KAZATOMPROM
NATIONAL ATOMIC COMPANY

DEVELOPMENT OF URANIUM MINING BY ISL IN KAZAKHSTAN.

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IAEA Vienna, 23-27June 2014

URANIUM RESOURCES

In the second half of the 60s, feasibility of Uranium production from low-grade ores by in-situ leaching (ISL) was proved.

This radically changed the situation in the raw material base in Kazakhstan.

Rapid development of uranium mining by ISL in Kazakhstan caused by factor of availability of large sandstone type uranium deposits.

URANIUM RESOURCES

Uranium provinces

Volume of natural uranium resources in Kazakhstan is about **1.7 mln. tU** (1.0 mln. tU identified and 0.7 mln. tU undiscovered), 77% of them available for ISL production

EXPLORATION AND PROSPECTING

In Kazakhstan continuously carry out exploration and prospecting to expand the resource base of uranium.

In 2011 and 2012 uranium resources increased by more than 110 thousand tU and 40690 tU was mined. Resource growth is 2.5 times higher than the depleting.

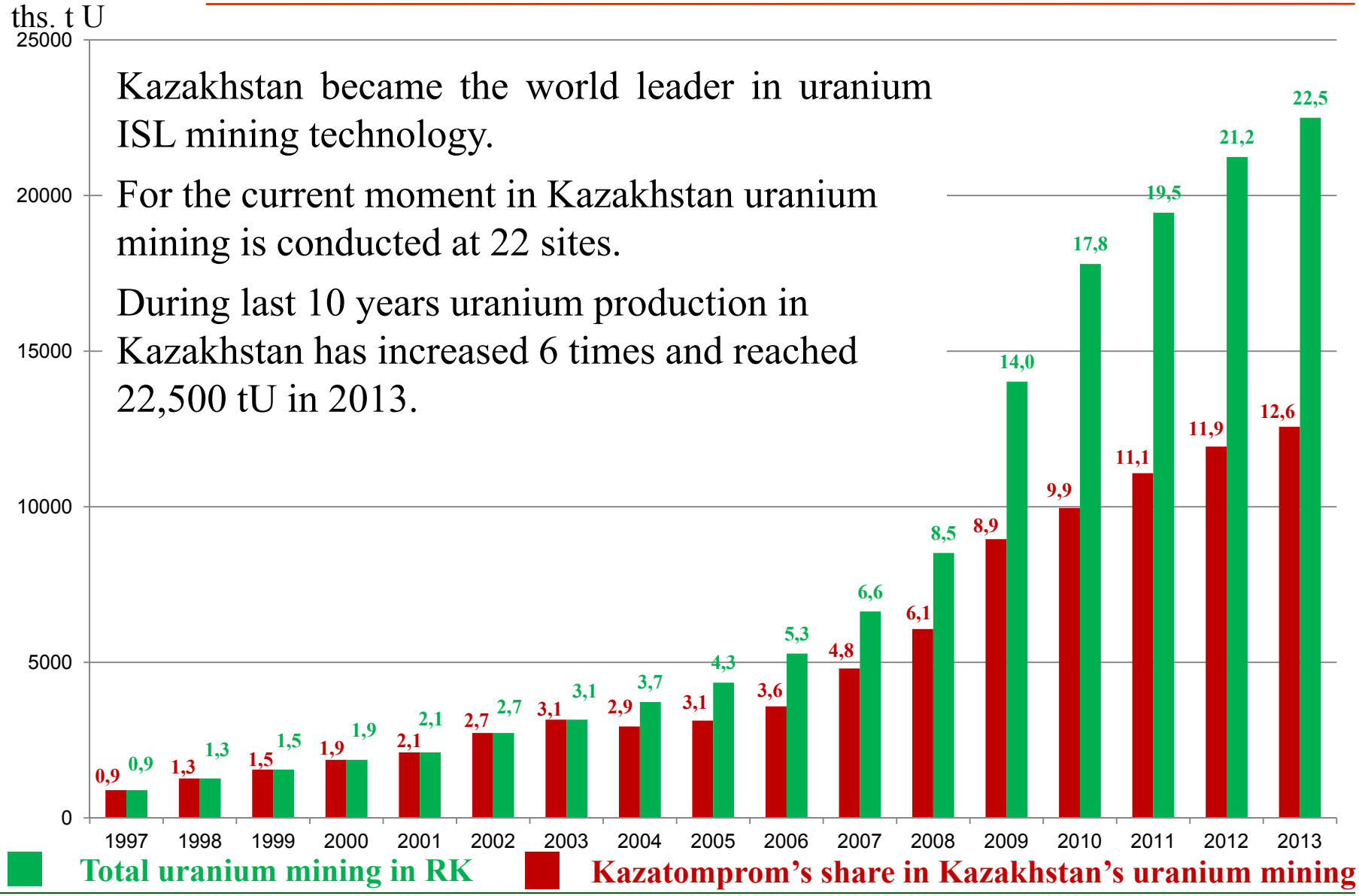
Since 2012 Kazatomprom is prospecting for new uranium sandstone deposits in southern Kazakhstan by efforts of Volkovgeologia and at their own expense. The program lasts until 2030. Prior to 2015, allocated more than 20 mils. U.S. dollars in prospecting works. In near future is expected discovery of new deposits.

URANIUM PRODUCTION IN KAZAKHSTAN, TU

Kazakhstan became the world leader in uranium ISL mining technology.

For the current moment in Kazakhstan uranium mining is conducted at 22 sites.

During last 10 years uranium production in Kazakhstan has increased 6 times and reached 22,500 tU in 2013.

