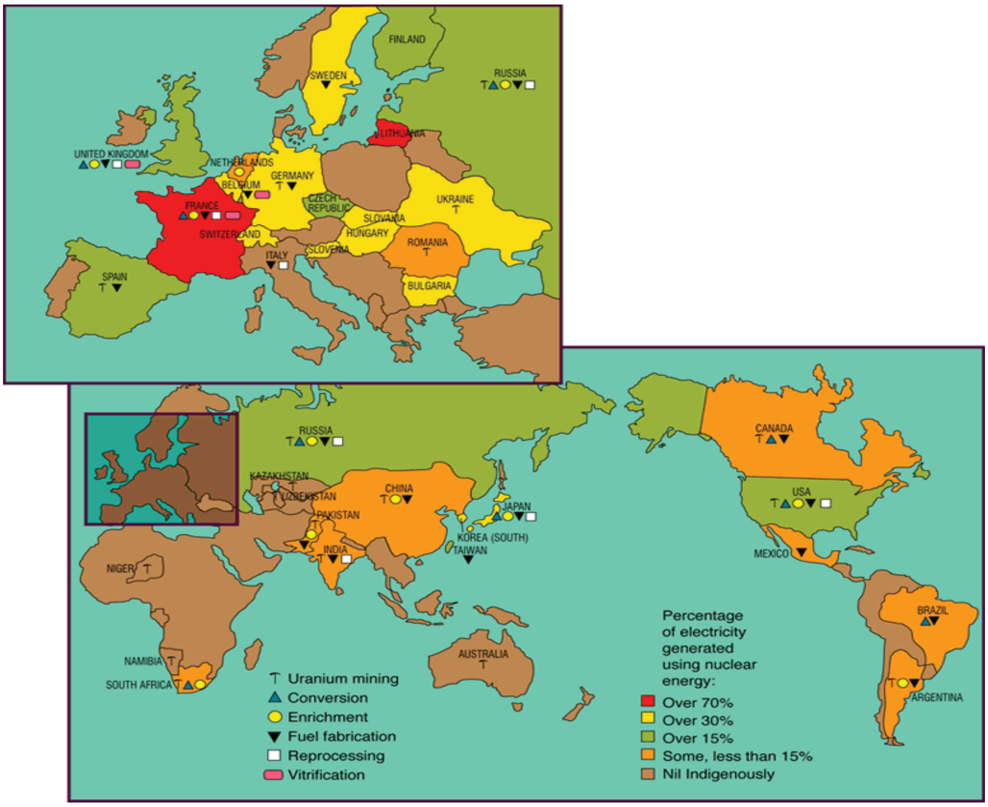
1.5 The Nuclear Fuel Cycle

Like coal, oil and natural gas uranium is an energy resource which must be processed through a series of steps to produce an efficient *fuel for generating electricity. Each fuel has its own distinctive fuel cycle: however the uranium or 'nuclear fuel cycle' is more complex than the others.*

To prepare uranium for use in a nuclear reactor it undergoes the steps of mining and milling conversion enrichment and fuel fabrication. These steps make up the 'front end' of the nuclear fuel cycle.

After uranium has been used in a reactor to produce electricity it is known as 'spent fuel' and may undergo a further series of steps including temporary storage reprocessing and recycling before eventual disposal as waste. Collectively these steps are known as the 'back end' of the fuel cycle.

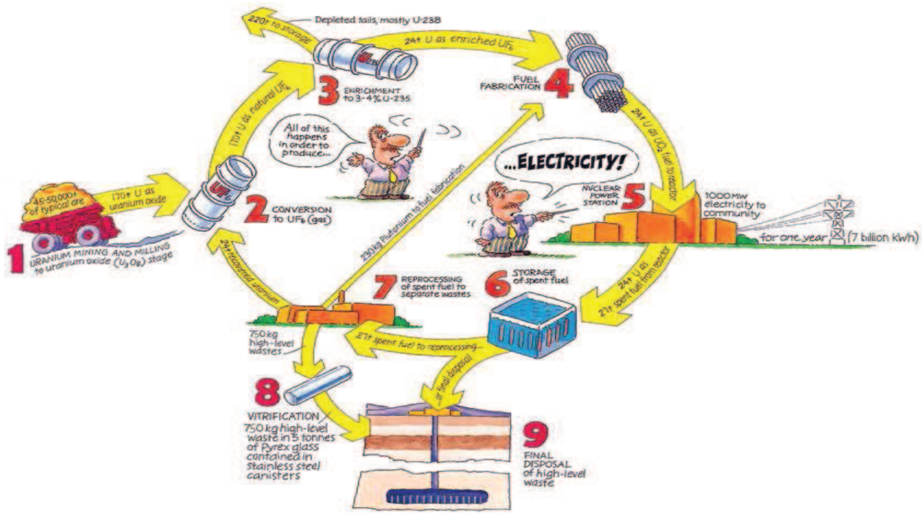
Figure 4 – General map of Nuclear Fuel Cycle



These are the various steps that together to make up the entire Nuclear

Fuel Cycle:

Figure 5 - Nuclear Fuel Cycle



1.6 Demand and Supply of uranium in the World

Global electricity use is projected to increase by 66%, from 13 trillion kilowatt-hours in 1999 to 22 trillion kilowatt-hours in 2020. In North America the growing demand for power has reached the point where the grid is increasingly vulnerable to massive failures there was some instances when about 50 million people remained in darkness for more than two days.

To meet this demand, energy has to come from somewhere, and nuclear power is the only sensible & reliable choice. There are about 30 new reactors in various stages of construction around the world. All the developing countries have started thinking of enhancing the share of nuclear energy in their Primary energy mix. India is a latest example of it.

China alone is planning for at least one new reactor per year for the foreseeable future. Even in the United States, despite all the hand-wringing about nuclear power, the share of electricity generated by the nuclear power has risen from just 4.5% in 1973 to over 20% today making it the second most frequently used fuel source for producing electricity (after coal).

From the beginning of civilian nuclear power in the 1950s through the mid 1980s the annual production of uranium exceeded demand. Annual production of uranium peaked at 69 080 tones uranium (t U) in 1980 gradually declined thereafter to 31 500 t U in 1994 and then rose to 40 263 t U in 2004. Since the early 1990s annual production has been consistently lower than uranium demand and the gap has been filled by five secondary sources: stockpiles of natural uranium stockpiles of enriched uranium, reprocessed uranium from spent fuel. MOX fuel with 235U partially replaced by 239Pu from reprocessed spent fuel and re-enrichment of depleted uranium tails (depleted uranium contains less than 0.7% 235U).

The rapid global expansion in the 1960s and early 1970s drove up the price of uranium (see Figure 3) and prompted an expansion in exploration and production capacity. However, the slowdown in nuclear power's growth after 1975 and the concomitant price decline decreased the incentives for exploration and production and when the price reached a historic low of $18/kg U in the 1990s led to the closure of several mines. However as expectations have risen recently about the future expansion of nuclear power and as secondary supplies appear likely to tighten. The uranium industry has revived with an upswing in uranium exploration mining and milling around the world. Beginning in 2001 the price of uranium started to climb and the spot price reached $112/kg U in May 2006.

Projecting uranium production and demand into the future is highly uncertain. To estimate the longevity of current resources therefore the Agency commissioned a set of uranium demand scenarios reflecting a range of assumptions about economic growth the competitiveness of nuclear power the availability of secondary sources and other factors. Figure 4 shows the resulting low high and 'reference' global projections and compares them to the low and high projections through 2030. The projections' most distinctive feature is their uncertainty. The low and high projections span an even broader range in 2030 than the low and high projections and the demand projections for 2050 range from 52 000 t U (less than today's demand) to 225 000 t U. more than a factor of four higher. However, the overall conclusion drawn by the study is that the total uranium resource base can supply the projected demand up to 2050 and beyond. But the gap between uranium 'in the ground' and 'yellow cake in the can' will have to be closed by further expansion of uranium mining and milling capacities.

1.6.1 Uranium price

Figure 6 – Uranium Spot Price History

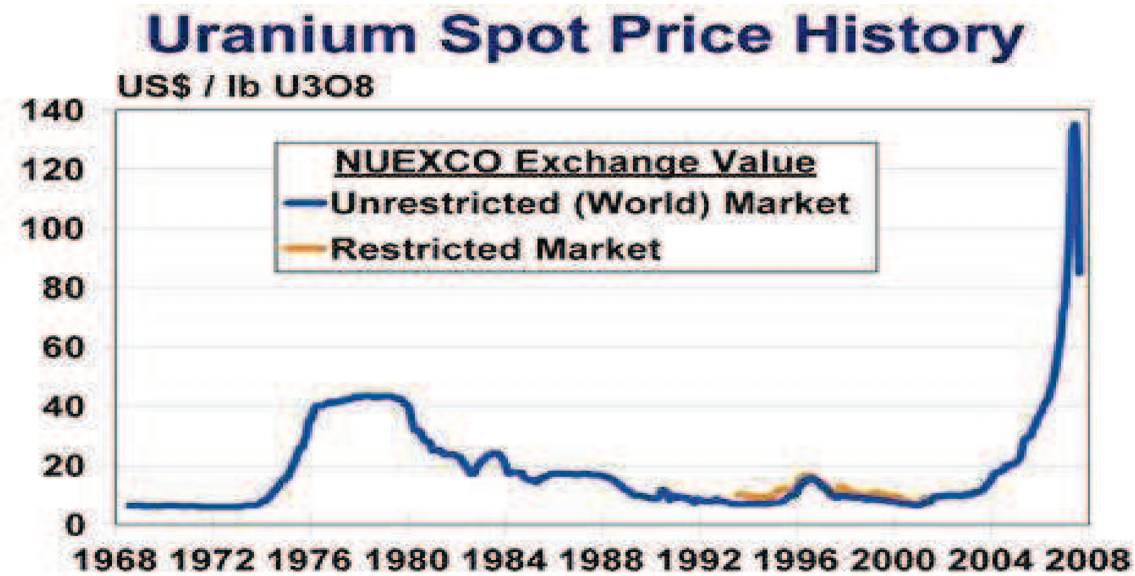


Figure 7 – Uranium Price in 2007 -2009

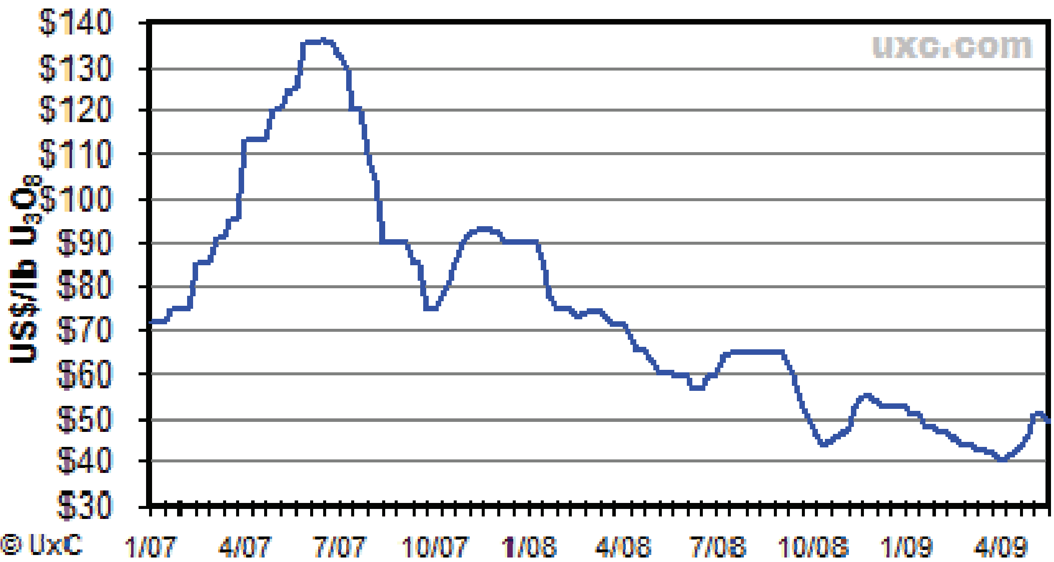
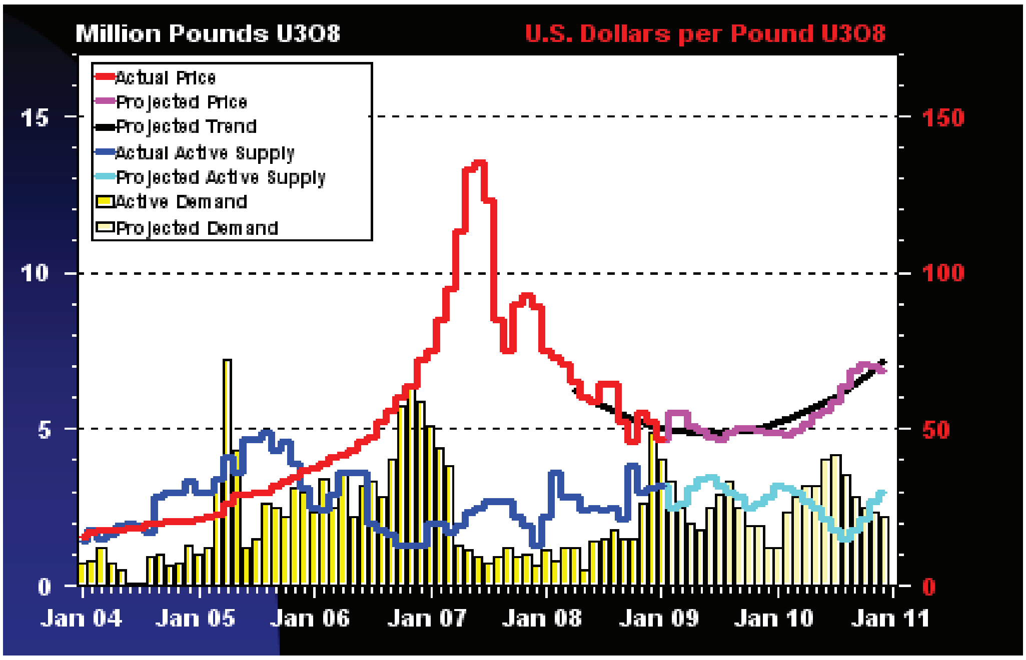


Figure 8 – Analyze of uranium price



Assuming moderate demand until mid-2010, recovery of spot price depends on duration/extent of the credit crunch and drawdown of utility inventories. With continued financial crisis and low interest/ability in the investor segment (low demand), price could stay in the range of $40-60 for several years. Uranium prices could recover faster, if the investor segment rekindles interest and utilities buy for inventory: price expected to rebound to above $80 by late 2009 said Dr. R. Gene Clark, C.E.O. of Mining INDABA Cape Town.

1.6.2 Uranium demand projection through 2050

Figure 9 - Uranium demand projection through 2050

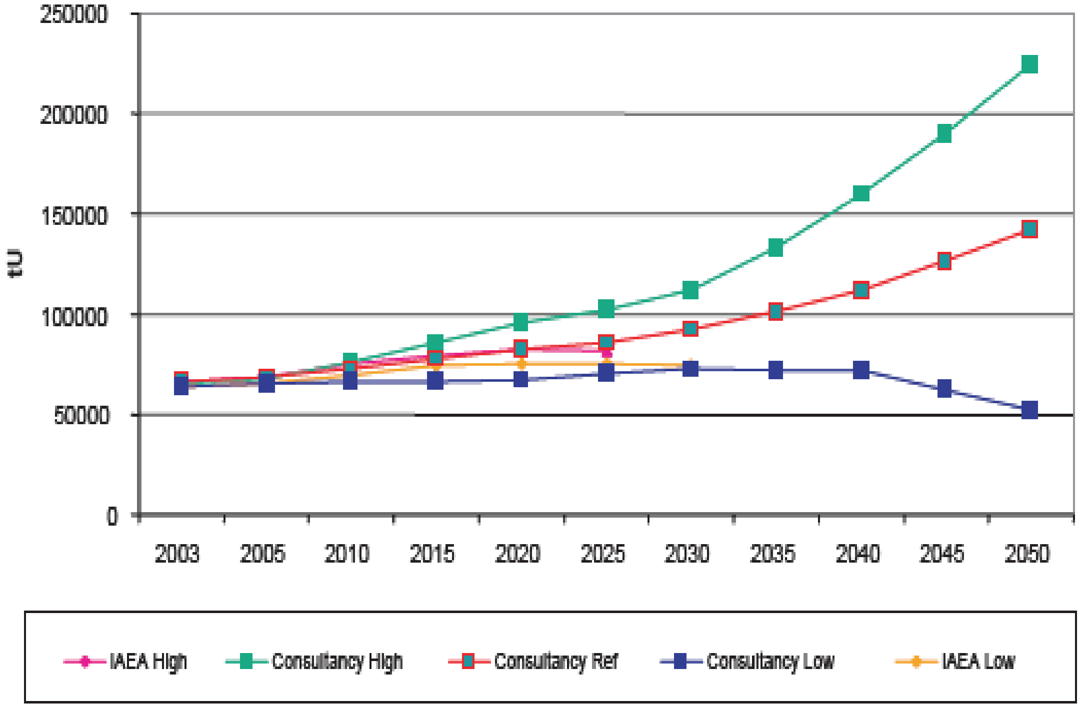
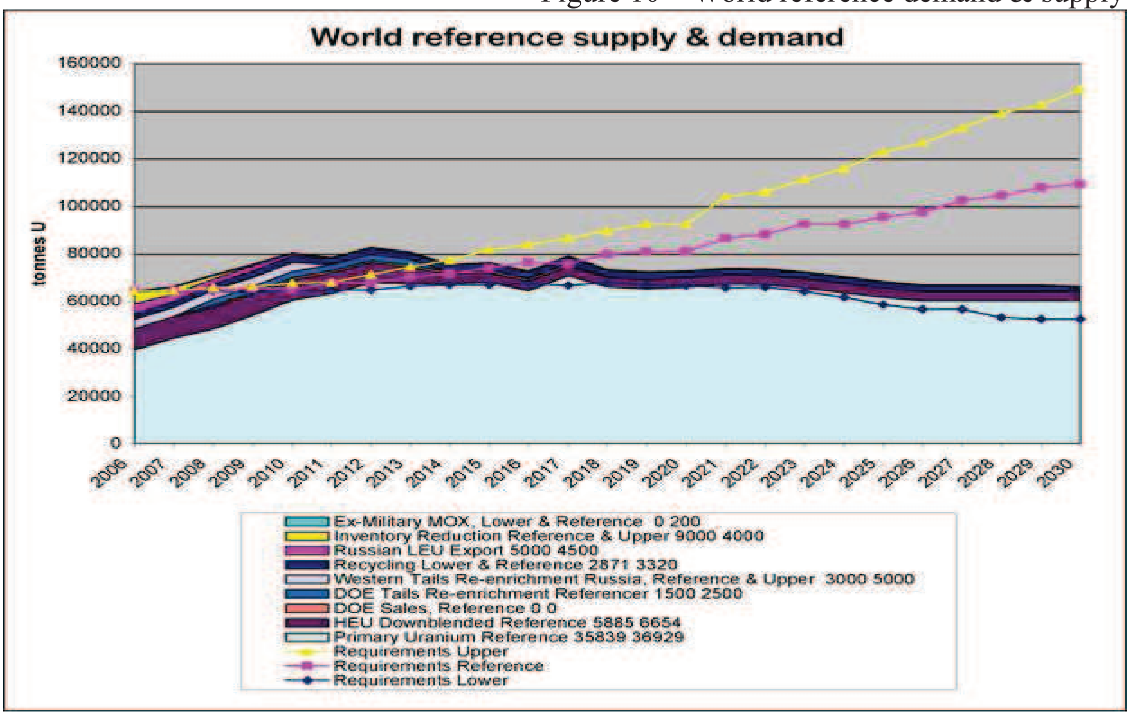