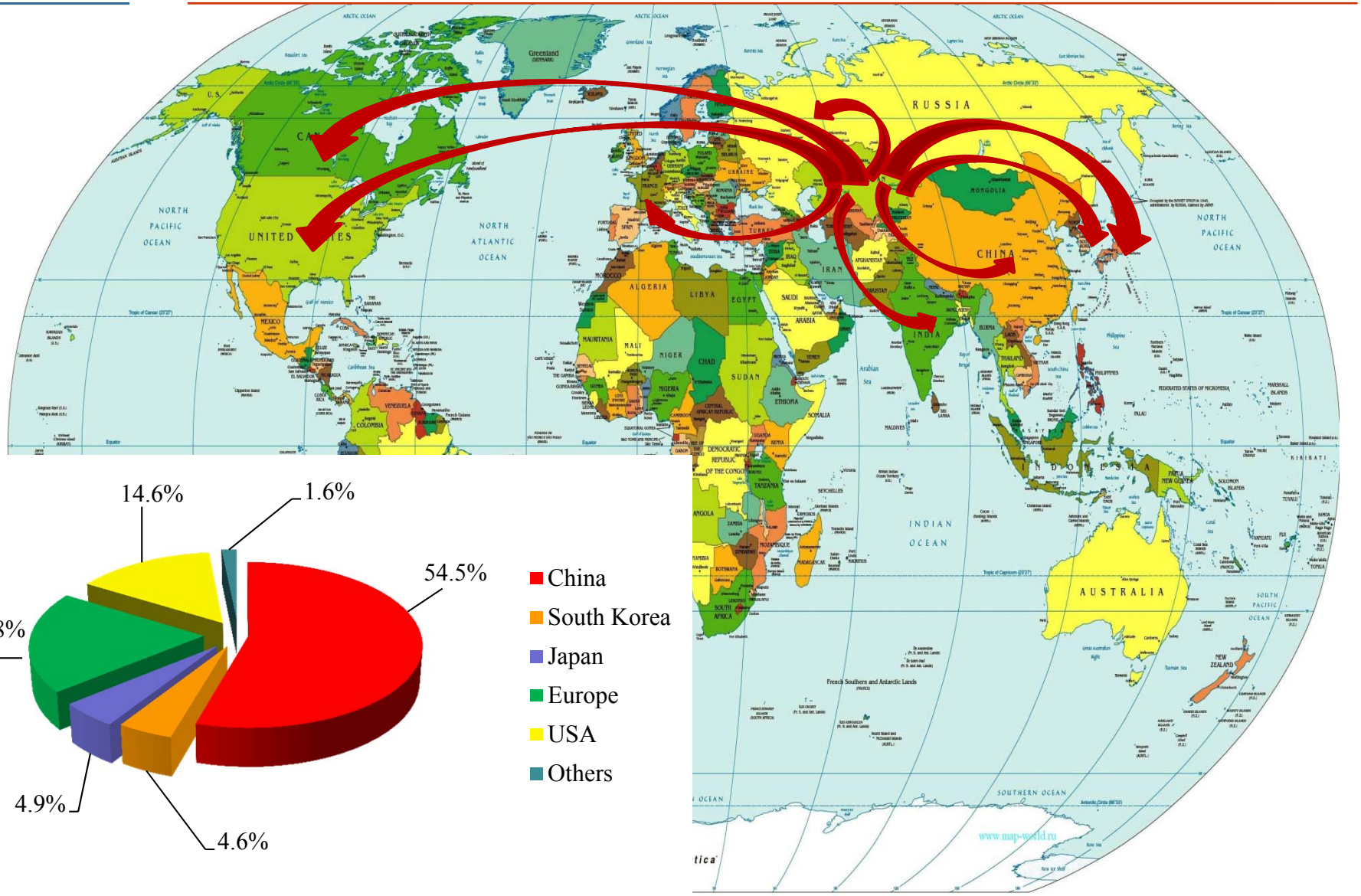


FOREIGN PARTNERS

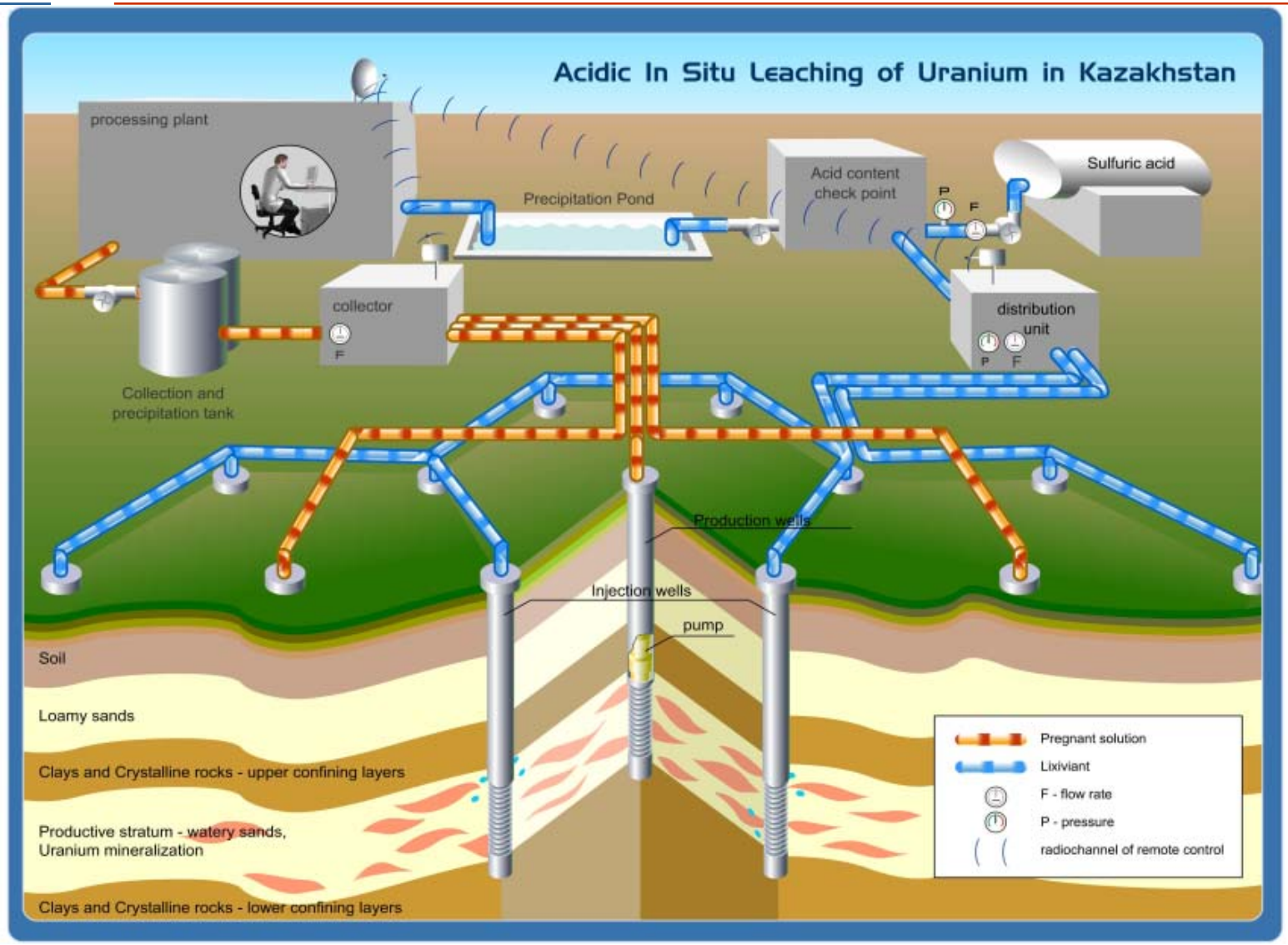
There are 10 joint ventures for uranium production in Kazakhstan:

- Kazakhstan-Japan-Russia (Canada) – Kyzylkum LLC;
- Kazakhstan-Russian (Canada) – JV Betpak Dala LLC;
- Kazakhstan -Canada – JV Inkai LLC;
- Kazakhstan -Russia-Kyrgyzstan – JV Zarechnoye JSC;
- Kazakhstan -Russian – Karatau LLC;
- Kazakhstan -Russian – JV Akbastau JSC;
- Kazakhstan -France – JV KATCO LLC;
- Kazakhstan –China – Semizbai-U LLP;
-Kazakhstan -Japan – APPAK LLP;
- Kazakhstan -Japan – Baiken-U LLP.

THE GEOGRAPHY OF KAZAKHSTAN'S NATURAL URANIUM SUPPLIES



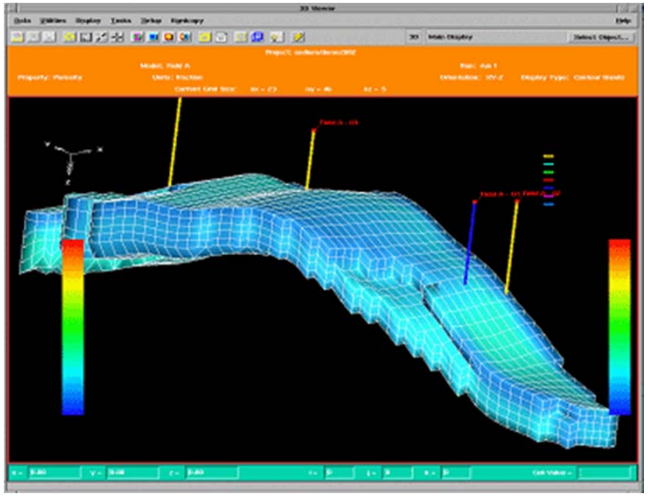
ISL MINING


Acidic In Situ Leaching of Uranium in Kazakhstan
processing plant
Precipitation Pond
Acid content check point
Sulfuric acid
collector
distribution unit
Collection and precipitation tank
Production wells
Injection wells
pump
Soil
Loamy sands
Clays and Crystalline rocks - upper confining layers
Productive stratum - watery sands, Uranium mineralization
Clays and Crystalline rocks - lower confining layers
Pregnant solution
Lixiviant
F - flow rate
P - pressure
radiochannel of remote control

INNOVATION

Kazakhstan has not only a tremendous resource base, but also the modern technology of uranium mining and processing, and goes forward to the full nuclear fuel cycle market.

Since the first ISL site launch, ISL technology and processing are being improved constantly. Today the exploitation of uranium deposits is associated with a set of complex technological solutions.

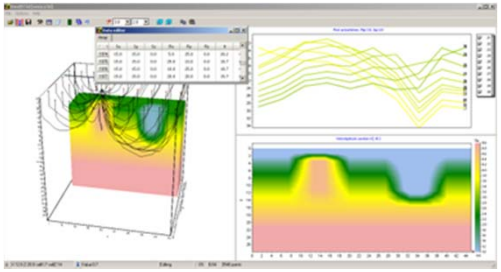


More and more complicated deposits are being involved to mine requiring a new approach to fields design and screen positions. New methods for modeling and forecasting of uranium mining are being successfully implemented.

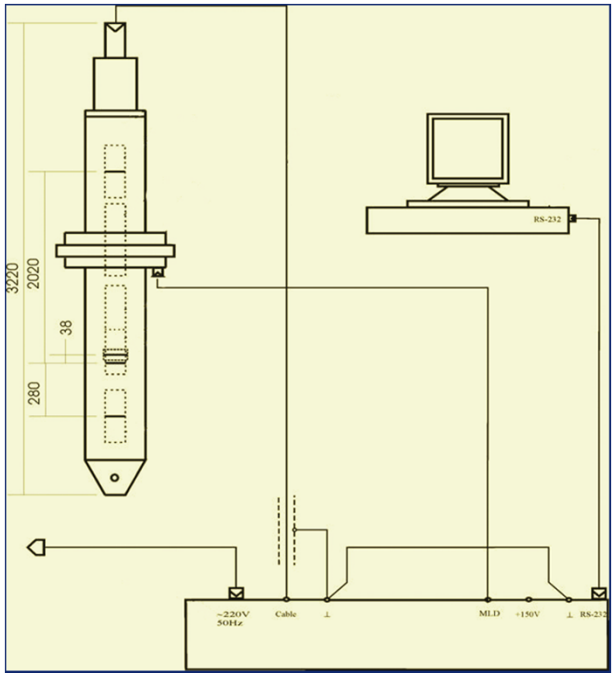
INNOVATION

Kazakh experts successfully mine suspended ore body of uranium (not having lower aquifuge), and deposits with more than 700 meters occurrence depth of uranium ore, and herewith minimal ore mining mass volumes are being involved to leach.

Gained extensive experience in the application of advanced (passive) acidification (leaching solutions are injected to the ore body without pumping), it gives the opportunity to get rich uranium-containing solution at an early stage of production, shortens mining, as well as reduces colmatation. Solutions for advanced acidification come from blocks at the finalizing stage of production that allows starting remediation of aquifers.

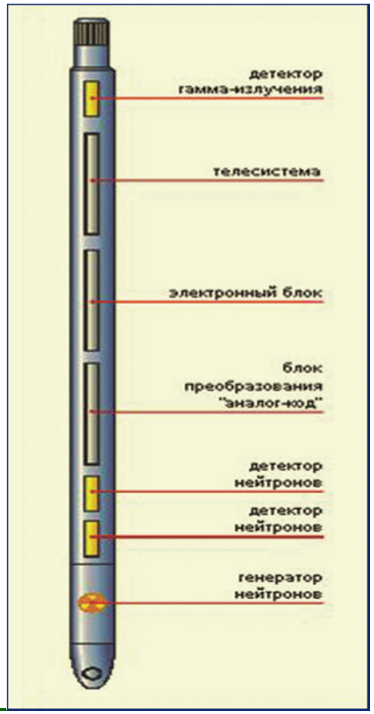


PROMPT FISSION NEUTRON LOGGING



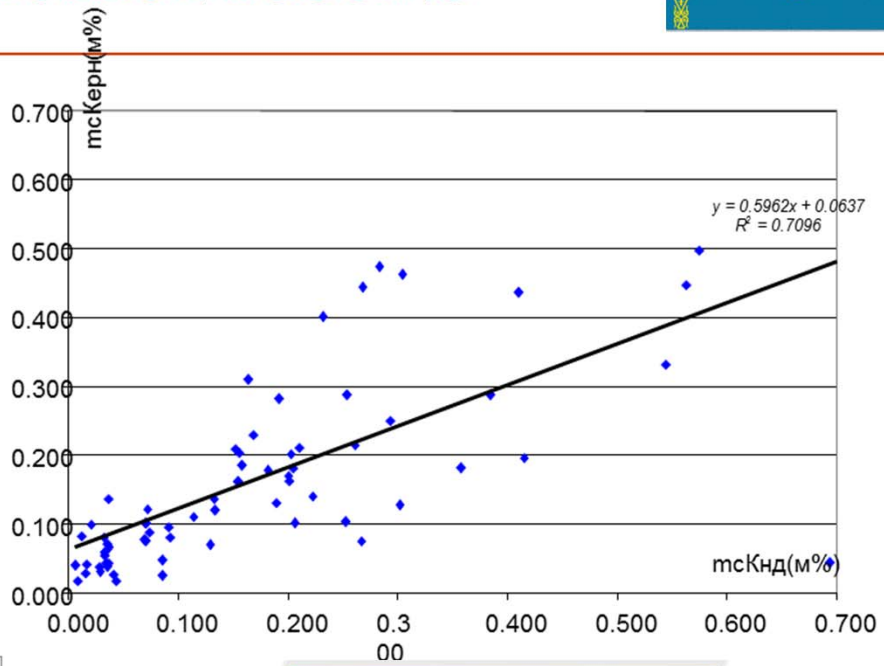
Solving the problem of the direct determination of uranium offered by prompt fission neutrons logging that expands the scope of application of the method for the quantitative determination of uranium in situ.

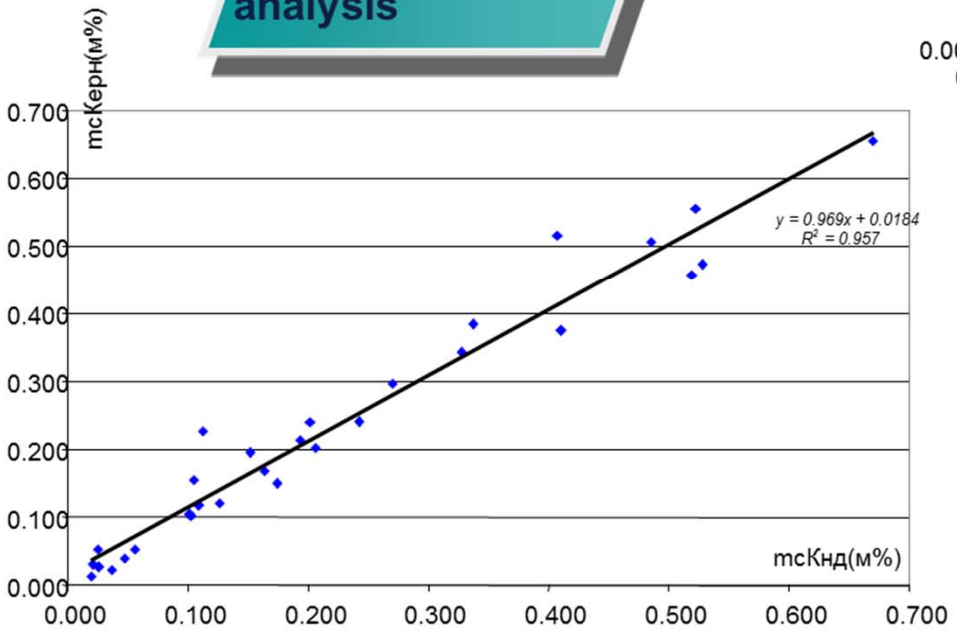
Under Professor A.G. Talalay's leadership, the group of companies Nedra and Kazatomaprom developed the theory, geophysical instrumentation and double neutron logging device measurement method of uranium mineralization (moisture, clay content and porosity, coefficient of radioactive equilibrium and direct determination of uranium) in situ.



PROMPT FISSION NEUTRON LOGGING

A comparison between the results of the interpretation of the single neutron logging device and the results of core analysis

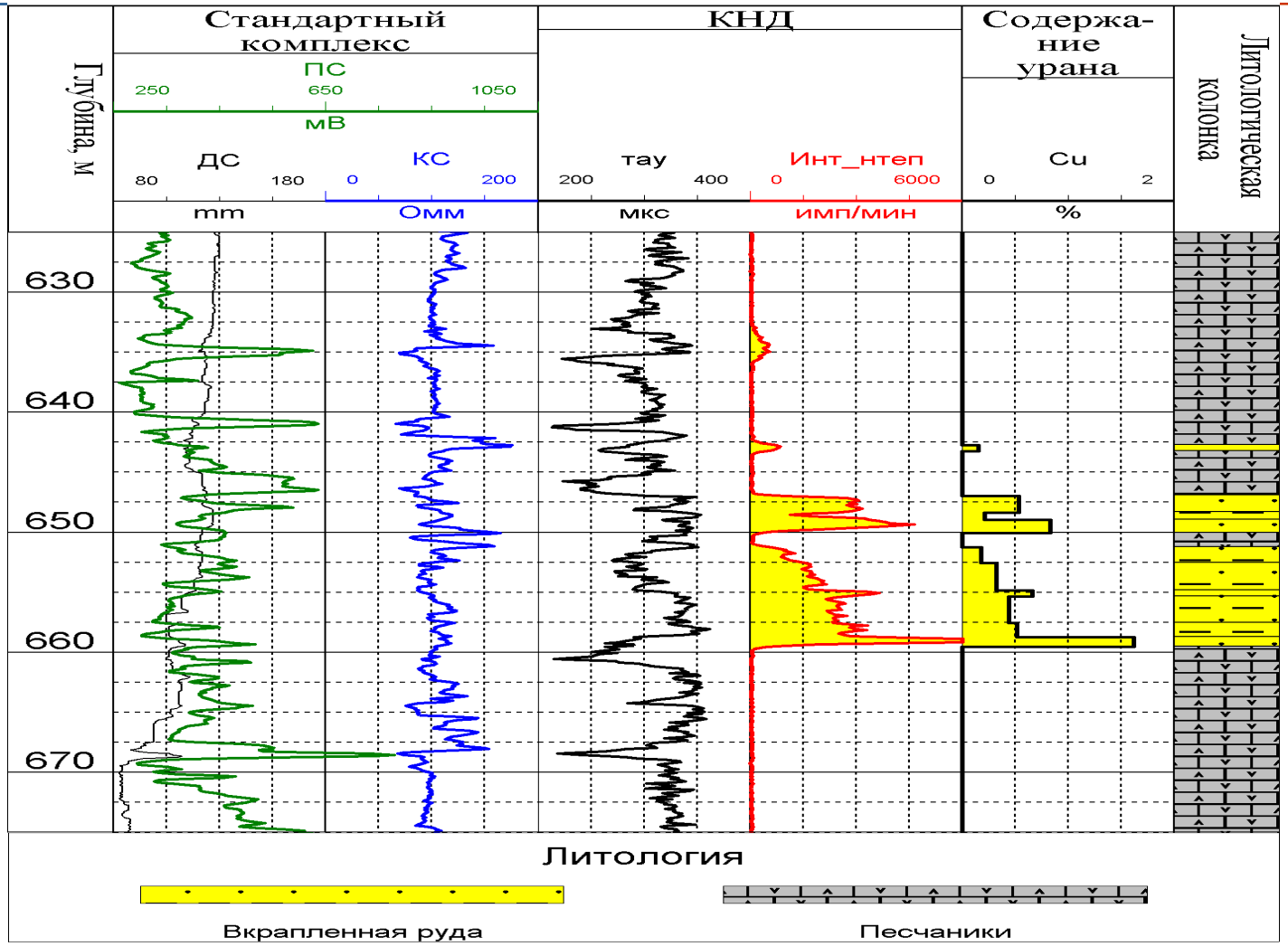




A comparison between the results of the interpretation of the double neutron logging device and the results of core analysis