Figure 10 – World reference demand & supply



2 Kazakhstan

2.1 Uranium Resources of the World & the Republic of Kazakhstan

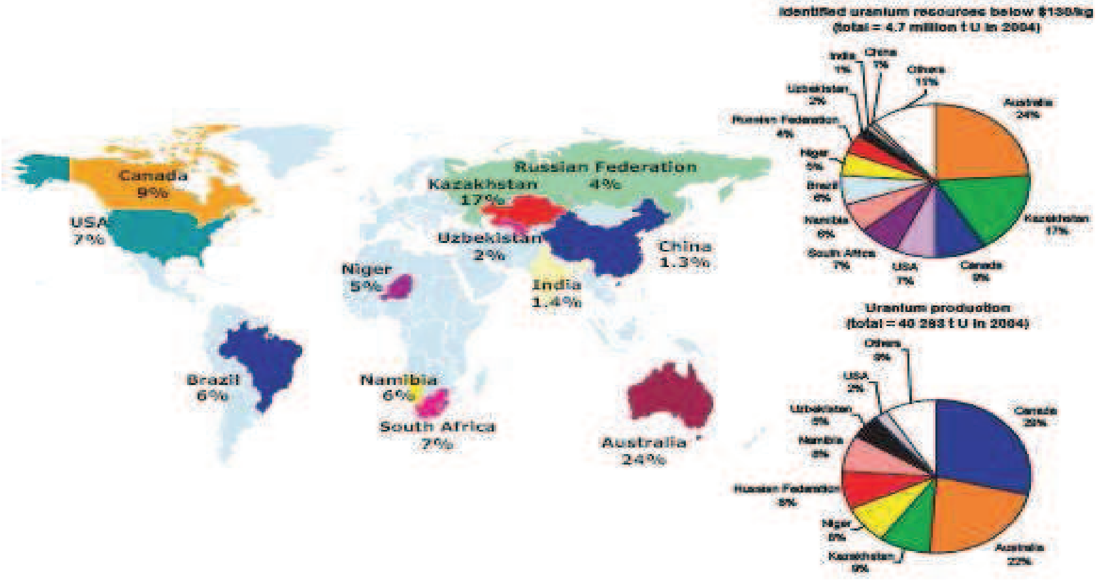
Uranium mining is the process of extraction of uranium ore from the ground. As uranium ore is mostly present at relatively low concentrations. Most uranium mining is very volume-intensive, and thus tends to be undertaken as an open-pit mining. It is also undertaken in only a small number of countries of the world, as the resource is relatively rarely found.

The worldwide production of uranium in 2003 amounted to 41.429 tones, of which 25% was mined in Canada. Other important uranium mining countries are Australia, Russia, Niger, Namibia, Kazakhstan, Uzbekistan, South Africa and the USA.

A prominent use of uranium from mining is as fuel for nuclear power plants. As of 2008, known uranium ore resources which can be mined at about current costs are estimated to be sufficient to produce fuel for about a century, based on current consumption rates.

Distribution of identified uranium resources and uranium production in the world in 2008

Figure 11 – Uranium reserve in the World



2.2 Uranium and Nuclear Power in Kazakhstan

Kazakhstan has 15% of the world's uranium resources and an expanding mining sector, aiming for 15.000 tU annual production by 2010 and 30.000 tonnes by 2018.

Its nuclear power reactor operated from 1972 to 1999, generating electricity and for desalination.

Kazakhstan has a major plant making nuclear fuel pellets and aims eventually to sell value-added fuel rather than just uranium. It aims to supply 30% of the world fuel fabrication market by 2015.

Kazakhstan has been an important source of uranium for more than fifty years. Over 2001-2006 production rose from 2000 to 5279 tonnes U per year, and further mine development is under way with a view to annual production of 18.000 tU/yr by 2010 and 30.000 tU by 2018.

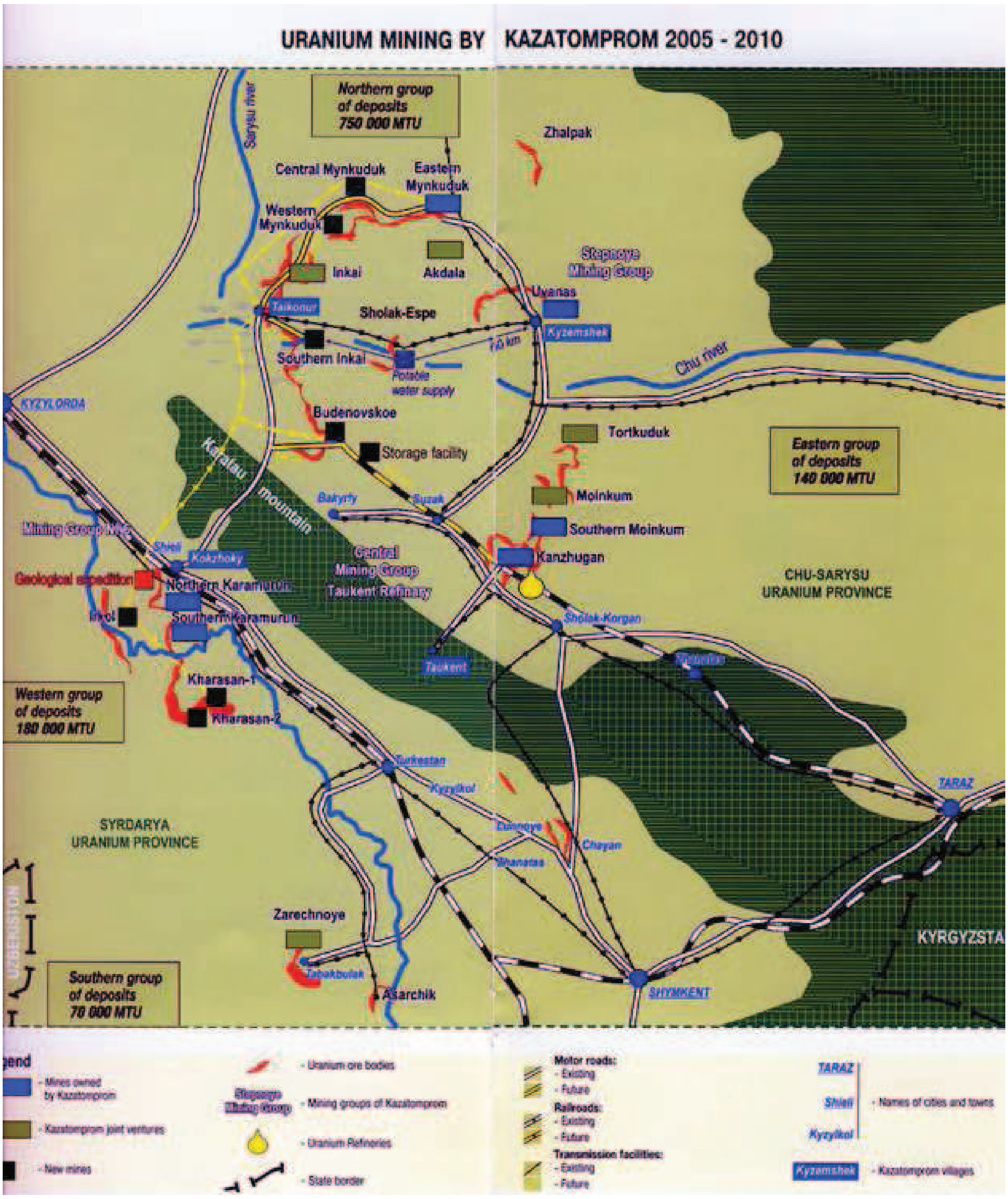
Kazatomprom is the national atomic company set up in 1997 and owned by the government. It controls all uranium exploration and mining as well as other nuclear-related activities, including imports and exports of nuclear materials. It announced in 2008 that it aims to supply 30% of the world uranium by 2015, and through joint ventures: 12% of uranium conversion market, 6% of enrichment, and 30% of the fuel fabrication market by then.

2.3 Recent international collaboration

Kazatomprom has forged major strategic links with Russia, Japan and China, as well as taking a significant share in the international nuclear company Westinghouse. Canadian and French companies are involved with uranium mining and other aspects of the fuel cycle.

In June 2008 Areva signed a strategic agreement (MOU) with Kazatomprom to expand the existing Katco joint venture from mining 1500 tu/yr to 4000 tU/yr (with Areva handling all sales). To draw on Areva's engineering expertise in a second JV (49% Areva) to install 1200 tonnes per year fuel fabrication capacity at the Ulba Metallurgical Plant, and in a third JV (51% Areva) to market fabricated fuel. The agreement is to be concluded in September.

Figure 12 – Uranium mining in Kazakhstan



2.4 Mining and milling organization in Kazakhstan

Table 2 - Kazakh ISL uranium mines

Region	Mine	Resources tu	Operator	Annual production target tu/yr	Start production. full prod'n
Northern/Stepnoye in Chu-Sarysu Basin	Uvanas	8100	Stepnoye-RU LLP (K'prom)	400	2006
	Inkai 1. 2. 3	44.000+	Inkai JV: Cameco 60%. K'prom 40%	4000	2004. 2010
	South Inkai	24.000	BetpakDala JV: Uranium One 70%. K'prom 30%	2000	2007. 2011
	Akdala	25.500	Betpak Dala JV: Uranium One 70%. K'prom 30%	1000	2006. 2007
	Central Mynkuduk	52.000	Ken Dala KZ Stepnogorsk (K'prom)	2000	2007. 2010
	West Mynkuduk	26.000	Appak JV: K'prom 65%. Sumitomo 25%. Kansai 10%	1000	2008. 2010
	East Mynkuduk	22.000	Stepnoye-RU LLP (K'prom)	1300	2006. 2007
	Budenovskoye 1. 3. 4	30.000	JV Akbastau: K'prom 50% ARMZ 50%	1000 (1) 2000 (3.4)	2008. 2015 2010
	Budenovskoye 2		JV Karatau: K'prom 50% ARMZ 50%	1000	2007
	Zhalpak	15.000	JV with China (CNNC 49%)	1000	2012?
Central/East in Chu-Sarysu Basin	Moinkum (southern Moinkum. Katco)	44.000	Katco JV. Areva 51%. K'prom 49%	1000	2006. 2007

Region	Mine	Resources tu	Operator	Annual production target tu/yr	Start production. full prod'n
	Tortkuduk (Moinkum North)	20.000	Katco JV Areva 51%. K'prom 49%	2000	2007. 2008
	South Moinkum (east moinkum)	35.000	Taukent Mining & Chemical Plant LLP (K'prom)	1000	2006
	Kanzhugan / Kaynarski	22.000	Taukent Mining & Chemical Plant LLP (K'prom)	300	2007
Western in Syrdarya basin	Kharasan 1(north)	41.000	Kyzylkum JV. Japanese 40%. Uranium One 30%. K'prom 30%	3000	2008. 2014
	Kharasan-2		Baiken-U JV. Japanese 40%. K'prom 60%	2000	2009. 2014
	Irkol	30.000	Semizbai-U JV (K'prom 51%. CGNPC 49%)	750	8/2008. 2010
	N. Karamurun	16.000	Ru-6 LLP (K'prom)	1000	2007. 2010
	S. Karamurun	18.000	Ru-6 LLP (K'prom)	250	2009
Southern In Syrdarya basin	Zarechnoye	40.000	Zarechnoye JV: K'prom 49%. ARMZ 49%	1000	2006. 2009
	Southern Zarechnoye		Zarechnoye JV: K'prom 49%. ARMZ 49%	1000	2010
Northern province					
Akmola region	Semizbai		Semizbai-U JV (K'prom 51%. CGNPC 49%)	500 (680 later)	2009. 2018

The Stepnoye or Northernmining group in the Chu-Sarysu basin consists of Uvanas. East

Mynkuduk, Akdala and Inkai mines, with Central and West Mynkuduk, South Inkai, Budenovskoye and Zhalpak planned. All these deposits are amenable to in-situ leaching (ISL) mining method.

Moynkum (Muyunkum): Initially a pilot plant was commissioned for a period of three years. Exploitation in the pilot plant continued till 2004. Thereafter Areva and the state utility Kazatomprom agreed in April 2004 to set up a 500 tU/yr in situ leach (ISL) uranium venture at Moinkum in this part of the Chu-Sarysu basin. Areva holds 51% and funded the US$ 90 million Katco joint venture. Having spent some US$ 20 million already since 1996. Resources are 52.000 tu3O8. Operation began in June 2006, with a capacity leaching, almost its full 500 tU in 2007.

Tortkuduk (Moinkum North) is also part of the Katco JV and was expected to reach full production of 1000 tU/yr by the end of 2008.

A June 2008 agreement expanded the Katco joint venture from mining 1500 tU/yr to 4000 tU/yr and sets up Areva to handle all sales from it until 2039. In 2008 Areva reported total Muyunkum phase 1 production as 1356 tU.

2.5 Resource of uranium in KAZAKHSTAN

A 2005 KazAtomProm publication listed uranium resources in the Chu-Sarysu and Syrdarya provinces as:

Northern (Stepnoye) - 750.000 tU

Eastern (Tsentralnoye) - 140.000 tU

Western (# 6) - 180.000 tU

Southern (Zarechnoye) - 70.000 tU

this being 72% of total Kazakh U resources and all suitable for acid ISL recovery.

In other provinces: Northern Kazakhstan has 256.000 tU mostly in hard rock. Ili has 96.000 tU in coal deposits. Caspian has 24.000 tU in phosphate deposits and Balkhash 6000 tU after major deposits were exhausted in the Soviet era.

2.6 Non-proliferation

Kazakhstan is a party to the Nuclear Non-Proliferation Treaty (NPT) as a non-nuclear weapons state. Some 1300 nuclear warheads were destroyed after independence. Its safeguards agreement under the NPT came into force in 1994 and all facilities are under safeguards. In February 2004 it signed the Additional Protocol in relation to its safeguards agreements with the IAEA, and this came into force in 2007.

3 KATKO

3.1 Presentation of JV KATCO

The Kazakhstan-French Joint Venture KATCO LLP was established in 1996.

KATCO JV's Founders are: the AREVA Group 51% (France) and the National atomic company Kazatomprom 49% (Kazakhstan).

The main activity of KATCO JV involves:

- Geological exploration;
- Planning and construction of capacities for uranium-bearing ore, mining and processing and the use of these capacities at deposits, especially at the Moinkum deposit in the South Kazakhstan region;

The KATCO JV mines uranium by the in-situ leaching method in the northern part of the Site No.1 Yuzhnyi of the Moinkum deposit and at the Site No.2 Tortkuduk, also of the Moinkum deposit.

The main events in the history of KATCO JV are:

- In 1999 KATCO JV received a license for uranium mining in the northern part of the Site No.1 Yuzhnyi and for exploration and mining of uranium at the Site No.2 Tortkuduk of the Moinkum deposit.
- In 2000 KATCO JV signed a contract for uranium mining at the Site No.1 Yuzhnyi and for exploration and mining of uranium at the Site No.2 Tortkuduk of the Moinkum deposit.
- In 2001 KATCO JV started pilot work on in-situ leaching at the Site No.1 Yuzhnyi and exploration at the Site No.2 Tortkuduk.
- In 2003 a feasibility study for a commercial operation project was approved.
- In 2004 the first concrete was poured for construction of the production plant at the Site No.1 Yuzhnyi. Drilling work (commercial mine development) at the Site No.1 Yuzhnyi of the Moinkum deposit was started the same year.
- In 2005 the contract area was extended to include the northern part of the Site No.3 Tsentralnyi. The contract validity period was also extended until 03.03.2039 and construction of the shift camp was

started at theSiteNo.2 Tortkuduk.

- In 2006 an ISL mine with a capacity of 500-1000 tonnes of uranium per year, at the Site No.1 Yuzhnyi was put into operation.
- An ISL mine with a production capacity of 2000 tonnes of uranium per year, at the Site No.2 Tortkuduk was put into operation in 2007.
- In 2008 AREVA and Kazatomprom signed a contract for KATCO to increase uranium production up to 4000 tonnes per year and for social sphere financing.

In 2008 the average number of employees was 1060 people.

3.2 Commodity markets study of the final product

KATCO place in the market of uranium has been certain by studying of ratio demand / production of uranium

In specialized press are published numerous analyses of demand/offer of uranium in which attempts are made to provide need for uranium for the period 2002-2015

On geographical zones demand is distributed as follows:

Stable demand in America: the limited quantity of the enterprises will be closed, considering competitiveness of existing reactors with prolongation of the license for operation;

Gradual reduction in demand in Europe, closing of reactors in Germany and Sweden at the end of the considered period, the moratorium in Belgium and Switzerland;

The stable tendency of increase in demand in Asia;

Reduction in demand in Russia and the Eastern Europe, considering economic difficulties in the countries of the specified region.

In general, increasing of demand is predicted from 3 up to 10 % for next 10 years. In countries with market economy up to 7 %.

3.3 Potential consumers and conditions of sale

Until 2039 year of manufacture КАТСО, AREVA will be commercial agent of КАТКО, it means that:

AREVA will negotiate sale contracts for the totality of uranium produced by KATCO and AREVA will sell it. The French state-controlled nuclear engineering group;

AREVA will represent these contracts to board of KATKO which will approve them; AREVA will receive compensation for marketing;

КАТСО will have the full responsibility for sale contracts.

3.4 KAZATOMPROM

The Atomic Company KAZATOMPROM is the national operator of the Republic of Kazakhstan for import and export of uranium. Rare metals, nuclear fuel for power plants, special equipment and dual-purpose materials.100% of the Company's stock is held by the Government under the National Welfare Fund SAMRUK-KAZYNA. At present, over 25.000 workers are employed by the Company. Kazatomprom is one of the world's leading uranium mining companies.

3.5 AREVA

AREVA is a French industrial group with the major part of its shares (80%) belonging to the CEA governmental organization (the French atomic energy commission). AREVA was established on September 3rd, 2001 as a result of the merging of COGEMA and FRAMATONE.

It is a global leader in the nuclear power sector. The Group represents a vertically integrated company with a complete nuclear production cycle including:

- Uranium mining and reprocessing;
- Uranium enrichment and fuel production;
- Construction of nuclear reactors and their maintenance;
- Reprocessing of used fuel.

AREVA is also engaged in the transfer and distribution of electric power (taking third place in the world) and electric power production from alternative sources free from carbon dioxide emission (the so-called greenhouse gas).

The aim of AREVA is to provide access to the most environmentally sound, safe and economically advantageous power possible.

3.6 Katko's existing production

KATCO has three sites:

- Site # 1 MKM (Moyunkym) 1000t/y
- Site # 2 TKD (Tortkuduk) 1000t/y
- Site # 3 TKDN (Tortkuduk North) 1000t/y
- Site # 4 TKDC (Tortkuduk Center) under implementation

Development and plans:

- 2005 year - 400t U
- 2006 year - 530t U
- 2007 year - 1000t U
- 2008 year - 1500t U
- 2009 year - 2500t U
- 2010 year - 3000t U
- 2011 year - 4000t U

Until 2039 year 4000 t U per year

Figure 13 – Sites of Katko

4. Tortkuduk Central

4.1. Location of Tortkuduk Central

The section Tortkuduk Central of Muyunkum deposit, is located in the sozakskiy region of Southern- Kazakhstan region. The total area of geological outlet composes 560 km^2. The region of section is desert, folded by the sandy massif of Muyunkum with the absolute marks from 200 m in the northern boundary part of the massif to 525 m in south that passes in the axial part of the massif into the large- growing sands.

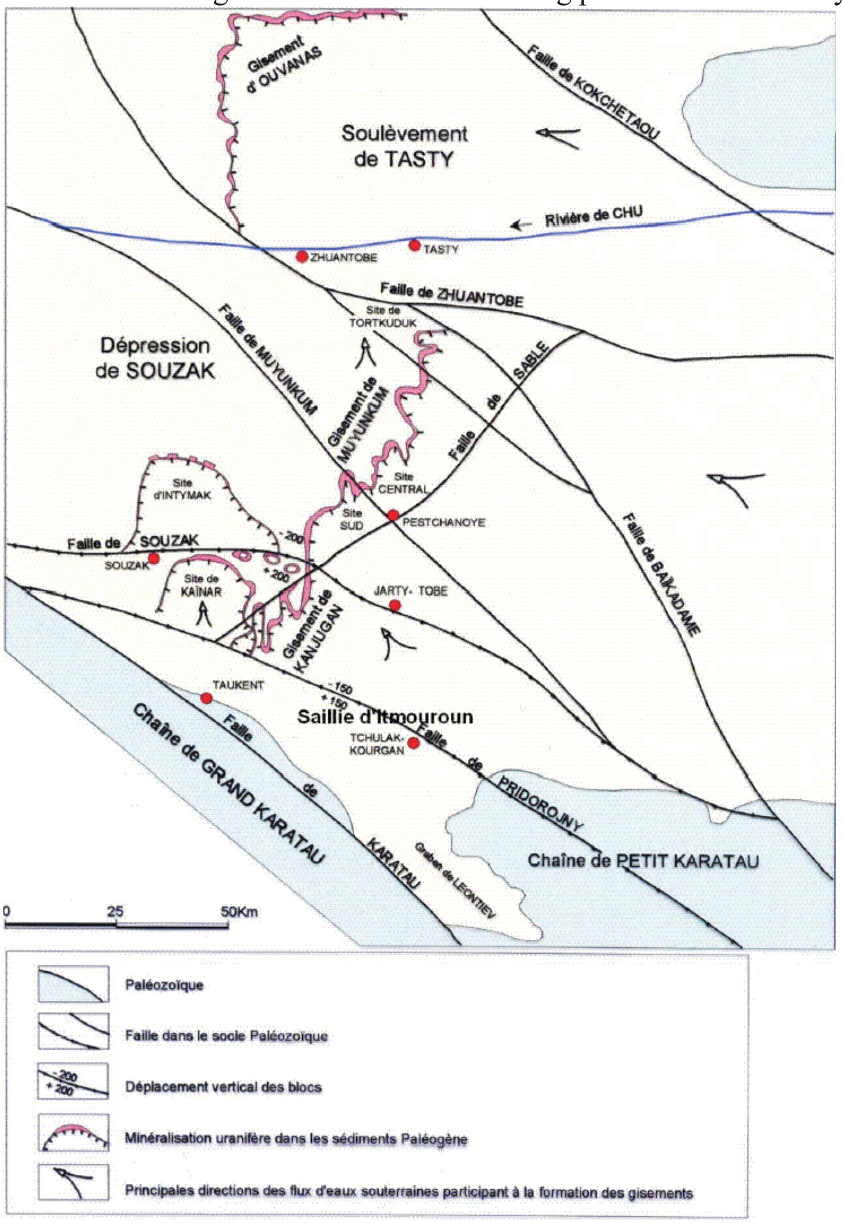
Hydrographic network in the limits of the sandy massif of Muyunkum is absent. River Chu located on 75 km north of section. It dries up in the summer time. Being converted into the chain of the separated reaches with the musty water.

Climate is sharply continental with the cold and slightly snowy in winter (the minimum temperature of air to -35° C) and the hot (to +40°C) arid summer. Atmospheric precipitations fall out. In essence, in the mountain part of hill B.Karatau. In the limits of sandy massif the amount of precipitation does not exceed 120-190 mm per year with the maximum (to 85%) during the winter-spring period. Snow cover to 10 cm is established in December - January and descends in March. Summer season lasts 150 days. The surface of sandy soils in the summer time heats up to 60°C. In the winter time the depth of freezing up to 75 cm. The ruling wind direction is south-western and north-eastern. Plant and animal are typical for the deserts and the semi-deserts. In the limits of sandy stand the saxsaul predominates. Large mammals are by Saigas, Gazelles, Subgutturosa, Wild pigs, small - by hares, by Gophers, by Jerboas and others.

Region is economically weakly mastered and little settled. In the limits of sandy massif there is no permanent population. Only in the winter time on the wintering live shepherds,and grazing flocks of sheep. Basic population is concentrated in the foothills B.Karatau is also along Chu river. Kazakhs and Uzbeks predominate, who carry out stock raising and partially agriculture.

The largest populated areas are villages. Chulak- Kurgan, Suzak, Taukent, located at the foothills of B.Karatau at a distance of 100-150 km from this section. In the valley of the river of Chu are located eight live farming. All settlements are connected by gravel roads. Regional center Chulak- Kurgan is connected with the asphalted highway from Chimkent city, the suzak settlements, Juan –Tobe, Stepnoe (deposit “uvanas”), sections PV-19 (deposit “mynkuduk”), PV-5 (deposit “kanzhugan”), № 1 (deposit “muyunkum”) and with the constructed city Taukent (Fig. 2). On muyunkum deposit forces JV “KATCO” built the bituminous road with an extent of about 100 km. which penetrates the sandy massif along the basic ore bodies and it connects the layers of “kanzhugan” and “muyunkum” with the section “tortkuduk”.

Figure 13 - Structural diagram of the uranium-bearing province of Chu-Saryssu



Industry is connected in essence with the mastery of the kanzhugan deposits. Muyunkum (№ 1- southern), “Uvanas”, “Mynkuduk”, whose finalizing is conducted by forces TGHK (Taykent Mining chemical Enterprise) mine management Stepnoe TOO “GRK” (Mining Company).

The nearest railway station is station Sozak. that has communication with a length of 73 km to station Zhanatas, where is located the terminal TGHK (NAK Kazatomprom) or railroad dead-end siding, which is found in 15 km from Kanzhugan mine and 30 km to the south Yuzhnyy Moinkum mine. Equipped with warehouse accommodations, the acid reservoir and other auxiliary accommodations. Distance to the provincial centers (cities Shymkent and Taraz) is correspondingly 270 and 300 km.

The drinkable and technical water supply of watch settlement and section of works is ensured due to the underground waters of artesian basin. Mineralization in the water does not exceed 0.5-1.0 g/l. The boundary of self-effusion penetrates the bed 11y. The depth of the piezometric level of formation water in the southern part of the section reaches 20-30m.

As a whole, the region of muyunkum deposit has its special features and difficulties in the region of the social and economic development, which are determined by its distance from the developed productive-cultural centers and the material and technical bases. By severe natural climatic conditions. From other side, the layer is located in the favorable conditions for mine uranium by in-situ leaching method - the mineralization of formation water of the productive horizons is 0.5-1.0 g/l. On the layer there is no earth suitable for the agricultural land. All these decrease problems and expenditures on the natural-guarding measures with the mastery of deposit.

4.1.1 Geology

The uranium deposit Muynkum is one of the large deposits of the Tchou-Sarysou depression. It is located in its southern part. Relief is consisted of series of dune sand cords of alluvial origin and covered by poor deserted vegetation. In the north, sands have border with plain of the river Tchou. Located in 50 km to the north. In summer, the river is desiccated and changes to series of small brooks separated by stagnant water.

The sand and sandstone are of the average granulometry, essentially quartz-feldspar. With very little content of carbonates (<0.2%)

and characterised by high permeability (5 to 15 darcy) are predominant in the basin. Which is of artesian group.

The grade of uranium mineralisation ranges from 0.2 to 1.0 kgU/t. the mineralisation occurs at a depth range of 80 to 700 m. Uranium is coffinite and uranite and associated with Rhenium and Yttrium. Less frequent with Selenium

Because of the big extent of a deposit, geological characteristics and the complexity of a relief, the deposit has been divided into four equivalent sites:

- Southern Muyunkum;
- Tortkuduk;
- Tortkuduk Northern;
- Tortkuduk Central.

4.1.2 Stratigraphy

The detailed study of the sediments deposited in the depression of Tchou-Saryssou and of the layer of Muyunkum made it possible stratiographically to study in detail the higher stage Mesocenozoic of platform represented by the sediments of the Cretaceous. Of the Palaeogene and Neogene and the deposits of Quaternary sediment

4.1.3 Mineralization

The composition of the ores and the host rocks was studied by geochemical and mineralogical samples taken from the carrots of the exploration surveys. On the whole 700 mineralogical samples and 2800 geochemical samples were taken for analysing. Industrial uranium-bearing mineralisation is related to slightly consolidated sands of gray colour and feldspato-quartzic composition. The chemical composition of the ores in % of the layer belongs to the silicates family, which has been indicated in the following table.

Table 3 – Chemical composition of the ore

Gîte	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5
Horizon Ikan										
3i	82.84	0.34	9.00	3.09	0.00	0.85	0.57	0.58	3.00	0.06
4i	82.84	0.31	9.46	3.07	0.00	0.81	0.55	0.58	2.32	0.06
Moyen	82.84	0.32	9.30	3.07	0.00	0.82	0.56	0.58	2.54	0.06
Horizon Uyuk										
1y	94.00	0.16	3.32	2.19	0.00	0.16	0.21	0.06	1.56	0.09
10y	91.54	0.20	4.35	2.17	0.00	0.10	0.19	0.04	1.43	0.06
16y	90.04	0.30	4.00	2.04	0.03	0.11	0.14	0.08	3.24	0.04
11y	90.00	0.26	4.00	2.30	0.01	0.09	0.27	0.08	2.96	0.06
13y	90.07	0.16	4.02	2.24	0.03	0.18	0.21	0.00	3.02	0.07
Moyen	91.37	0.20	4.17	2.16	0.01	0.11	0.19	0.04	1.86	0.06
Horizon Kanjugan										
12k	89.90	0.13	5.44	1.70	0.00	0.11	0.19	0.08	2.12	0.07

Figure 14 - Geological cross-section of the basins of Syr-Darya and Chu-Saryssu

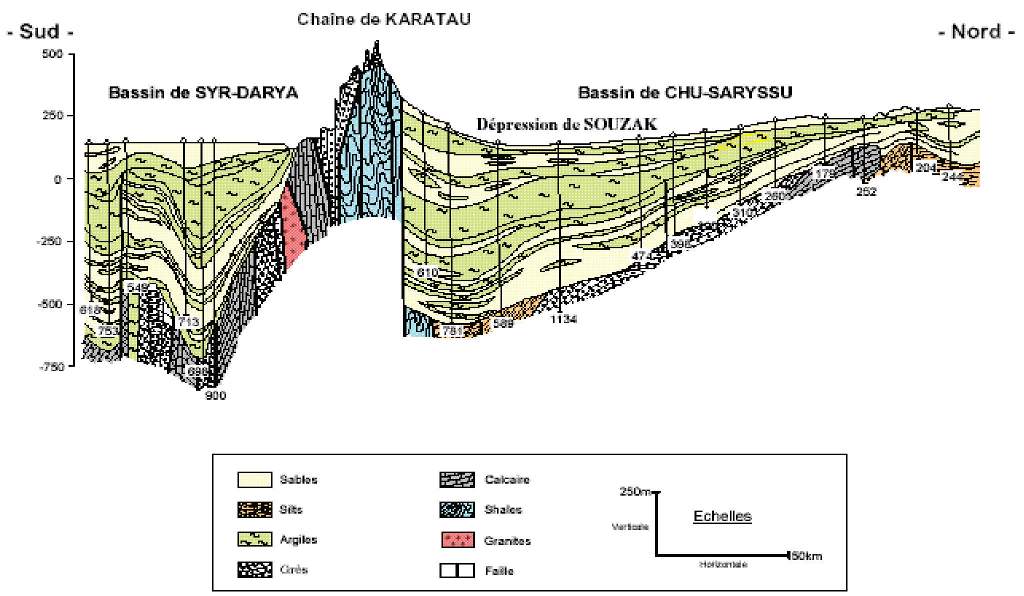
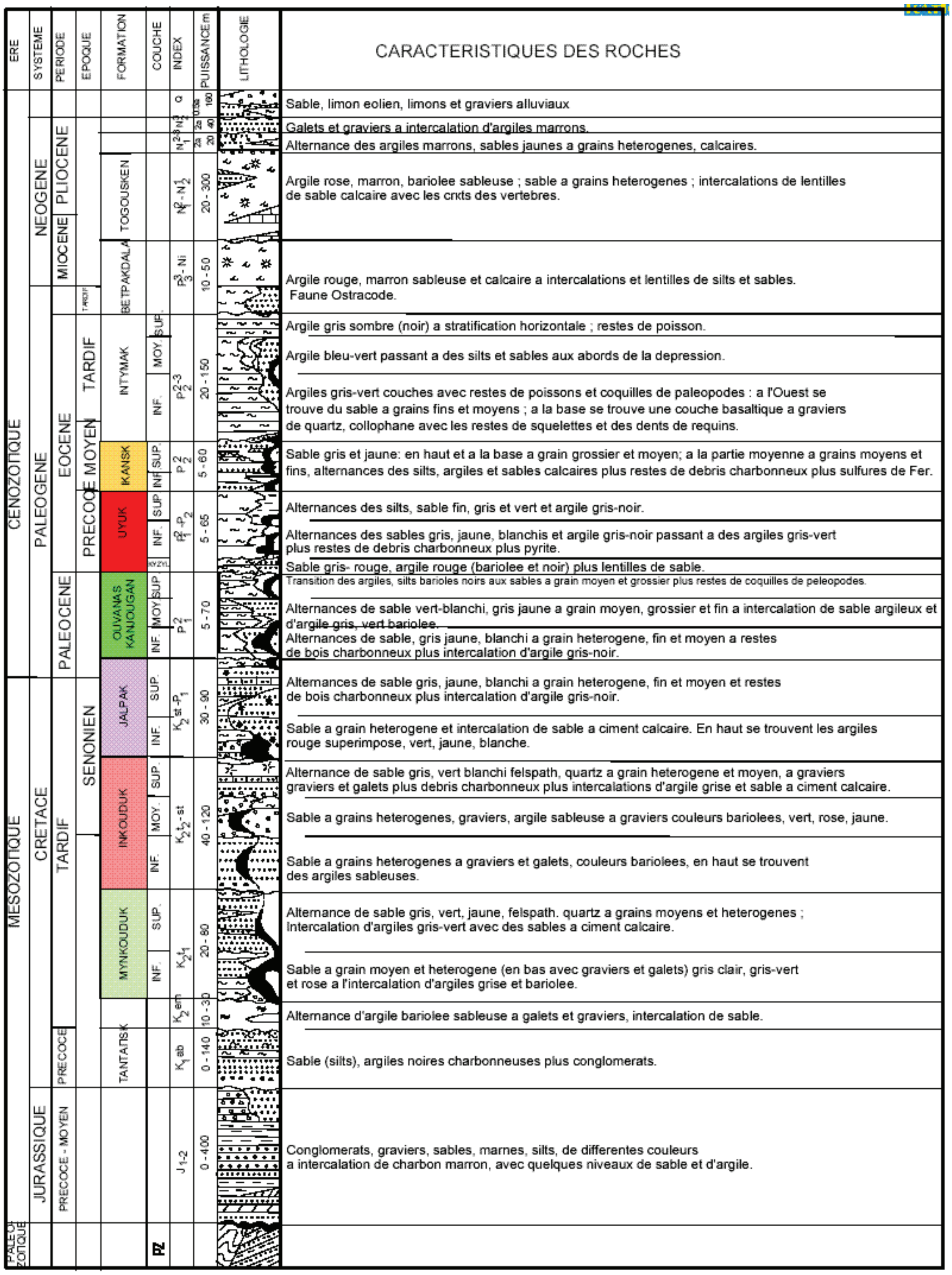