Comparing of two methods

PROMPT FISSION NEUTRON LOGGING



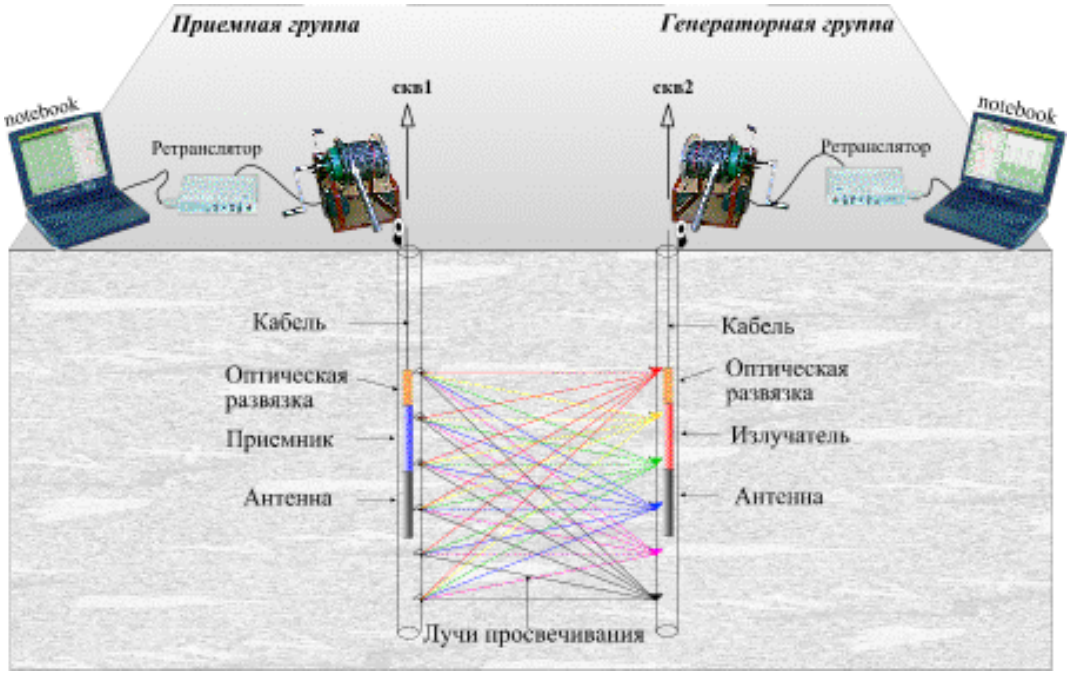
Example of PFN method use in one of deposits in Kazakhstan determine of mass U share taking into account influence of hydrogen content

4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

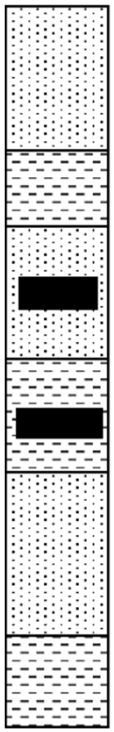
Successfully Kazatomprom develops and applies new methods of research to control and optimize uranium production.

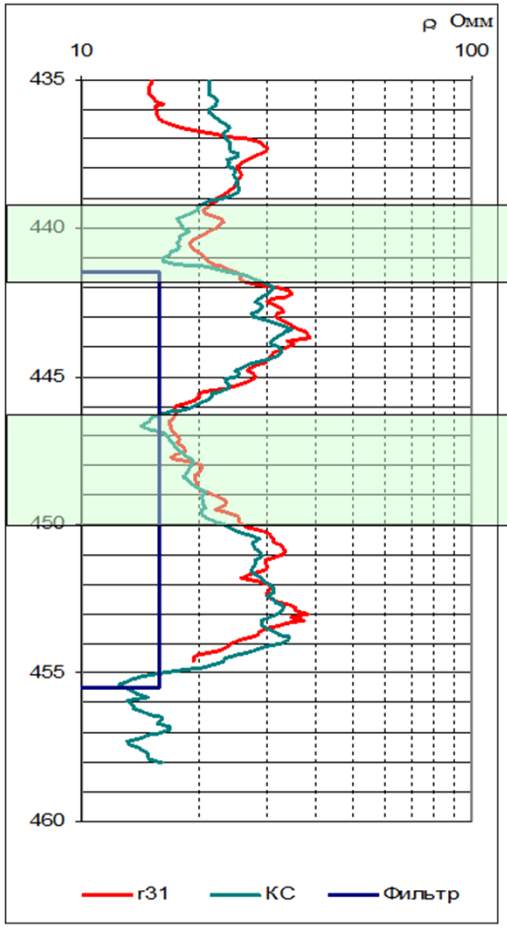
Introduction of new methods of geophysical research can solve the problem of modeling the dynamics of the ISL process using radiowave method “4D monitoring of ISL development of uranium deposits” by Dr. V.A. Istratov.

The method allows monitoring the spatial distribution of acidic solutions in time and managing the process of in-situ leaching for full mining of uranium ores and reducing acidification of the host rocks.