Figure 15 - Stratigraphic column of Chu-Saryssu



Ruslan BATIYEV
CESPROMIN 2008/09

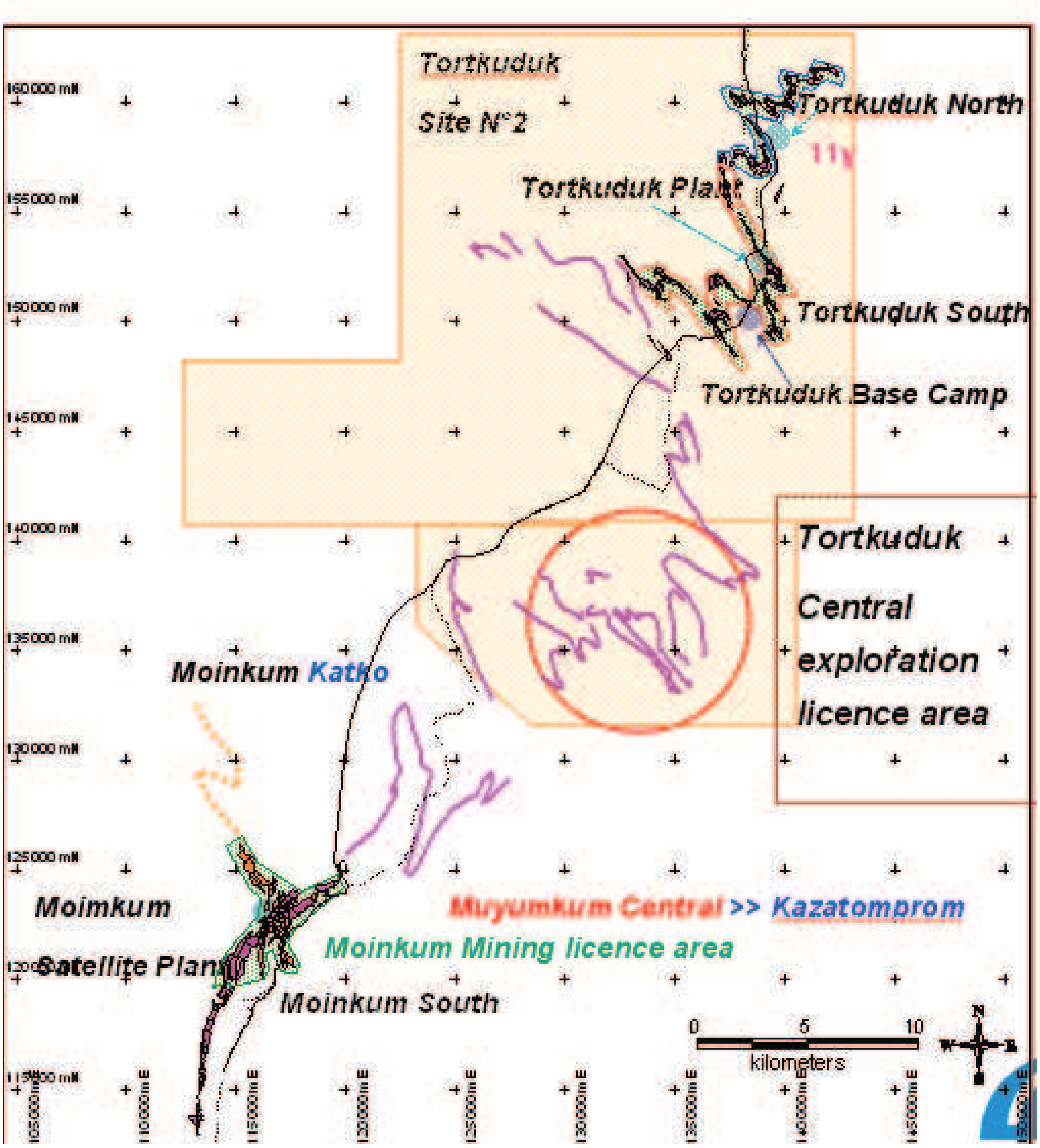


Figure 16 - The section Tortkuduk Central

4.1.4 Ore reserve estimation

The exploration of the section Tortkuduk Center was carried out in the period from 1979 until 1987. In accordance with the instruction of state commission for reserves (GKZ) dated 1986 according to the classification of minerals, for the detection of the reserves of uranium on Muyunkum, deposit was accepted the following exploration network:

- category P1: 200 - 100 X 50 - 25 (200 X 50)
- category C2: 800 - 400 X 100 - 50

The part of reserves of uranium on the Central Tortkuduk of Muyunkum deposit were affirmed in GKZ of the USSR in 1987 and were set to the balance in GKZ RK (table.). Results of the chemical core of the exploration wells and gamma-ray logging. or the equivalent U, obtained with the measurement of radioactivity in the bore holes by the method KND-M has been used for the estimation of reserves.

According to preliminary data reserves estimated at 20 000 tU, with average content of 0.052%. These data were taken for pre-feasibility study of this project.

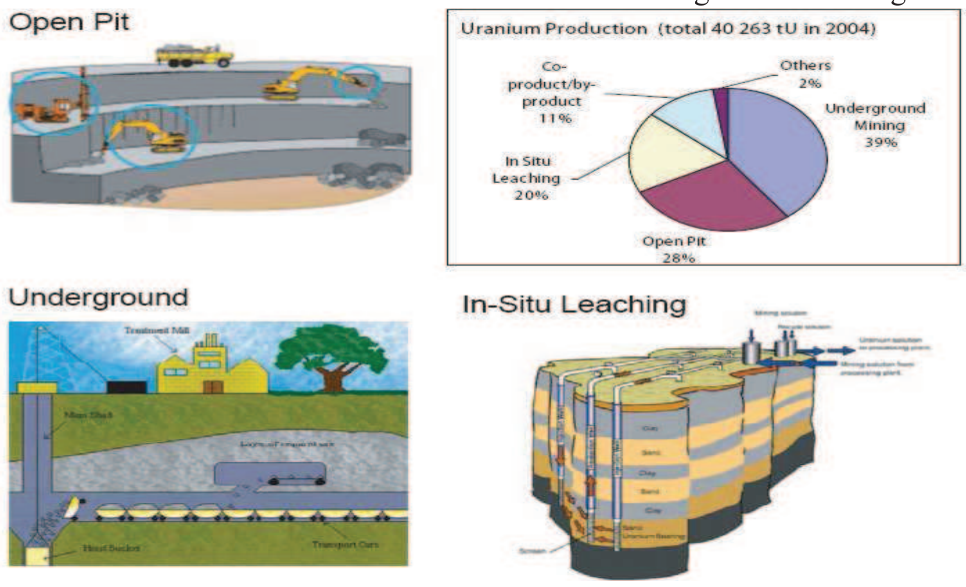
At present, exploration continues and will be finished in two years.

The Tortkuduk Center relates to the average objects in the reserves of uranium and is characterized by favorable conditions for the extraction of uranium by the in-situ leaching method.

4.2 Uranium mining

Uranium ore is removed from the ground in one of three ways depending on the characteristics of the deposit (Figure 4.1): open pit mining, conventional underground mining and in situ leaching (ISL). Open pit mining is used to recover uranium deposits close to the surface. i.e. generally less than 100 meters depth. Deep deposits require conventional underground mining. Uranium underground mines require extra care with ventilation to control particularly radiation exposure and dust inhalation. Normally the ore is hoisted to the surface for milling. In some underground mines, however, to reduce radiation exposure from the high-grade ore, the ore is processed underground to the consistency of fine sand. Diluted with water and pumped to the surface as slurry. ISL is a process that dissolves the uranium while still underground and then pumps the uranium bearing solution to the surface. Depending on the composition of the ore body. Weak sulphuric acid or sodium carbonate is used. The ISL process limits environmental disturbances on the surface, leaving all the surrounding rock in place while the dissolved uranium is pumped to the surface and circulated through a processing plant for extraction. By their nature ISL mines are smaller than open pit and underground mines and require correspondingly less up-front investment. ISL is the sole extraction method used in Kazakhstan and Uzbekistan and currently accounts for nearly all of production in the US.

Figure 17 - Mining methods



The process of In-Situ Leaching combines both the mining and processing of the uranium at the same time. However, method ISL cannot be applied to all of the uranium deposits.

Ore bodies must have the following properties:

- Occur in porous and permeable rocks (generally sands and sandstones);

- Between continuous and thick impermeable levels such as clays or shales;

- Located in water tables;

- The water pressure must be artesian relative to the clay confining layer above (minimum about 15 m. 75 m or more is desirable)

- Must contain minimum grade and thickness criteria necessary for economically profitable extraction of the contained uranium;

- To provide effective contact between the leaching solution and uranium minerals

4.2.1 Results of laboratory tests

According to the results of the laboratory tests, the following conclusions are essential:

- Concentration in sulphuric acid in mode of acidification: ~ 16 g/l;

  A stronger concentration would cause to increase the consumption of acid and the pressure loss to very slightly increase the recovery of uranium; A weaker concentration, would cause to strongly decrease the recovery of uranium without major reduction in the consumption of reagent;
- It is rather difficult to predict the actual value of the pressure losses
- The concentration in sulphuric acid in period of active leaching must gradually drop up to the value of 4 g/l. in order to obtain production solutions with pH of ~ 1.5.

Moreover, it is necessary to take into account the evaluation of the consumption of acid to acidify the wall-rocks. According to the data of the test:

- In the horizontal columns under atmospheric pressure 16 g/l H_2SO_4: 8.2 kg of H_2SO_4/t of mining mass;
- In the vertical column under pressure : 3.2 kg of H_2SO_4/t of mining mass.

At the time of the industrial development of the deposit, the most probable value is 8 kg of H_2SO_4/t of mining mass.

In addition, the use of oxygen under pressure of ~ 6 bars is possible to generate Fe^{3+} and to accelerate the kinetics of dissolution like for probably generating sulphuric acid by oxidation of sulphur.

The geotechnological field of wells :

Types and design of the wells:

The geotechnological field of wells consist of three types of wells: injectors, producers and observation wells. The function, the characteristics and the principal differences in each type are given below.

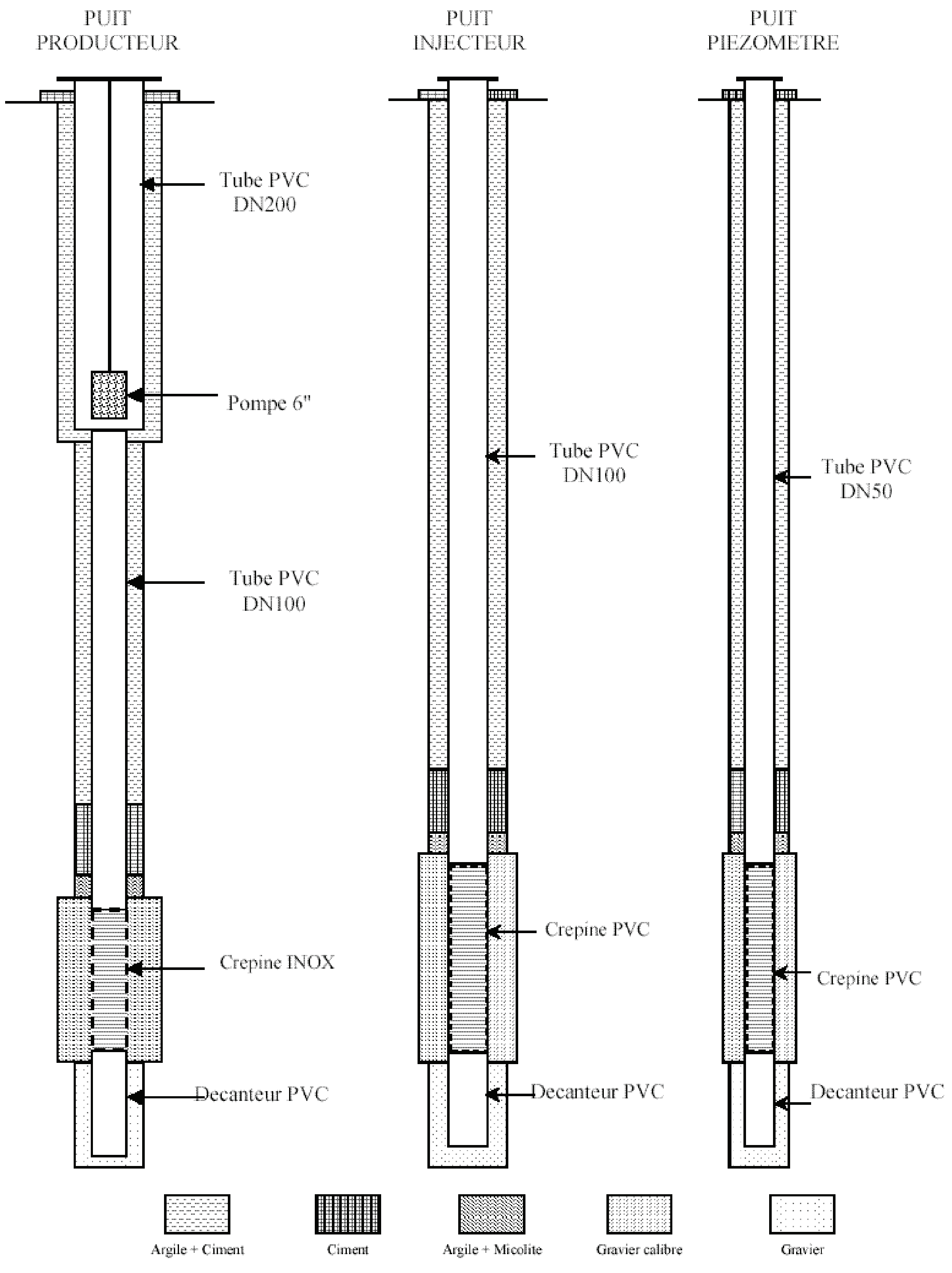
The injecting wells are intended to distribute the leaching solutions in the productive horizon.

The casing, the strainer and the decanter for injecting drillings are realized in only one diameter DN100.

The producing wells are intended to pump out the productive solutions enriched by uranium.

The observation wells are intended to monitor the environmental impact. Located within the limits of the blocks of exploitation and observe the penetration of the solutions in auriferous stratum.

Figure 18 – Design of the wells


PUIT
PRODUCTEUR
PUIT
INJECTEUR
PUIT
PIEZOMETRE
Tube PVC
DN200
Pompe 6"
Tube PVC
DN100
Crepine INOX
Decanteur PVC
Tube PVC
DN100
Crepine PVC
Decanteur PVC
Tube PVC
DN50
Crepine PVC
Decanteur PVC
Argile + Ciment
Ciment
Argile + Micolite
Gravier calibre
Gravier

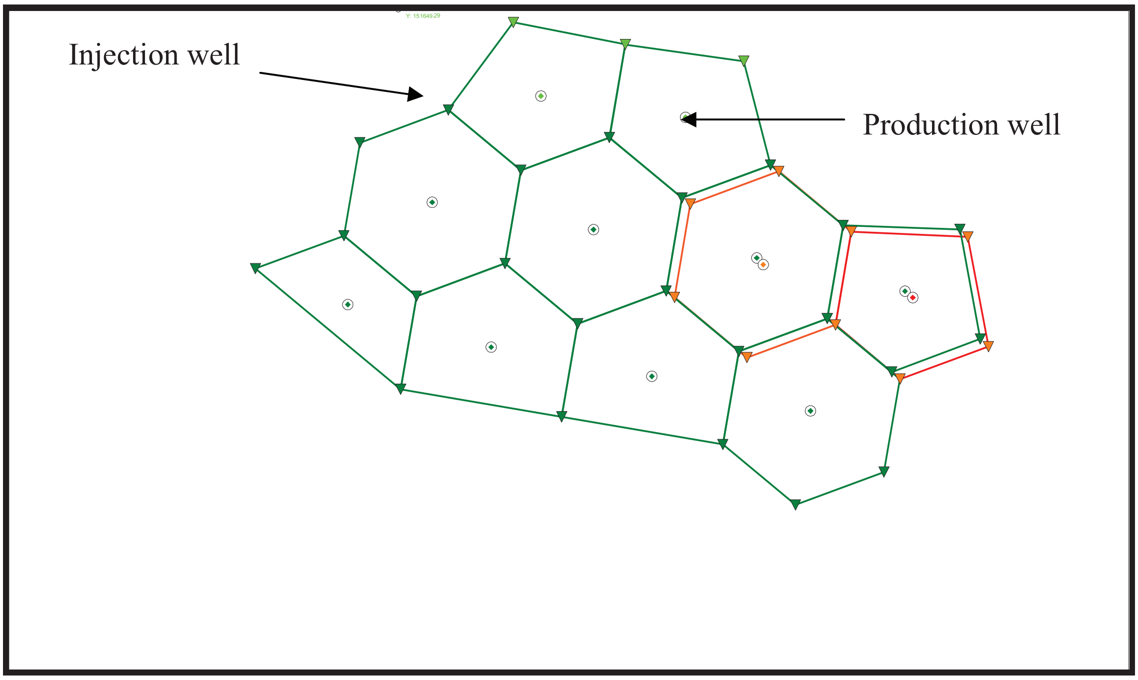
1.2.2 Drilling

Katko has subcontracted the drilling work to "Volkovgeology" company. Which caters for the drilling need of Katco. According to the contract value of productive wells, 40000 euros with the pump, Injecting well costs 30000 Euros and monitoring wells 6000 euros for each well. The average depth of wells is about 450 meters.

Table 6 – Calculating of drilling

	Wells			
	Production	Inject	Monitoring	Cost
0 year	80	240	8	10432000
1 year	79	240	8	10424000
Total	**159**	**480**	**16**	**20856000**

Figure 19 - Hexagonal scheme of the opening



4.3 Plant & Processes

Obtaining the desorbates (eluates) on central installation on the Central Totkuduk using the "classical" scheme of the cascade of the pressure columns of desorption (NH_4NO_3). Then desorbates transportation for refining to Tortkuduk and obtaining U_3O_8;

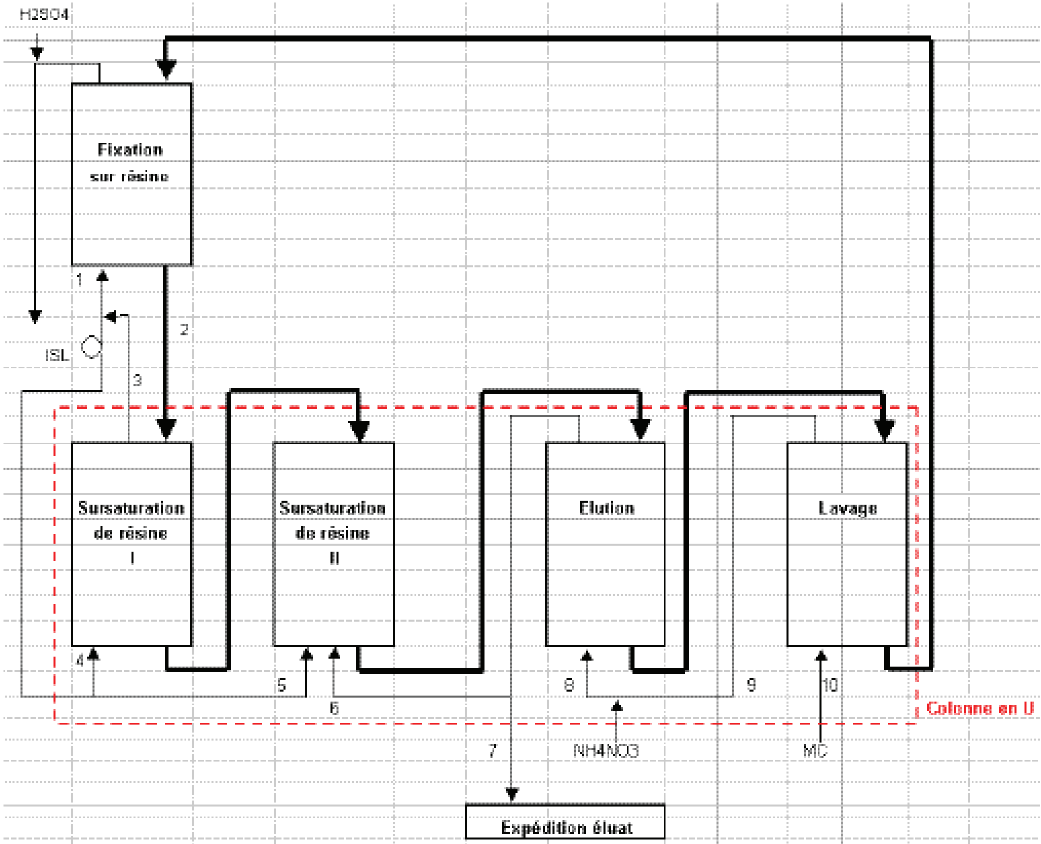
Complex for processing of productive solutions consist from several sections. Each includes its technological process and equipment formulation:

- Tanks for the productive and leaching solutions. Pumping the productive and leaching solutions, the sorption of productive solutions, the knot of filtration;

- Complementary saturation by uranium the sorbent, the desorption of the uranium-bearing sorbent, the denitration of sorbent, the washing of sorbent from the excess acidity;

- Storages of sulfuric acid and ammonium saltpeter with the department of the preparation of the desorbing solutions. The point of deactivation with the final product storage.

Figure 20 – Process flow sheet



The main technological parameters for production 1000t U/year are presented in table below:

Table 7 – The main technological parameters

№ п/п	Designation	Unit of measurement	Value of parameter	Notes
1.	2.	3.	4.	5.
	1. Mode of operation.			
1.1.	Number of the working days	day	333	
1.2.	Number of working hours.	hour	8000	
	2. Uranium extraction from the solutions.			
2.1.	Coefficient of the uranium extraction from the productive solutions	%	98.0	
	3. Productivity			
3.1.	Productivity on the productive solution: – Per year; – Per hour.	km^3/year m^3/hour	12000 1500	
	4. Leaching of uranium			
4.1.	Uranium content in PS. average.	mg/l	85	
4.2.	Volume of buffer tank for PS	m^3	1000	

4.3.	Content of H2SO4 in PS	g/l	<5	
4.4.	Content of SO_4^{2-} in PS.	g/l	5.0÷10.0	
4.5.	pH of productive solution	PH unit	1.5÷2.5	
4.6.	Density of PS.	t/m^3	1.01	
4.7.	Summary output of RS (recurrent solution)	m^3/hour	1500	
4.8.	Volume of buffer tank for RS.	m^3	1500	
4.9.	Acidity of RS.	g/l	5÷7	
	5. Sorption of uranium			
5.1.	Volume of sorbent in the column	m^3	44.8	
5.2.	Quantity of sorption columns	unit	10	
5.3.	Height of the operating layer of sorbent.	m	6.0	
5.4.	Linear speed of the motion of solutions.	m/hour	25÷35	
5.5.	Uranium content in the saturated sorbent.	kg/m^3	> 28	
5.6.	Uranium content in the sorbent after desorption	kg/t kg/m^3	< 3.0 < 1.2	
5.7	Uranium content in the recurrent solution.	mg/l	< 3.0	
	6. Washing the saturated by uranium sorbent			
6.1.	Volume of sorbent in the column	m^3	10÷15	
6.2.	Volume of the moved through the column sorbent.	m^3/hour	1.8	
6.3.	Feed of the recurrent solution for the washing of sorbent.	m^3/hour	5.0	
1.	2.	3.	4.	5.
	7. Complementary saturation by uranium the sorbent			
7.1.	Volume of sorbent in the column.	m^3	18	
7.2.	Volume of the moved through the column sorbent.	m^3/hour	3.6	
7.3.	Feed the eluates for complementary saturation	m^3/hour	3.6	
7.4	Uranium content in recurrent solution of complementary saturation	g/l	< 0.2	
7.5.	Uranium content in the sorbent after complementary saturation	kg/m^3	> 70	
	8. Nitrate desorption of uranium..			
8.1.	Volume of sorbent in each of the columns of desorption	m^3	18	
8.2.	Quantity of columns in the cascade of desorption.	unit	2	
8.3.	Volume of moved through the cascade of desorption sorbent	m^3/hour	1.8	
8.4.	Feed of column of the cascade of desorption.	m^3/hour	3.6	

8.5.	Composition of the desorbing solution: – the concentration of nitrate ion; – acidity.	g/l g/l	70 35	
8.6.	Temperature of the supplied to the desorption solution.	°C	30÷40	
8.7.	Yield of eluate.	m^3/hour	3.6	
8.8.	Uranium content in eluate	g/l	≥ 35	
8.9.	Uranium content in the sorbent after desorption	kg/m^3	< 1.0	
	9. Denitration of sorbent.			
9.1.	Volume of sorbent in each of the columns of denitration.	m^3	20	
9.2.	Number of columns in the cascade of denitration.	unit	2	
9.3.	Volume of moved through the chain of denitration sorbent.	m^3/hour	1.8	
9.4.	Feed of the denitrating solution to the "head column" of the cascade of denitration.	m^3/hour	3.6	
9.5.	Acidity of the denitrating solution	g/l	90	
9.6.	Output of solution after denitration	m^3/hour	3.6	
9.7.	Content of nitrate ions in the solution after denitration	g/l	> 35	
9.8.	Uranium content in the sorbent after denitration.	kg/m^3	< 1.0	
	10. Washing the sorbent after the denitration (regeneration)			
10.1.	Volume of sorbent in the column.	m^3	18	
10.2.	Volume of the moved through the column sorbent.	m^3/hour	3.6	
1.	2.	3.	4.	5.
10.3.	Supply of industrial water to the washing the sorbent	m^3/hour	3.6	
10.4.	uranium content in the regenerated sorbent.	kg/m^3	< 1.0	
	11. hauling the eluates			
11.1.	Daily volume of transportable eluates	m^3/day	≈45	
11.2.	Volume of tank truck for the production transport	m^3	12-16	
11.3.	Quantity of voyages of tank truck in a 24 hour period	voyages	3÷4	

4.3.1 Characteristic of the desorbate (eluate)

Product of given technological flow-sheet is the uranium-bearing solution - desorbate (eluate). Desorbate (eluate) is obtained via the desorption (elution) of the connections of uranium from the saturated by uranium sorbent (resin) by nitrate (nitratesulfate) solutions. The uranium-bearing desorbates are intermediate products for obtaining the commodity concentrates of uranium – U^3O^8.

The uranium-bearing desorbates are liquid aqueous solutions from greenly – yellow color to yellow. Uranium is present in the solution in the form of the anionic complex of sulfate - uranyl $[(UO_2)^{2+}(SO_4)_3{}^{2-}]^{4-}$. Besides uranylsulfate the basic salt composition of solutions (desorbates) it is sulfates, ammonium nitrates $(NH_4)_2SO_4$, NH_4NO_3, and free acid H_2SO_4. The deviation of the color of solutions from the yellow to the darker colors is caused by the presence of admixtures (for example, gland).

The composition of the desorbates (eluates) of the nitrate desorption of uranium is given in Table 8.

Table 8 – Composition of the desorbate

Designation	Average	Possible deviations
Uranium content. g/l	<55	35 ÷ 90
Content of nitrate ions. g/l	25	5 ÷ 30
Acidity (by H_2SO_4). g/l	40	20 ÷ 40

4.3.2 Quality of the final product (U_3O_8)

Production of finished products is a nitrous-oxide of uranium:

U_3O_8 –Chemical formula;

- The color is dark olive-green substance;
- At least 2.0 g/cm^3. - bulk density ;
- 842.09 g-mole - molecular weight;
- Not soluble in water.

Dissolved in HNO3 and H2SO4. Requirements for nitrous-oxide of uranium determined by technical conditions TU 70 00 RK 38229886-JSC-2001 «Uranus nitrous-oxide. Specifications »:

• Nitrous-oxide, natural uranium must be made in accordance with the requirements of technical conditions of the present technological regulations.

• Nitrous-oxide of natural uranium should not contain foreign materials and objects that are not part of the product or which could adversely affect the sampling, or damage the equipment for sampling.
• Physic-chemical indicators nitrous-oxide of uranium to meet the standards set forth in Table 9.

Table 9 - Physic-chemical indicators of U_3O_8

№	Designation	Name	Standard of concentration
1	**2**	**3**	**4**
1.1.	U	concentration %	>=80.0
1.2.	U^{235}	concentration %	0.711±0.0007
2.	% impurity in Uranium		
2.1.	As	Arsenic	0.01
2.2.	B	Boron	0.01
2.3.	Ca	Calcium	0.05
2.4.	Cl+Br+I	Halogens	0.05
2.5.	CO_3	Carbonate	0.2
2.6.	F	Fluorite	0.01
2.7.	Fe	Iron	0.15
2.8.	K	Potassium	0.2
2.9.	Mg	Magnesium	0.02
2.10.	Mo	Molybdenum	0.1
2.11.	Na	Sodium	0.5
2.12.	PO_4	Phosphate	0.1
2.13.	SO_4	Sulfate	1.0
2.14.	SiO_2	Silicone	0.5
2.15.	Th	Thorium	0.25
2.16.	Ti	Titan	0.01
2.17.	V_2O_5	Vanadate	0.1
2.18.	Zr	Zirconium	0.01
2.19.	Gd+Sm+Eu+Dy	Rare-earth elements	0.05
2.20.	Cu+Pb+Bi+Sb	Heavy metals	
3.		Mass fraction of insoluble uranium in nitric acid	< 0.1 %
4.		Mass fraction of extracted organics	< 0.1 %
5.		Mass fraction of volatile material	< 4.0 %
6.		Physical indicators:	
6.1.		Humidity	< 2.0 %
6.2.		Size	-6 mm

4.3.3 Utilities

This chapter is description of subsidiary elements to provide the normal operation of the principal production

The subsidiary elements are:

- Storage;
- Electric service;
- Machine shop and of maintenance;
- Service of supply water, The drains, The heating and ventilation;
- Service of transport;
- Base supply materials and technical equipment with stocks;
- Service of fire control.

4.4 Personnel. Labour management

The operating mode starts on the basis of the guarantee of a continuous round-the-clock operation of mine.

For the change personnel, occupied in the harmful working conditions:

Duration of the shift - 12 hours;

Number of the shifts - 4 (2 shift per day of 12 hour period another two shift remains under rest & they work alternatively);

Quantity of operating time per month - 165 hours;

Quantity working days in the year – 185 days.

In structure of enterprise are separated the following production division:

- geo-technological field;
- processing plant
- utilities

The Number of engineers and employees we establish without calculation, on the basis of the work experience of the existing productions. The calculation of the number of workers is brought to the table indicating operating cost.

4.4.1 Choice the rhythm and duration of production

Initial hypotheses

In conclusion the estimated economic reserves make it possible to develop the fields of well with the output of 1000 tU/yr. For memory, by exploiting the economic reserves over the duration of the licences the maximum outputs are:

- Reserves estimated 20 000 tU
- Production rate - 1000 tU/an or 3 tU/day
- Availability factor of working time - 95 % or 8000 h/year
- Recovery from the ore - 85%
- Sorption/desorption - 98.0 %;
- Extraction - 99.9 %;
- Precipitation - 99.9 %;
- Losses with drying and conditioning – 0.1%

Thus: 20 000*0.85*0.98*0.999*0.999*0.999 = 16 610 tU

Duration of production : 16 610/1000 = 16.5 years

5. Environmental protection

Process of extraction of uranium by in situ leaching supposes the handling of radioactive chemical substances at the risk for the personnel and the environment. According to legislative and lawful requirements'. it is necessary to define the importance of this influence and to work out protective measurements.

This chapter is prepared by using the following documents:

- Project of work tests of uranium in situ leaching on Muyunkum. "PKO" LTD. Stepnogorsk. 1999;
- Detailed project of work tests of uranium in situ leaching on Muyunkum (Tortkuduk). "PKO"LTD. Stepnogorsk. 2001;
- Estimated simulation of the impact on the Uyuk aquifer after exploitation by ISL of the layer of Muyunkum. J.-M. Schmitt. V Lagneau. IGC. ENSMP. 2002;
- Official report of the meeting of work between "Kazatomprom" and KATCO of the 09/08/2002;
- Statement of decisions 160AJ-AW/AS/02/009 of the 16/07/2002 on the results of the presentation of the studies: "estimated Simulation of the impact on the Uyuk aquifer after exploitation by ISL of the layer of Muyunkum", realized with the IGC of the École Nationale Supérieure of the Mines of Paris (ENSMP. J.-M. Schmitt. V Lagneau);
- Official report of the meeting of work enters the IHT of "Kazatomprom". COGEMA. ENSMP and KATCO of the 06/11/2002;
- Statement of decisions 160 AJ-AW/AS/02/012 of the

08/11/2002 on the results of the discussion of the conclusions of the study: "Estimated Simulation of the impact on the Uyuk aquifer after exploitation by ISL of the layer of Muyunkum", carried out with the IGC of the École Nationale Supérieure of the Mines of Paris (ENSMP. J.-M. Schmitt. V Lagneau).