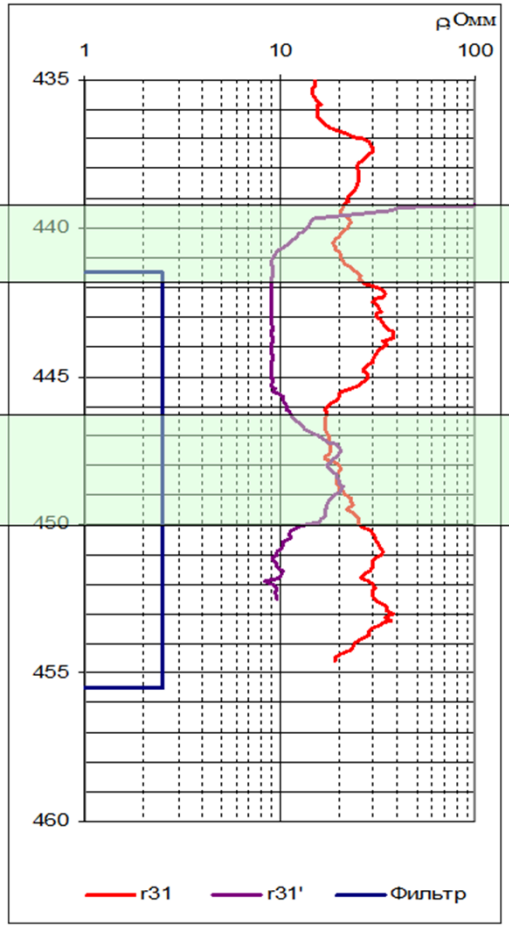


4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

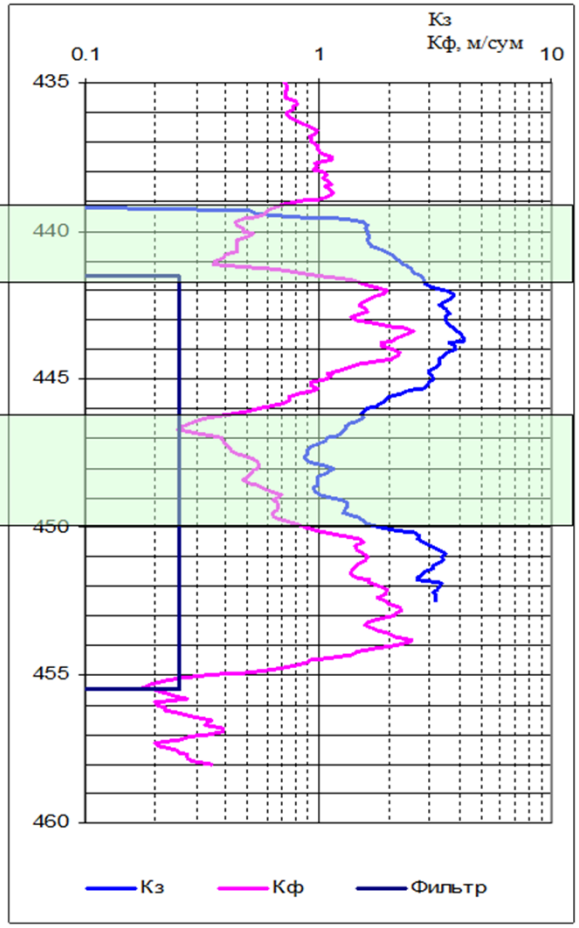




Electrical characteristics of sands, the resulting electrical logging

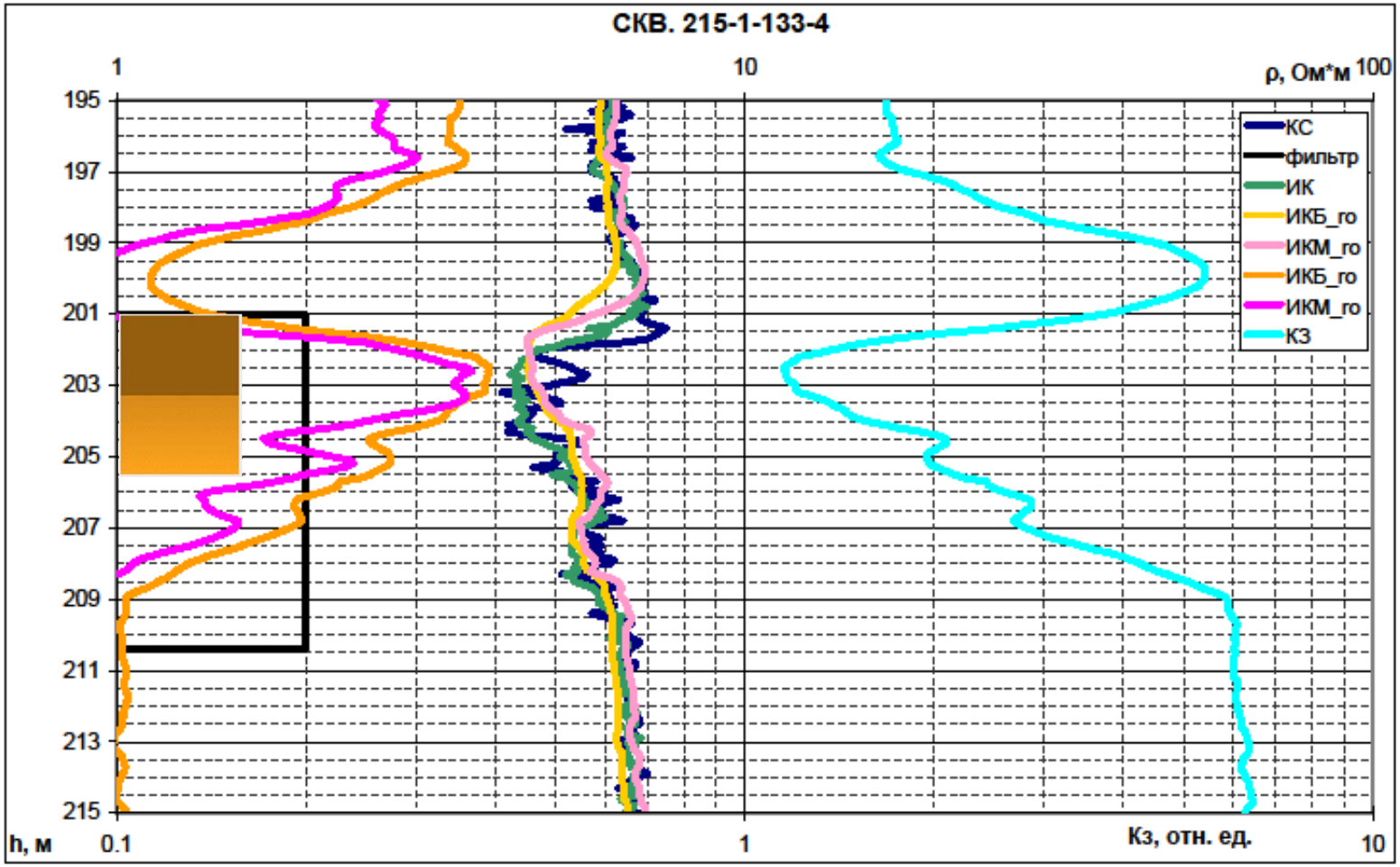


Electrical resistance clays and siltstones before and after acidification



Correlation coefficient of acidification and filtration coefficient

4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

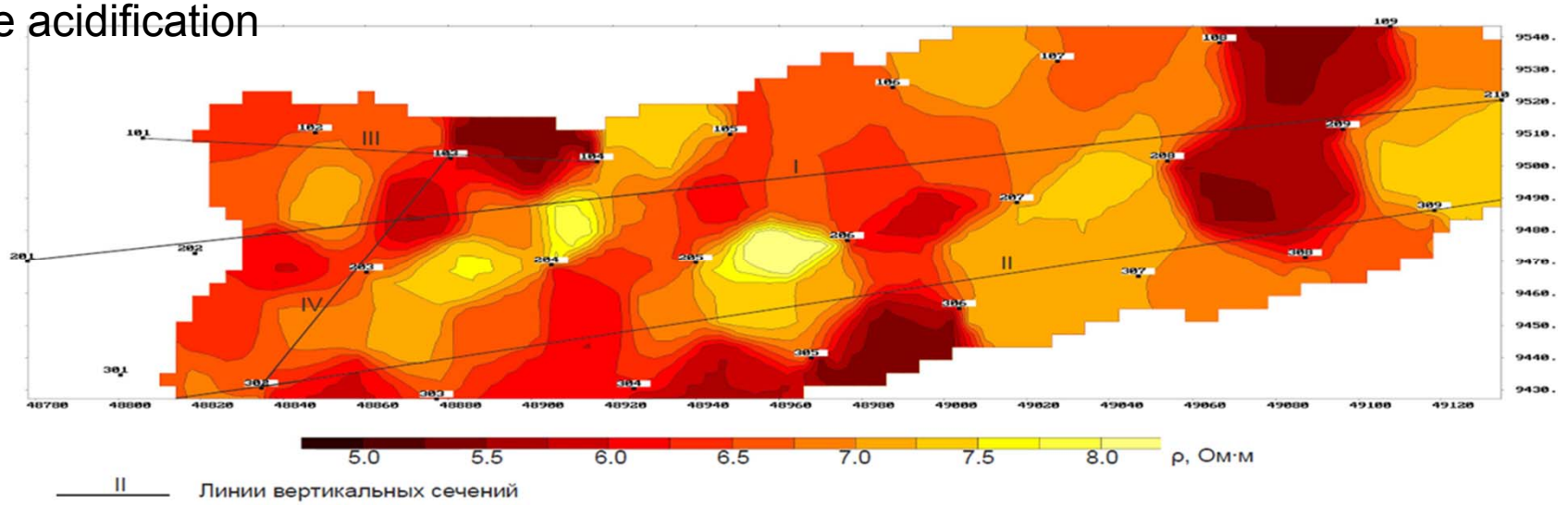


high clayey
slightly clayey

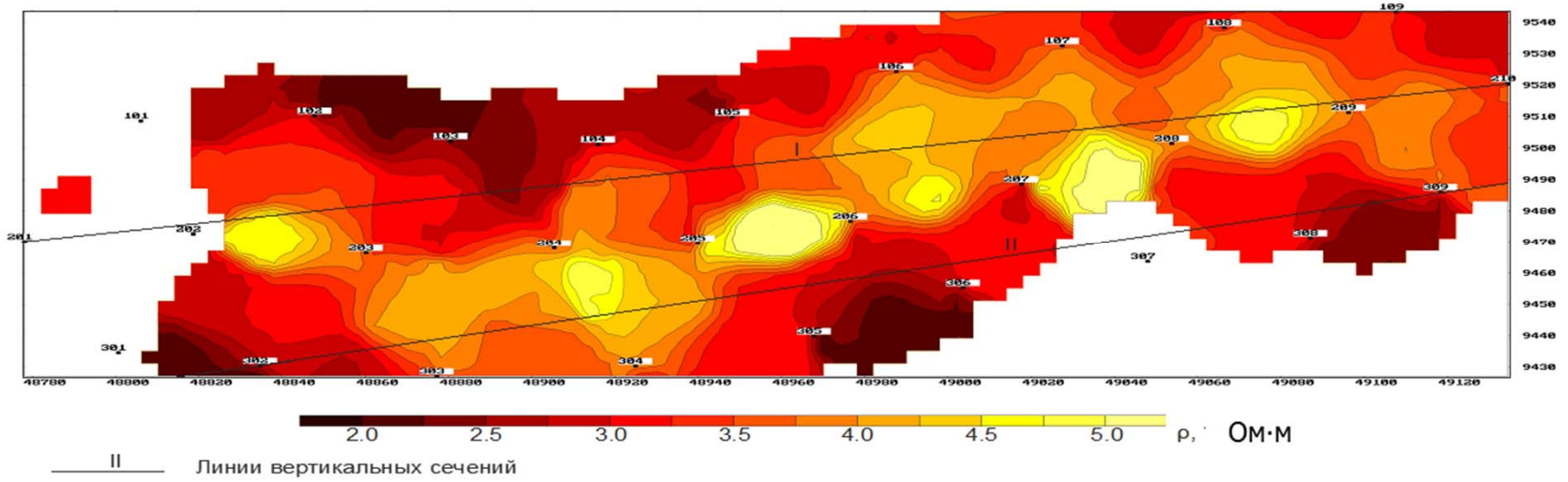
Induction electric log of two probes (0.5 m and 1 m) before and after acidification