5.1 Estimation of the environmental impact

Geotechnology is in fact a whole of process and operations, whose realization generates a minimum of negative influence on the environment. The In situ leaching is the safest method of metals extraction from the ecological point of view. Broadly in situ leaching is characterized by following environmental impacts:

The in-situ leaching, is actually waste-free mining method. It is realized on the place of the ore and usually don't need mining openings. Disturbed existing natural subsurface conditions, except drill holes. As well as, it is not related to drainage of the ground waters.

- Process ISL is carried out in closed cycle. Based on natural balance between volumes of solutions injected and pumped. A closed hydrodynamic contour is formed in the zone of leaching on the periphery of the contact. On borders of this contour is formed strong acid-alkaline barrier and it excludes any significant dispersion of the solutions;

- Process ISL bring rather major changes to the chemical composition of subsoil waters in the zones of leaching, by causing the increase in about ten time of total mineralization. Sulphates, aluminium, iron, nitrates, heavy metals of the micronutrients as well as radionuclide

- There is no formation of dust on the extraction sites. The volume of the treatment operations is strongly reduced by the absence of handling of the ore. Ore preparation and leaching. Moreover volumes of the rejections and effluents of radioactive chemical substances and vermin for the environment are strongly reduced.

The estimation of influence on an environment is carried out on following elements:

- Atmospheric air;
- Surface and underground waters;
- The ground, vegetative and fauna;
- Electromagnetic influence;
- Noise and vibrations;
- Radiating and toxic safety.

5.1.1 Air

The principal pollutants of the atmosphere are:

- Nitrogen oxides, carbon monoxide, sulphur oxides, hydrocarbons, aldehydes during the power generating units operation and the boilers;
- Sulphuric aerosol of acid and insoluble uranium at the time of the operation of the technological equipment;
- Hydrocarbons and hydrogen sulphide from the fuel stock;
- Radon;
- Dredge at the time the vehicle's work.

5.1.2 Surface and underground waters

The possible pollution sources of surface and underground waters are:

- Industrial water and not purified or badly purified sewage;
- Harmful substances escapes of the tanks. the conduits and other constructions;
- Factory site and fields of wells;
- Ways of transportation of the final product;
- Storage of the wastes.

5.1.3 Grounds, flora and fauna.

The grounds of Muyunkum deposit are inappropriate for the agricultural use. This is why no withdrawal of the topsoil before construction is envisaged.

The principal sources of pollution of the ground are:

- Escape of technological solutions by rupture of the conduits;
- Discharge of solutions and suspensions at the time the technological wells cleaning.

At the places of discharge, the surface of the ground can be polluted by sulphates or natural radionuclides of the uranium -radium family.

If ISL process and the water cycle system are correctly carried out, the surface of the ground is almost not polluted and that brings to minimal expenditure of rehabilitation.

After finishing the extraction and the solutions processing, providing the gamma survey of the site and on the basis of its result writing the rehabilitation project.

Taking into account the fact that the deposit is situated in a desert area, the type of rehabilitation considered as "medical and hygienic".

The considered factory site cannot have significant impact on surrounding flora and fauna.

5.2 Radiological and toxic safety

The principal factors of radiological and chemical impact and measurements to reduce its environmental impact are presented in table 10.

Table 10 – Factors of radiological and chemical impact

°	Type of pollution	Measurements
	External gamma irradiation	Posting of precautionary and information signs on borders of the enterprise and also on buildings and constructions where works with radioactive substances are conducted; Realization of a gamma survey of the field of wells territory and processing plant. Once every three year during the exploitation and after the end of exploitation work.
	Air pollution by radionuclides and its ingestion	Reduction of the aerosols releases due to applying the submerged pumps for pumping the productive solution; Measurements of pollution by the long lifespan radioactive aerosols on the processing plant once per month; Each shift control, the sealing of the technological conduits of ISL polygon.
	Air pollution by the harmful chemical substances	Choice of special matters for the equipment. which is resistant to the influence of the technological solutions; Organization of local aspirations on all the technological equipment; Technical revision of the vehicles within the deadlines

	Pollution of working surfaces of equipment, the buildings and constructions by the radionuclides	The hydrocleaning Organization for each shift of the working areas of processing plant; Desactivation of the equipment and the conduits sent in repair or intended for the hiding; Maximal automation of the technological processes.

After the end of work on the Central Tortkuduk the radiometric survey will be carried out. With sampling of ground for radiochemical analyses. Under the terms of the survey results, the plan of the rehabilitation of the whole deposit territory will be arranged.

The polluted grounds will be removed, dispatched and stored in the radioactive waste mortuary especially built by KATCO on the Central Tortkuduk.

5.3 Expenses for the environmental protection

The capital expenses for the equipment of the service of environmental protection and radiation protection evaluated to 50 000 €.

The liquidation of the KATCO activity and the industrial objects belonging to it, is carried out according to the programme of liquidation of the consequences of the activity of the user of the basement including/understanding the elimination of the consequences of the damages to the environment until the state, making it possible to use the components of the environment according to same categories'. In this pre - feasibility study, The liquidation expense are considered equal to 25 % of the volume of the capital costs for the processing plant and depends on the uranium reserves exploited on the site at the time of the mine liquidation. This expenses have been put in the last year of the production from the project.

The expenditure for work of rehabilitation is made by the funds of rehabilitation and the expenditure of wells liquidation.

Table 11 – Calculating of rehabilitation and liquidation per 1 well

Mobilization	600 €
Consumable	1000€
Plugging and liquidation the wells heads	500€
TOTAL	2100€

The technological wells are liquidated as follows:

- Embankment of the working area of the wells by sand;
- Installation of a wooden or concrete stopper of 2 m height

above the roof of the productive horizon;

- Filling the intervals between the productive horizon stopper by heavy mud solution up to depth of 1.5 m
- Installation of wooden or concrete stopper of 0.5m height on the depth of 1.5 m;
- Excavation of 1 m diameter around each well with the depth of 1 m;
- Cutting the tubes up to the depth of 1 m;
- Embankment of the funnels of the wells heads by a clean ground.

6. Economical part

Tenge is local money in Kazakhstan. 1 euro = 200tng

6.1 Capital cost

Table 12

#	Direct capital costs	Cost , k€
1	**Drilling**	
	Wells Drilling	20856
2	**Extraction**	
	Geotechnological field's infrastructure	
	Access, electricity, conduit	360
	Modules of controls	
	16 blocks	2050
	Mobile equipment	
	Well – logging equipment (75000 €/unit)	150
	Maintenance works 360000€/unit	1440
3	**Sorption – desorption – reactives**	
	Sorption workshop	5650
	Desoptoin workshop	3600
	Internal conduits	2775
	Pumps	134
	Bulding of Plant	500
	Ventilation	75
	Auxiliary equipment	1273
	Unaccounted elements	
	Desorbates storage	70
	Pump station	315
	Amonium Nitrat storage	125
	Productive solution tanks	616
	H2SO4 storage	82
	Decantation pool	55
4	**Support (Utilities)**	
	Partners study data	
	IHT/Kazatomprom	
	SEPA/Cogema	
	PKO Stepnogorsk Study	1025
	Utilities	
	Internal roads	734
	Service facility	
	Laboratory	261
	Radioprotection – Environment – Safety measures	50
	Geology and technical service	245
	Water treatment station	245
	Security of the site	82
	Furniture and equipment for offices	98

#	Direct capital costs	Cost , k€
	Infrastructure	0
	External power supply	13818
	Telecommunication	98
	Mobile equipment	
	Vehicles of help and emergency (20000€ + 40000€)	60
	Light vehicles (27000 each)	135
5	**Various and unforeseen**	
	Calculation at 10 %	5697
	Indirect capital costs	
6	**Engineering /designing**	
	Engineering	825
	Local expertises (10% from enginiring)	83
7	**Engineering and assembly supervision**	
	Department of the projects	2543
8	**First loading of materials**	
	Resin	5143
	Spare parts	
	3% from equipment, electricity and conduit costs	1224
9	**Tests – starting**	456
	TOTAL	**72946**

6.2 Operating cost

Table13

Name of costs	Unite	Price per unit, tng	Costs	
			Quantity	Amount, thousand tng
1	2	3	4	5
1. Auxiliary materials (including transportayion cost)				1276400
Sulfuric acid	t	19300.00	50000	965000
Ion-exchange resins	м3	1875000	30	56250
Ammonium nitrate	t	54000.00	3000	162000
Coagulant Magnaflok	t	1000000.00	1.9	1900
Filters. Tissue	м2	2500.00	500	1250
Miscellaneous				90000
2. Cost of Energy				339716
Electricity	MWh	5080.00	45200	229616
Diesel	м3	70000.00	1500	105000
Gasoline	м3	80000.00	45	3600
Motor Oil	м3	150000.00	10	1500
3. The salary of workers and technicians	person	1320000.00	56	73920
4. Social tax	tng	0.21	73920	15523
5. Expenditures for maintenance and operation of equipment	tng			571078
Costs:				
repair of equipment	tng	0.05	8158258.2	407913
Maintenance of Equipment	tng	0.02	8158258.2	163165
6. Factory costs				56092
Depreciation of buildings and structures	tng	0.07	534213.63	37395
Costs:				
repair of buildings and structures	tng	0.015	534213.63	8013
maintenance of buildings and structures	tng	0.02	534213.63	10684
7. Installations of Mining	tng			322740
8. Contingencies (10%)	tng			265547
9. Cost of production to U_3O_8	tng	487	1000	487000
Operating expenses	tng			3408017
10. Cost of administration	tng			95424
11. Cost of marketing	tng			153361
12. Cost of the pollution environment	tng			1700
TOTAL COST	tng			3658502
TOTAL COST	euro			18,292,509
Cost per 1 kg of Uranium	tng			3658.50
Cost per 1 kg of Uranium	euro			18.29

6.3 Economic evaluation

Table 14

GENERAL DATA ABOUT PROJECT		
Uranium reserves	t	16,610
Uranium grade	%	0.052
Initial investment	€	72,946
Operating cost	€/kg U	18.29
Operating cost in 17th year	€/kg U	28.29
Price of uranium	€/kg U	60
PRODUCTION AND INVESTMENT DATA		
Investment period	years	2
Percentage in year 0	%	50%
Percentage in year 1	%	50%
Production rate	t/year	1000
Production rate of first year	t/year	610
FINANCIAL DATA		
Discount rate	%	5
Amortization period	years	10
Percentage of investment to be amortized	%	100
First year of amortization	n°	2
Income tax rate	%	20%
Royalty	%	22%
Percentage of investment financed by loan	%	50%
Year of loan	n°	1
Duration of loan repayment	years	10
Interest rate of loan	%	10%
Duration of grace period	years	2

6.4 Study of Intrinsic Project

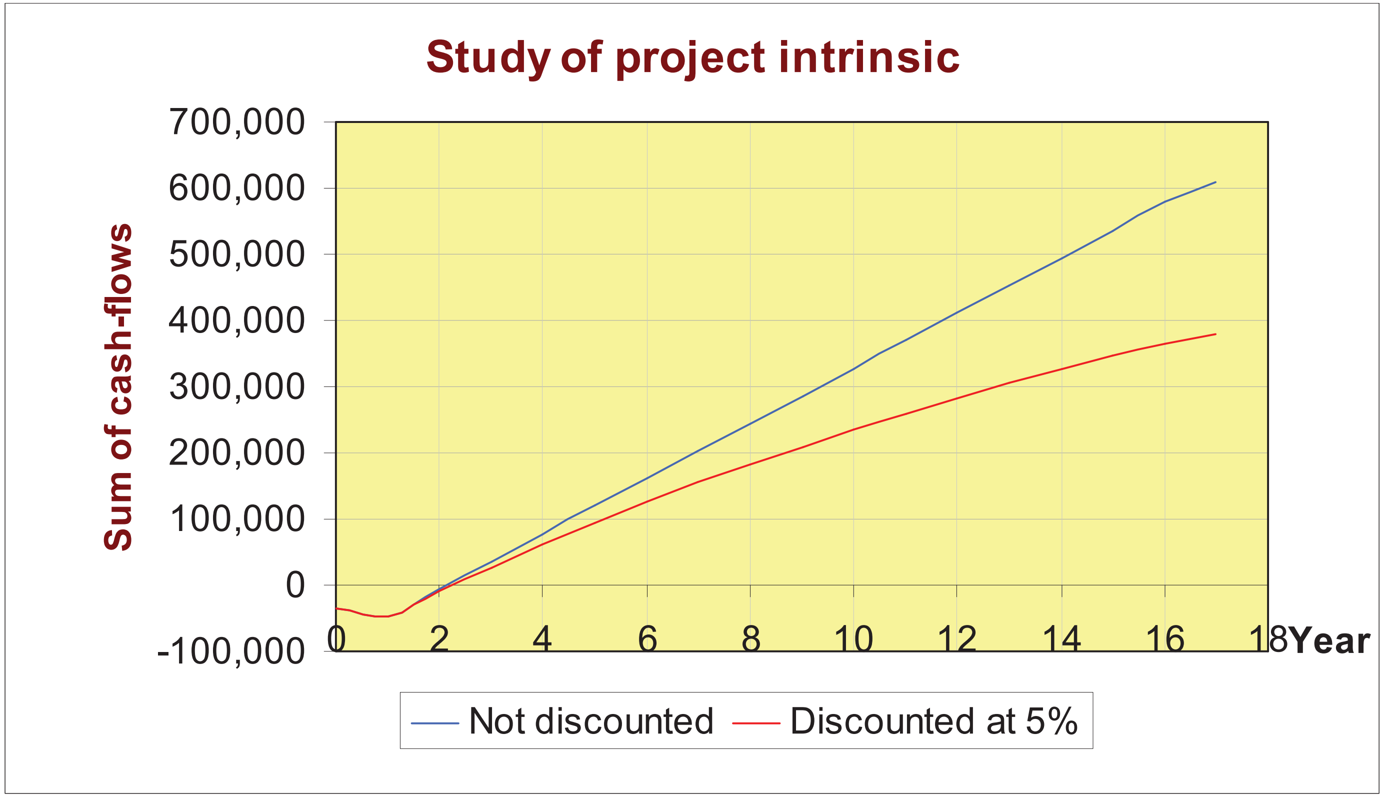
Table 15

Year	Investment	Production	Remaining	Revenues	Op. expenses	Cash-flows	Cumul. CF	CFfact@5%	Cumul. CFfact	IRR
	k€	k t	k t	k€	k€	k€	k€	k€	k€	
0	36,473	0	16,610	0	0	-36,473	-36,473	-36,473	-36,473	
1	36,473	610	16,000	36,600	11,157	-11,030	-47,503	-10,505	-46,978	
2		1,000	15,000	60,000	18,290	41,710	-5,793	37,832	-9,145	-7.12%
3		1,000	14,000	60,000	18,290	41,710	35,917	36,031	26,885	28.32%
4		1,000	13,000	60,000	18,290	41,710	77,627	34,315	61,200	43.56%
5		1,000	12,000	60,000	18,290	41,710	119,337	32,681	93,881	50.96%
6		1,000	11,000	60,000	18,290	41,710	161,047	31,125	125,006	54.85%
7		1,000	10,000	60,000	18,290	41,710	202,757	29,643	154,648	57.00%
8		1,000	9,000	60,000	18,290	41,710	244,467	28,231	182,879	58.23%
9		1,000	8,000	60,000	18,290	41,710	286,177	26,887	209,766	58.96%
10		1,000	7,000	60,000	18,290	41,710	327,887	25,606	235,372	59.40%
11		1,000	6,000	60,000	18,290	41,710	369,597	24,387	259,759	59.66%
12		1,000	5,000	60,000	18,290	41,710	411,307	23,226	282,985	59.82%
13		1,000	4,000	60,000	18,290	41,710	453,017	22,120	305,104	59.92%
14		1,000	3,000	60,000	18,290	41,710	494,727	21,066	326,171	59.98%
15		1,000	2,000	60,000	18,290	41,710	536,437	20,063	346,234	60.02%
16		1,000	1,000	60,000	18,290	41,710	578,147	19,108	365,342	60.05%
17		1,000	0	60,000	28,290	31,710	609,857	13,835	379,177	60.06%
TOTAL	72,946			996,600	313,797	609,857		379,177		

Table 16

Sum of cash-flows	609,857,100 €
Net Present Value	379,176,860 €
Internal Rate of Return	60.06%
Payback period (years)	2.14
Discounted payback period (years)	2.25
Cash break-even metal price	18.89 €
Break-even metal price	23.34 €

Figure 21



The above Economic diagram clearly indicates that the pay back period of the project is 2.14 years & with discount it is 2.25 years