4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

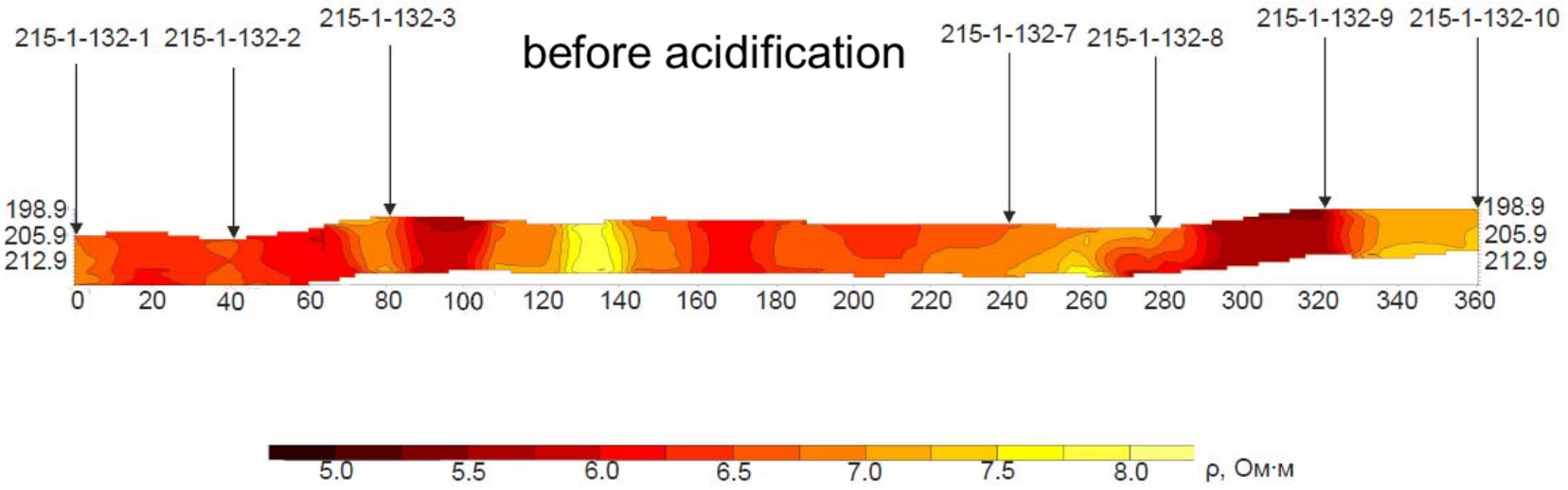
before acidification

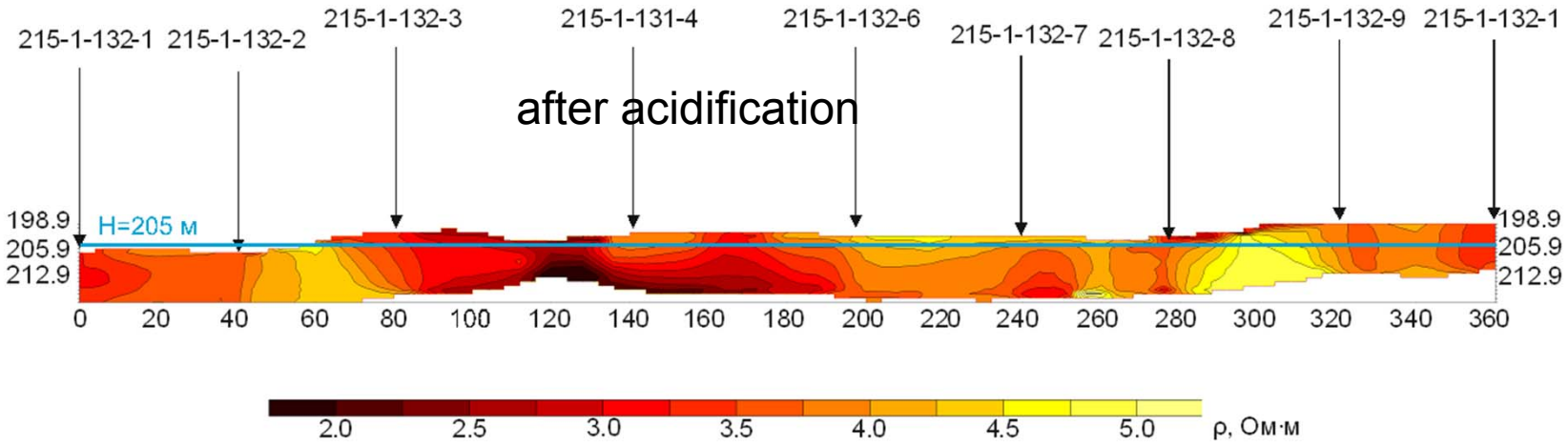


after acidification



4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

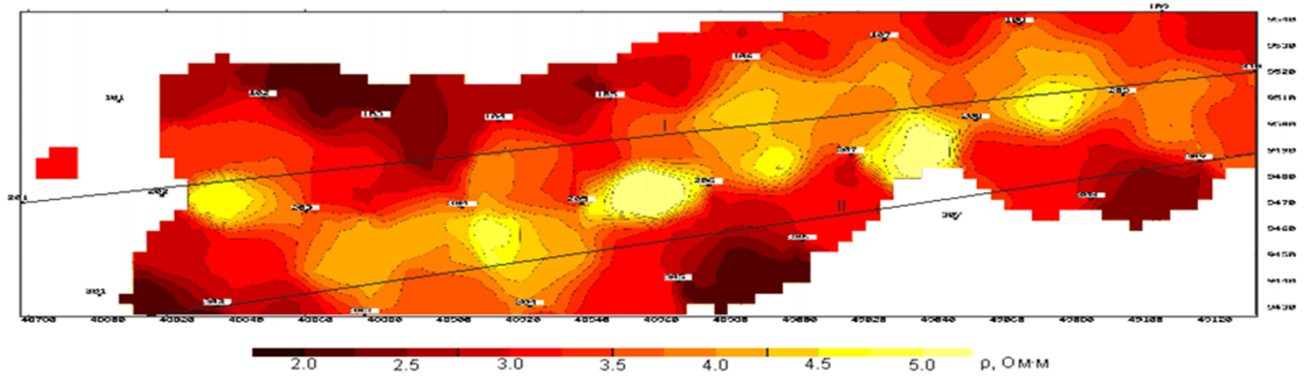




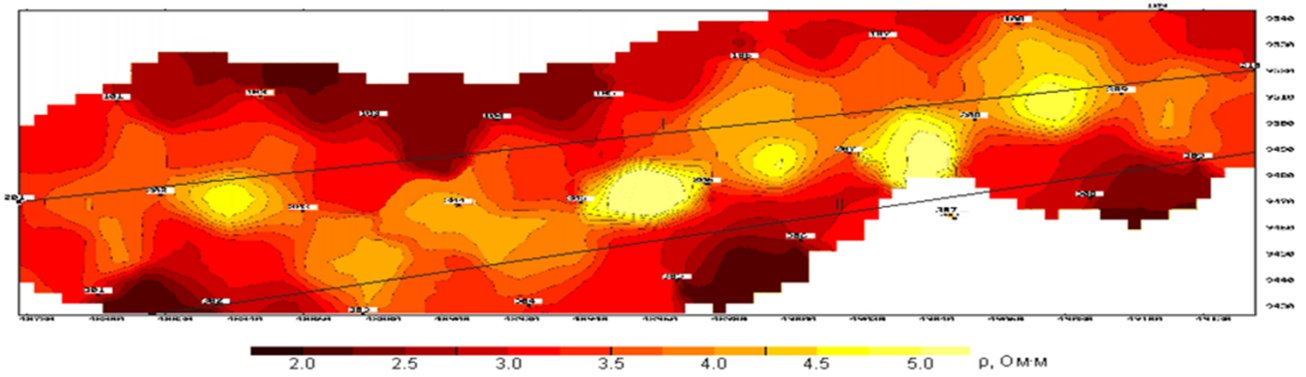
4D MONITORING OF ISL DEVELOPMENT OF URANIUM DEPOSITS

after acidification

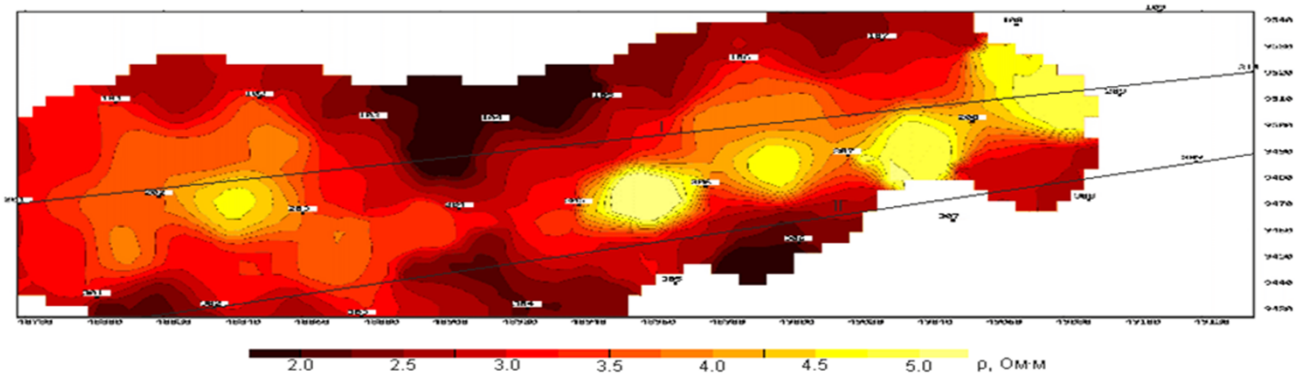
205 m



207 m



212 m



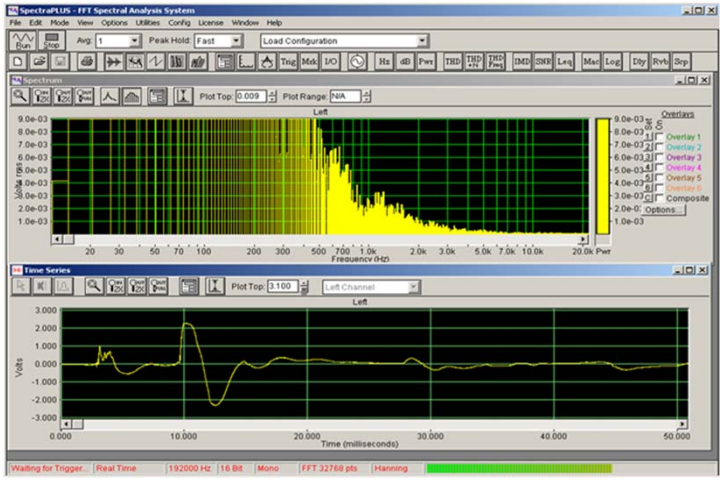
MUDDING AND REHABILITATION WORK IN WELLS

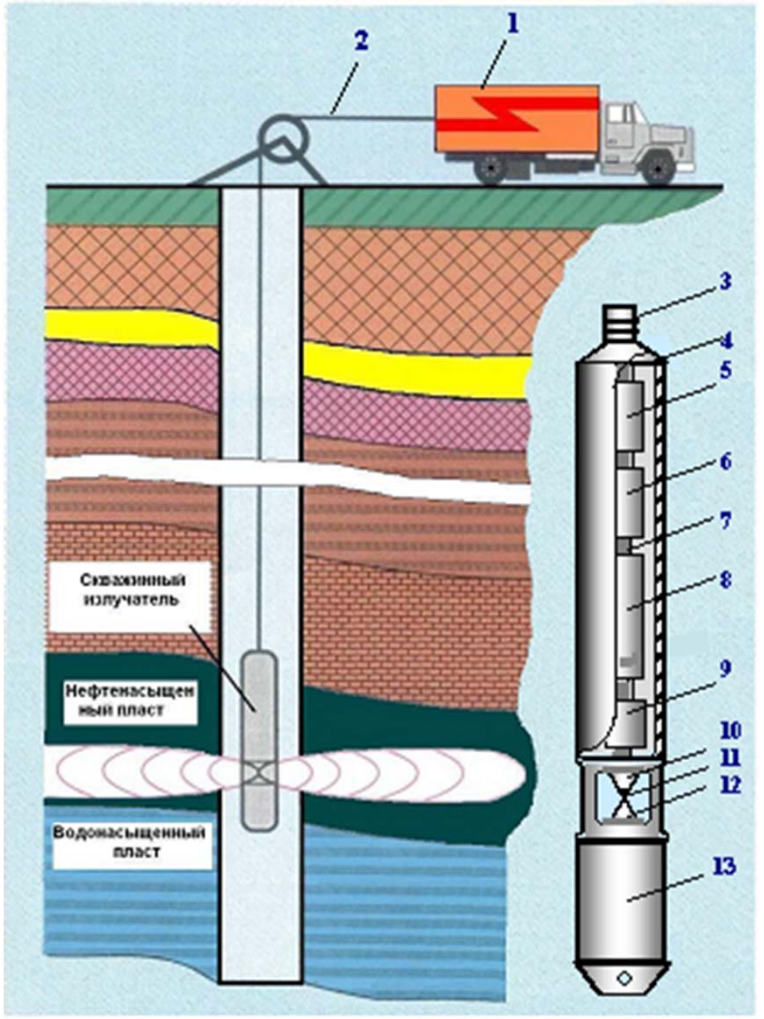
ISL of deposits with the depth of the ore body over 700 meters requires improved methods of well completion, combating mudding and technology for rehabilitation work in the wells. Rehabilitation work (RW) in the wells are performed to restore the productivity of technological wells decreased due clogging of the screen and prescreen area, deformation columns wells, as well as to eliminate sand plugs, reducing the addition of sand, etc.

The main types of RW are: air-lift pumping, flushing, sand plugs removal, pneumatic impulse treatment, chemical treatment and combined methods. For the moment Kazatomaprom and AREVA conduct research to study of mudding and factors affecting the amplification of this phenomenon. In the future we plan to develop new methods for removing and preventing clogging.

PLASMA-PULSE ACTION

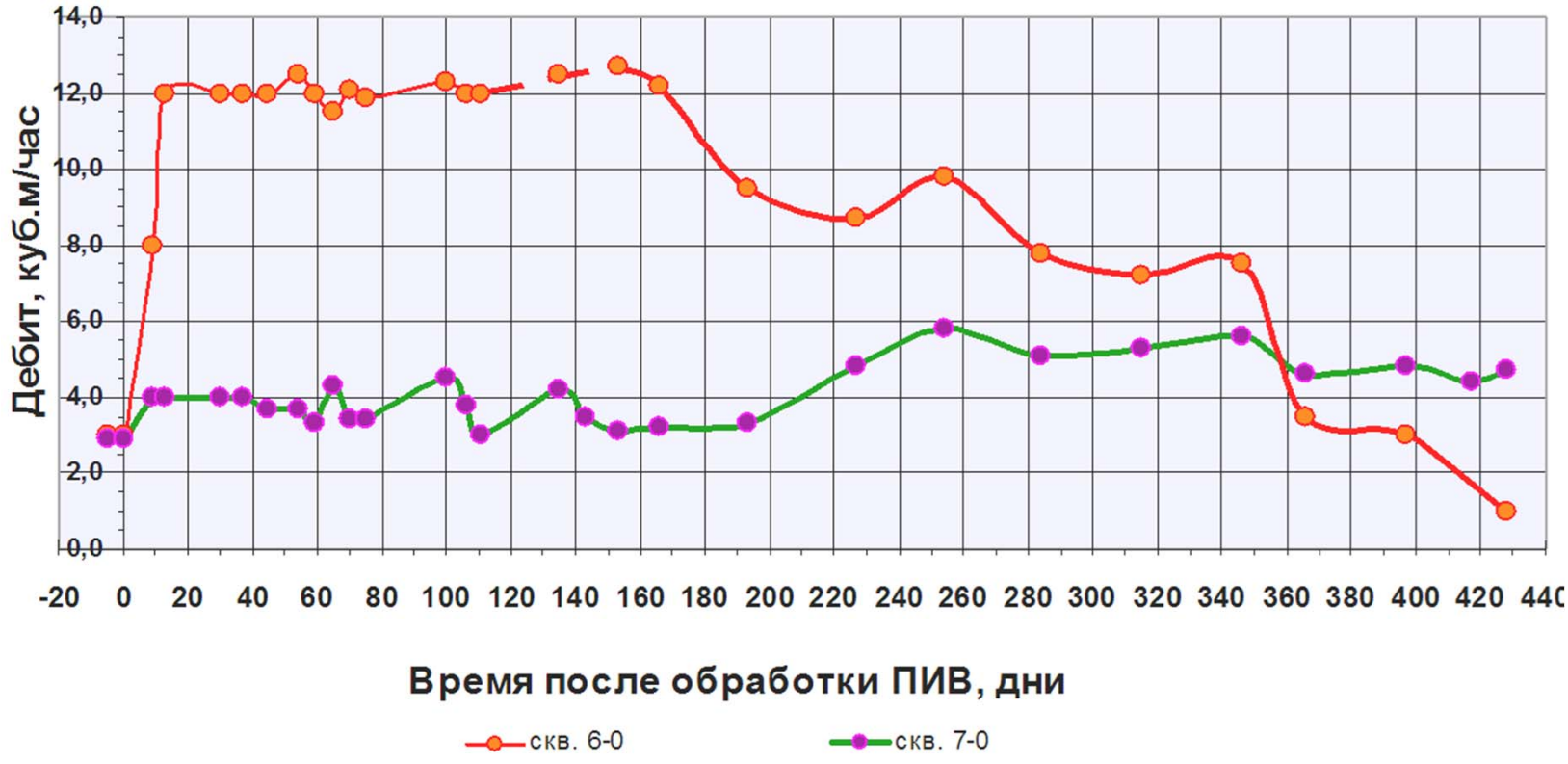
Under Professor A.A. Molchanov's leadership, the uranium companies successfully conduct research to use plasma-pulse action. In the well is created a powerful impulse effect by using the electrohydraulic discharge, which cleanses from plugging screen and penetrates deep into the sheet deposit, creating undamped fluctuations.