6.5 Study of project with taxes and without loan

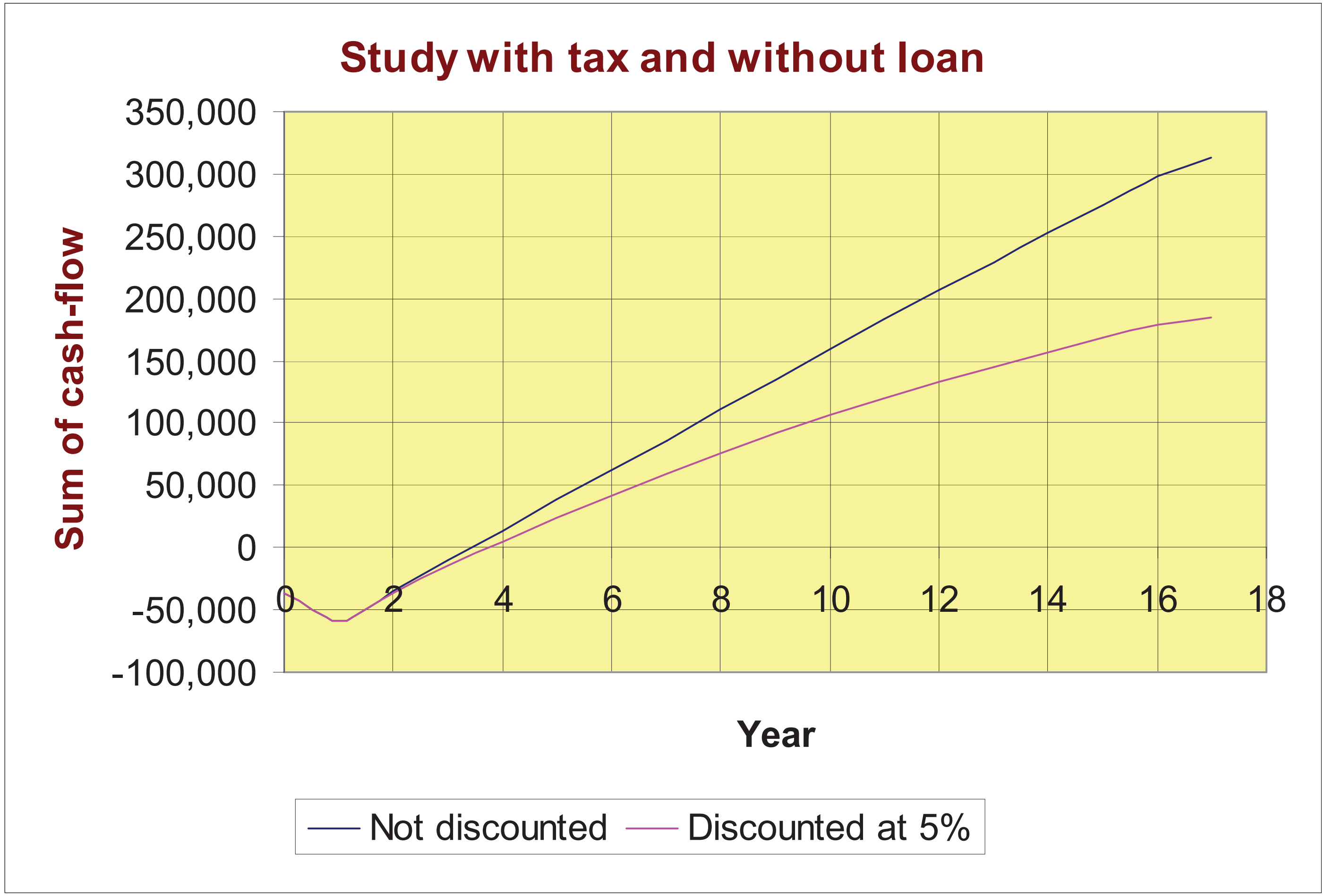
Table 17

time	invest	prod	remaining	Revenues	Op. expenses	Depreciation	Taxable inc	Corporate tax	Royalty	CF0	SUM CF	Cfact@5%	SUM Cfact	IRR
	k€	k t	k t	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	
0	36,473	0	16,610	0	0					-36,473	-36,473	-36,473	-36,473	
1	36,473	610	16,000	36,600	11,157		17,391	3,478	8,052	-22,560	-59,033	-21,486	-57,959	
2		1,000	15,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	-34,766	22,011	-35,948	
3		1,000	14,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	-10,499	20,963	-14,985	-8.83%
4		1,000	13,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	13,768	19,964	4,979	8.40%
5		1,000	12,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	38,035	19,014	23,993	17.81%
6		1,000	11,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	62,301	18,108	42,101	23.34%
7		1,000	10,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	86,568	17,246	59,347	26.78%
8		1,000	9,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	110,835	16,425	75,772	29.00%
9		1,000	8,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	135,102	15,643	91,415	30.47%
10		1,000	7,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	159,369	14,898	106,313	31.48%
11		1,000	6,000	60,000	18,290	7,295	21,215	4,243	13,200	24,267	183,636	14,188	120,501	32.18%
12		1,000	5,000	60,000	18,290		28,510	5,702	13,200	22,808	206,444	12,700	133,201	32.65%
13		1,000	4,000	60,000	18,290		28,510	5,702	13,200	22,808	229,252	12,096	145,297	32.98%
14		1,000	3,000	60,000	18,290		28,510	5,702	13,200	22,808	252,060	11,520	156,816	33.22%
15		1,000	2,000	60,000	18,290		28,510	5,702	13,200	22,808	274,868	10,971	167,787	33.39%
16		1,000	1,000	60,000	18,290		28,510	5,702	13,200	22,808	297,676	10,449	178,236	33.52%
17		1,000	0	60,000	28,290		18,510	3,702	13,200	14,808	312,484	6,461	184,697	33.58%
TOTAL	72,946			996,600	313,797			78,121	219,252	312,484		184,697		

Table 18

Sum of cash-flows	312,484,080 €
Net Present Value	184,696,742 €
Internal Rate of Return	33.58%
Payback period (years)	3.43
Discounted payback period (years)	3.75
Cash break-even metal price	22.79 €
Break-even metal price	29.93 €

Figure 22



The above Economic diagram clearly indicates that the pay back period of the project is 3.43 years & with discount it is 3.75 years, which is greater than intrinsic study. This signifies because of the impact of taxes both pay back period & NPV has gone up.

6.6 Study of project with loan and without taxes

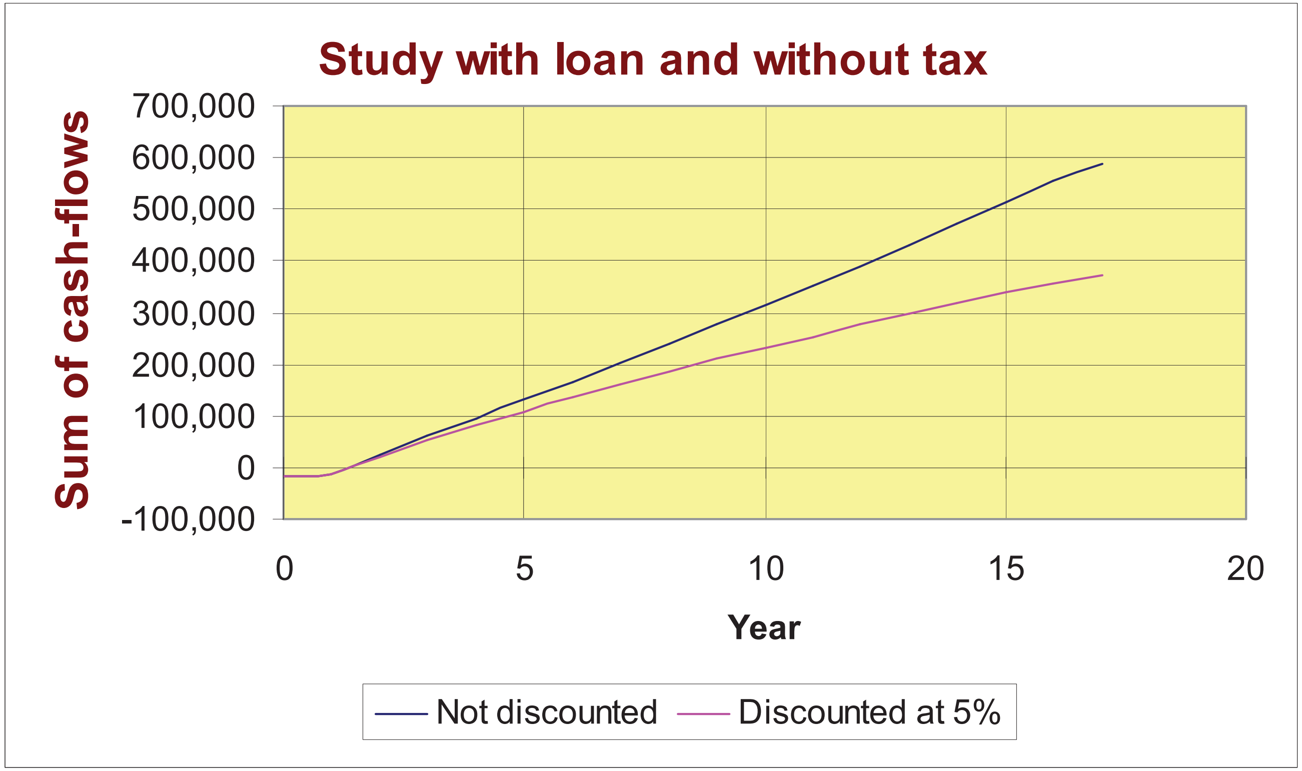
Table 19

time	invest	loan	prod	remaining	Revenues	Op. expenses	Principal repayment	Remaining loan	Interest payment	Intermediary interest	CF	Cumulated CF	Cfact@5%	SUM Cfact	IRR
	k€	k€	k t	k t	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	
0	36,473	18,237	0	16,610	0	0					-18,237	-18,237	-18,237	-18,237	
1	36,473	18,237	610	16,000	36,600	11,157		18,237		1,824	5,383	-12,854	5,127	-13,110	
2			1,000	15,000	60,000	18,290		36,491		3,649	38,061	25,207	34,522	21,412	60%
3			1,000	14,000	60,000	18,290	3,649	32,842	3,284		34,777	59,984	30,041	51,454	91%
4			1,000	13,000	60,000	18,290	3,649	29,193	2,919		35,142	95,126	28,911	80,365	102%
5			1,000	12,000	60,000	18,290	3,649	25,544	2,554		35,506	130,632	27,820	108,185	107%
6			1,000	11,000	60,000	18,290	3,649	21,895	2,189		35,871	166,503	26,768	134,953	109%
7			1,000	10,000	60,000	18,290	3,649	18,246	1,825		36,236	202,740	25,752	160,705	110%
8			1,000	9,000	60,000	18,290	3,649	14,596	1,460		36,601	239,341	24,773	185,479	110%
9			1,000	8,000	60,000	18,290	3,649	10,947	1,095		36,966	276,307	23,829	209,307	111%
10			1,000	7,000	60,000	18,290	3,649	7,298	730		37,331	313,638	22,918	232,225	111%
11			1,000	6,000	60,000	18,290	3,649	3,649	365		37,696	351,334	22,040	254,265	111%
12			1,000	5,000	60,000	18,290	3,649	0	0		38,061	389,395	21,194	275,459	111%
13			1,000	4,000	60,000	18,290			0		41,710	431,105	22,120	297,579	111%
14			1,000	3,000	60,000	18,290					41,710	472,815	21,066	318,645	111%
15			1,000	2,000	60,000	18,290					41,710	514,525	20,063	338,708	111%
16			1,000	1,000	60,000	18,290					41,710	556,235	19,108	357,816	111%
17			1,000	0	60,000	28,290					31,710	587,945	13,835	371,651	111%
TOTAL	72,946	36,473			996,600	313,797	36,491		16,421	5,473	587,945		371,651		

Table 20

Sum of cash-flows	587,945,033 €
Net Present Value	371,651,200 €
Internal Rate of Return	110.86%
Payback period (years)	1.34
Discounted payback period (years)	1.38
Cash break-even metal price	20.23 €
Break-even metal price	24.68 €

Figure 23



The above Economic diagram clearly indicates that the pay back period of the project is 1.34 years & with discount, it is 1.38 years, which is lesser than the intrinsic study. This signifies because of the impact of loan the return on equity becomes higher with a marginal reduction in NPV.

6.7 Complete study of project

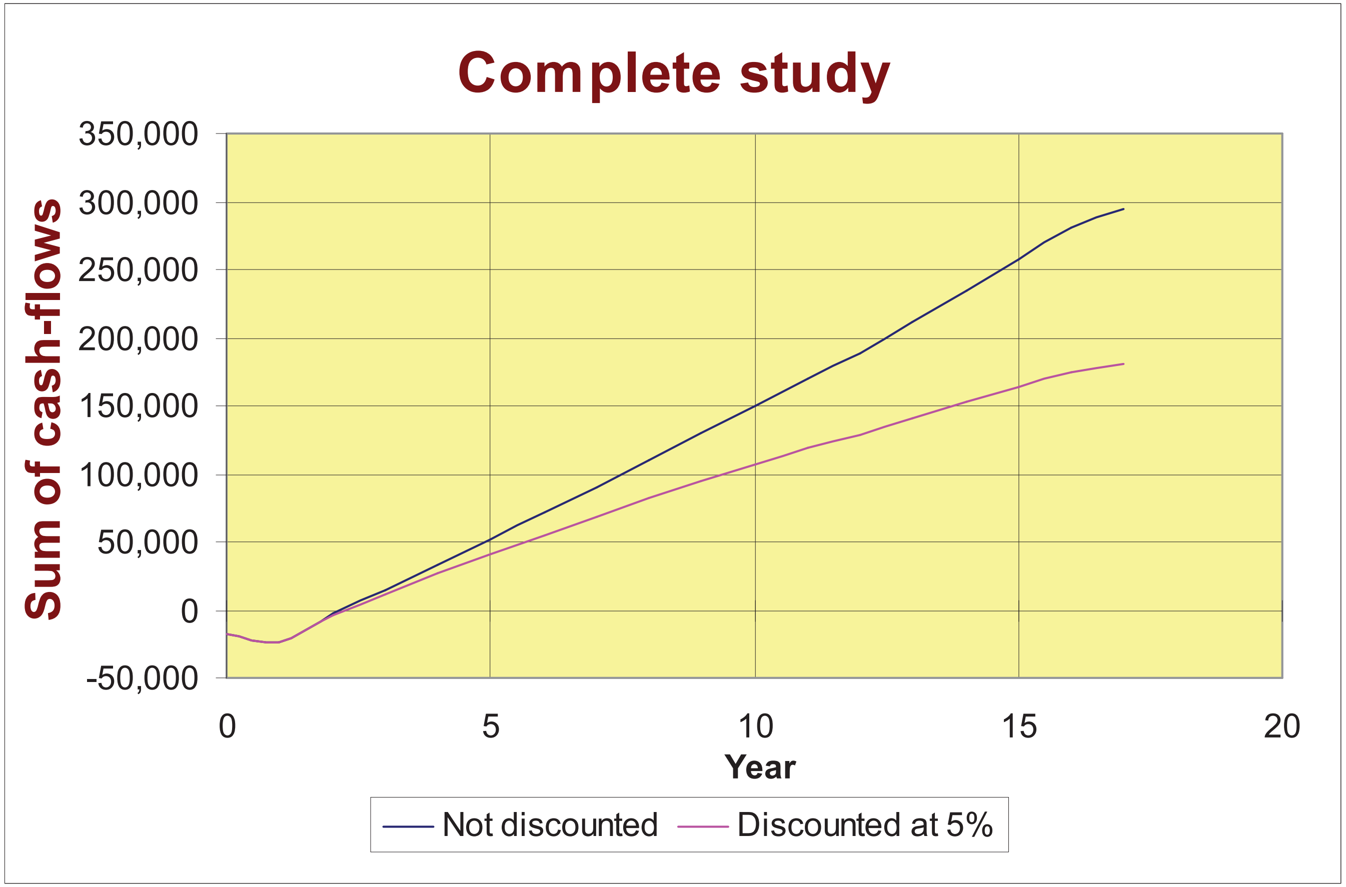
Table 21

time	invest	loan	prod	remaining	Revenues	Op. expenses	Principal repayment	Remaining loan	Interest payment	Interme-diary interest	Depreciation	Taxable inc	Corporate tax	Royalty	CF0	SUM CF	Cfact@ 5%	SUM Cfact	IRR
	k€	k€	k t	k t	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	
0	36,473	18,237	0	16,610	0	0									-18,237	-18,237	-18,237	-18,237	
1	36,473	18,237	610	16,000	36,600	11,157		18,237		1,824		15,567	3,113	8,052	-5,783	-24,019	-5,507	-23,744	
2			1,000	15,000	60,000	18,290		36,491		3,649	7,295	17,566	3,513	13,200	21,348	-2,671	19,363	-4,381	-0.07
3			1,000	14,000	60,000	18,290	3,649	32,842	3,284		7,295	17,931	3,586	13,200	17,990	15,319	15,541	11,160	0.25
4			1,000	13,000	60,000	18,290	3,649	29,193	2,919		7,295	18,296	3,659	13,200	18,282	33,601	15,041	26,201	0.40
5			1,000	12,000	60,000	18,290	3,649	25,544	2,554		7,295	18,661	3,732	13,200	18,574	52,176	14,553	40,754	0.47
6			1,000	11,000	60,000	18,290	3,649	21,895	2,189		7,295	19,026	3,805	13,200	18,866	71,042	14,078	54,833	0.51
7			1,000	10,000	60,000	18,290	3,649	18,246	1,825		7,295	19,391	3,878	13,200	19,158	90,200	13,615	68,448	0.53
8			1,000	9,000	60,000	18,290	3,649	14,596	1,460		7,295	19,756	3,951	13,200	19,450	109,650	13,165	81,613	0.55
9			1,000	8,000	60,000	18,290	3,649	10,947	1,095		7,295	20,121	4,024	13,200	19,742	129,392	12,726	94,338	0.55
10			1,000	7,000	60,000	18,290	3,649	7,298	730		7,295	20,486	4,097	13,200	20,034	149,426	12,299	106,638	0.56
11			1,000	6,000	60,000	18,290	3,649	3,649	365		7,295	20,850	4,170	13,200	20,326	169,752	11,884	118,522	0.56
12			1,000	5,000	60,000	18,290	3,649	0	0			28,510	5,702	13,200	19,159	188,911	10,668	129,190	0.56
13			1,000	4,000	60,000	18,290			0			28,510	5,702	13,200	22,808	211,719	12,096	141,286	0.57
14			1,000	3,000	60,000	18,290						28,510	5,702	13,200	22,808	234,527	11,520	152,805	0.57
15			1,000	2,000	60,000	18,290						28,510	5,702	13,200	22,808	257,335	10,971	163,776	0.57
16			1,000	1,000	60,000	18,290						28,510	5,702	13,200	22,808	280,143	10,449	174,225	0.57
17			1,000	0	60,000	28,290						18,510	3,702	13,200	14,808	294,951	6,461	180,686	0.57
	72,946	36,473			996,600	313,797				5,473	72,946		73,742	219,252	294,951		180,686		