PLASMA-PULSE ACTION

The penetration depth of the elastic energy due to the directional radiation reaches 50 meters or more (depending on the condition of the well). Therefore, the elastic waves are perceived by neighboring production wells, which also begin to work with a high flow rate. Research on the use of plasma-pulse action to intensify the output of uranium



SORPTION-PRECIPITATION TECHNOLOGY OF CHEMICAL NATURAL URANIUM CONCENTRATE PRODUCING WITH HIGH QUALITY

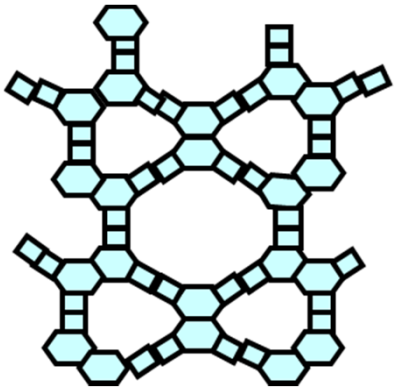
For several years, the Institute of High Technologies, owned by Kazatomprom, conducted research work for peroxide precipitation of uranium regenerates.

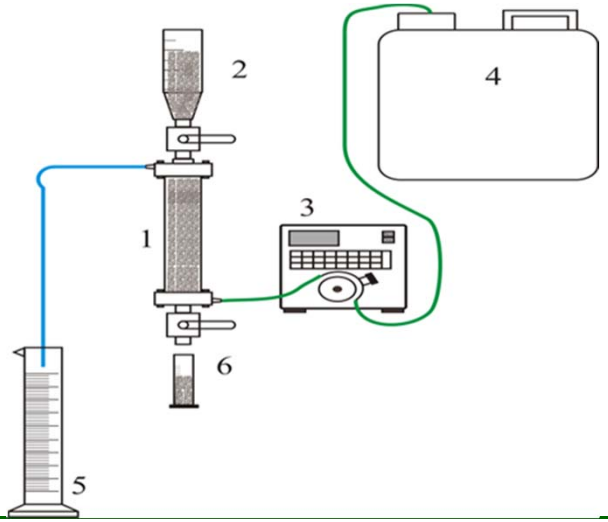
Developed the method for producing uranium concentrates allowed to improve the currently applying flowsheet and reduce processing. The results indicate the possibility of obtaining stable uranium concentrates corresponding international standard ASTM C 967-87, without extraction method.

ION EXCHANGE RESINS

Kazakhstan is working with leading manufacturers of ion exchange resins to optimize kinetic and physical properties of the resin, followed by their adaptation to the characteristics of each deposit

- Dow Chemical (U.S.)
- Cybber (China)
- АМП (Ukraine)
- Purolite (England)
- Lunxess (Germany)
- Elbrise (Switzerland)
- Resindion (Italy)



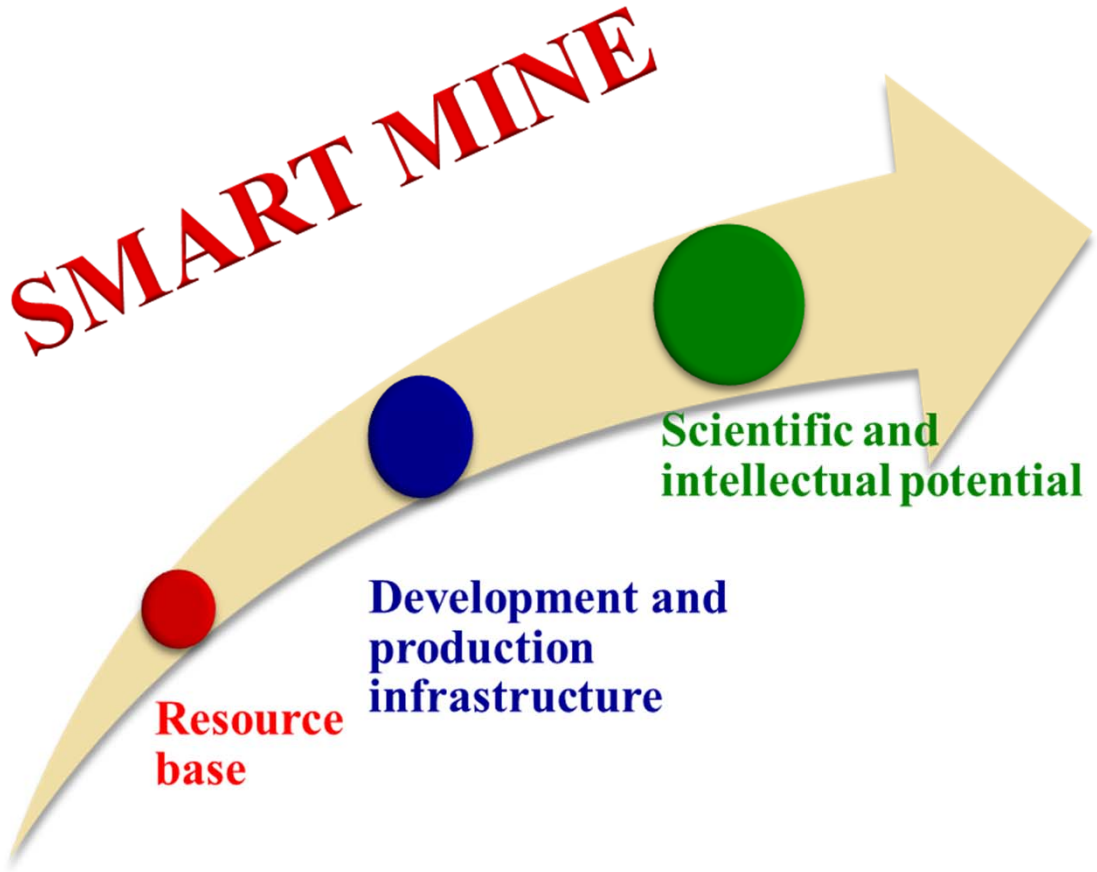


CREATION OF EXPERIMENTAL TEST SITE.

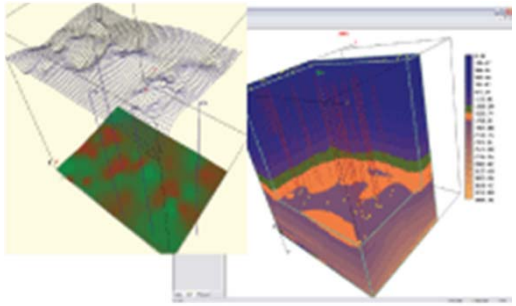
On the basis of Stepnoe Mining Group, an experimental technological test site was created, which providing carrying out pilot tests of new materials, innovative technologies, devices and equipment for the intensification of technological processes, improve quality and reduce the cost of the uranium concentrates and related (rare earth metals) goods in the enterprises of Kazatomprom.

SMART MINE

Based on the results already obtained work conducted at the experimental technological test site Kazatomprom considering the issue of creation of pilot intellectual mine new generation - "**SMART MINE**"



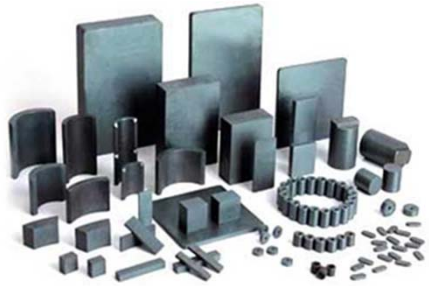
SMART MINE



- creation, testing and implementation of advanced technological innovations in various production processes (geological modeling, combined methods of leaching uranium ores, complex processing of pregnant solutions);
- use of modern energy and resource saving materials and equipment;
- use of complex processing of components;
- training and retraining of technical and engineering personnel to work on advanced technology and equipment;
- environmental safety;
- creation of intangible assets intellectual property rights for their commercial use;

PLASMA-PULSE ACTION

Years of experience in the study and exploitation of uranium deposits by ISL shows that in many cases the deposits are complex and in addition to uranium contain other beneficial ingredients: selenium, molybdenum, vanadium, yttrium, scandium, rhenium, rare earths, gold, silver, etc. Further development of geotechnical mining methods opens up new possibilities for a more complete work on the deposits.



Participation on the market for RM and REM:

- enterprises for ancillary mining of Re and REM from uranium ISL solutions

ISR solutions and products using REM

Thank you for attention!

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