Table 21

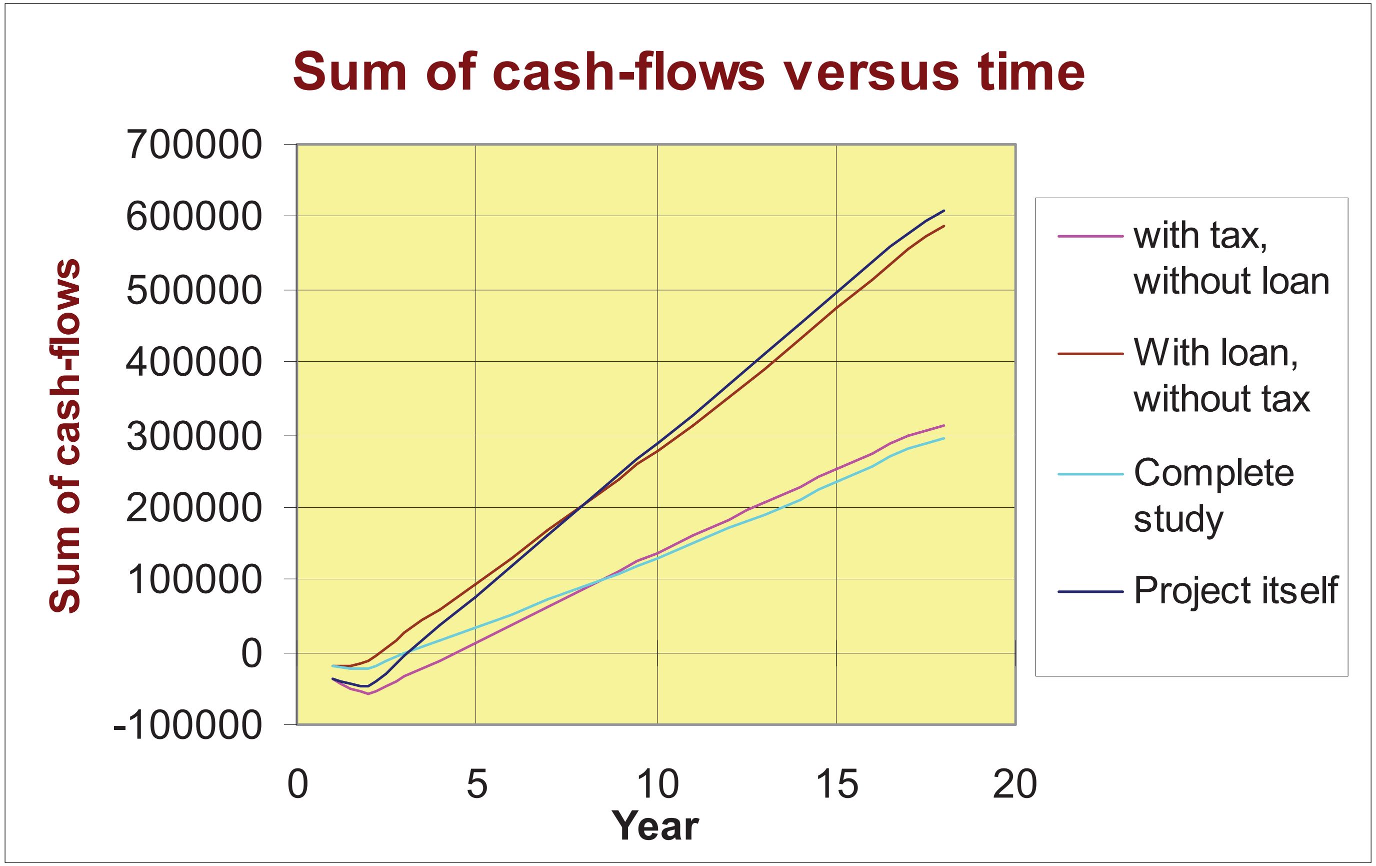
Sum of cash-flows	294,950,779 €
Net Present Value	180,685,556 €
Internal Rate of Return	56.78%
Payback period (years)	2.15
Discounted payback period (years)	2.28
Cash break-even metal price	24.50 €
Break-even metal price	31.64 €

Figure 24



The above Economic diagram clearly indicates that the pay back period of the project is 2.15 years & with discount, it is 2.28 years, which is higher than loan but lesser than taxes. In this case the adverse impacts of taxes are neutralized by loan. This applies in case of NPV of the project also.

Figure 25



The above Economic diagram is to indicate the comparative cumulative cash flows for different to justify that loan is better for neutralizing the impact of taxes.

Figure 26

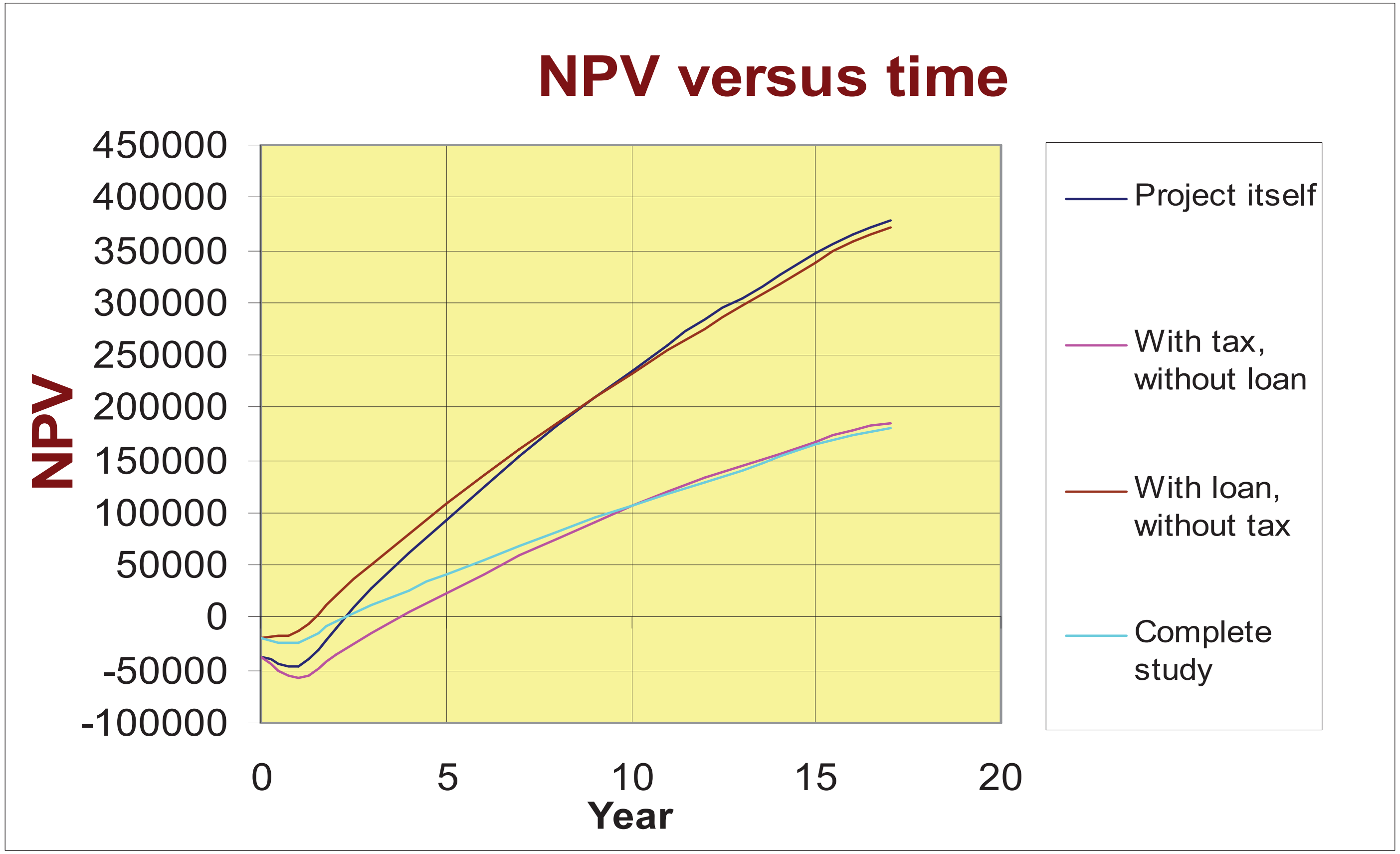
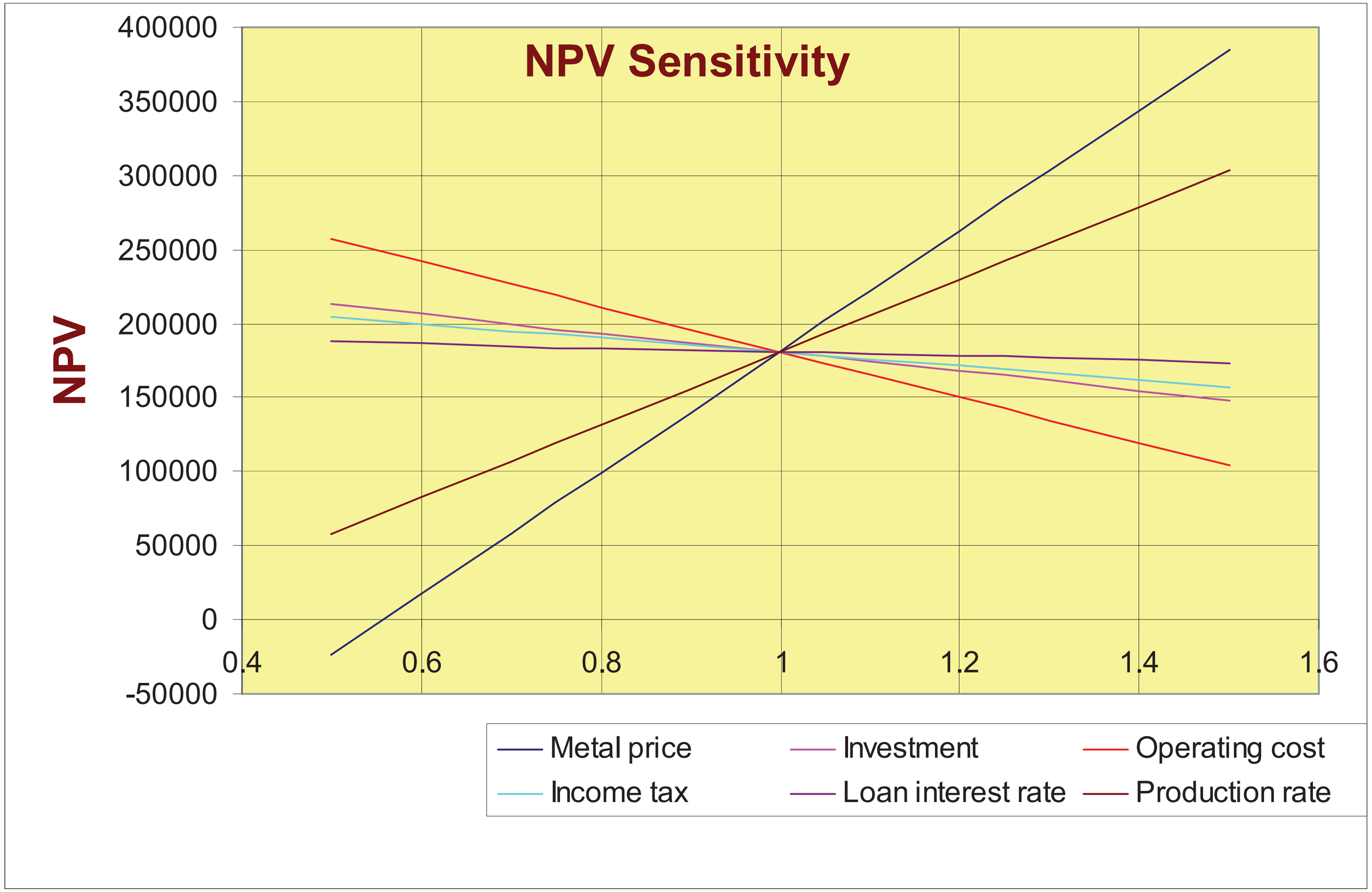
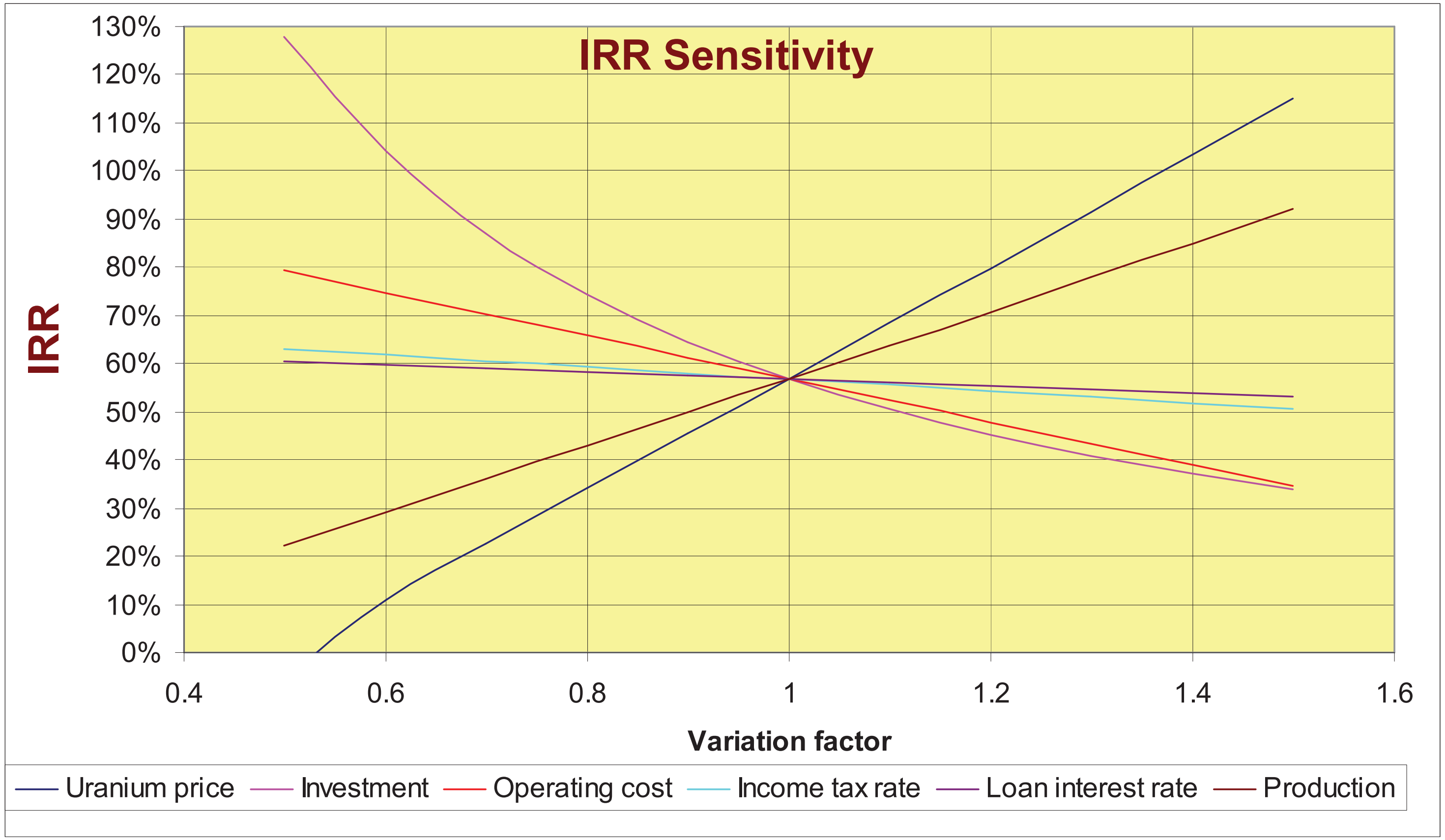


Figure 27



The above Economic diagram indicates the sensitivity of different project parameters on the project. The above graph indicates that the project is highly sensitive to sales price & production rate. Rest other parameters have not got much impact on the project viability.

Figure 28



The above Economic diagram indicates the sensitivity of different project parameters on the IRR of the project. The above graph indicates that the project is highly sensitive to sales price, production rate & investment. The Rest of the other parameters have not got much impact on the project viability.

7. Conclusion

The KATCO has subcontracted the drilling work to "Volkovgeology" company. Which caters the drilling need for KATCO.

Extraction of uranium from ore will be done by ISL, which are widely uses in Kazakhstan.

The extraction of uranium from the productive solutions will be achieved by local sorption installations Tortkuduk Central with aid of the desorption on the ion-exchange resin and then transports by trucks for refining and obtaining U3O8 to Tortkuduk processing plant

The extraction of uranium from the ion-exchange resin and its processing into the concentrate accordingly international standards of quality will be achieved on the process, similar to the process, used at the sites KATKO & sites of KAZATOMPROM.

From the economic point of view, the project is characterized by total investments of 72 946 k€. Operating cost is 18.29 €/kgU and the selling price 60 €/kgU. In the 17th year operating cost will increase for 10 euro because this year liquidation and rehabilitation will be done to eliminate radioactive pollution. The economic evaluations show that the project will provide an Internal Rate of Return of 56.78 %. The Net Present Value is 180 685 k€ & pay back period is 2.28 years.

From the above economic analysis & diagrams it is inferred that the project is highly profitable & thus it makes possible to say that the project of development of the Tortkuduk Central is an interesting in the current context of the uranium mining & worth taking up.

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