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AKIPS apparatus and method complex for downhole smallsize geophysical logging

The equipment was development by AO NPP VNIIGIS in cooperation with AO NPF GITAS

SCOPE OF APPLICATION

oil and gas, coal, ore and hydrogeological wells a diameter of 60-200 mm, max. operating pressure up to 60 MPa, max.operating temperature 120°C

FEATURES

•it has a basic module of relay + gamma log provides tying to depth for each method;

• program, power, design compatibility of modules;

•possibility of simultaneous registration of all parameters;

•software-controlled operating;

•the wireline digital system of registering and information transmission;

•high-passability of the complex because due to of controled centralizers, holding down devices and joint connector.

ADVANTAGES

•combination of different geophysical methods according to the solving geological problem and customer demands;

• it can be used for research of directional and horizontal wells;

• informational, energetic and constructive combination;

• complex openness for system combination and addition of new transducers on a customer's demand.

EQUIPMENT

digital transducers with a diameter of 36 and 48 mm,
which realize the following methods:
gamma-ray logging (GK);
spectrometric gamma-ray logging (SGK);
density gamma-gamma ray logging (GGK-P);
selective gamma-gamma ray logging(GGK-S);
litho-density gamma-gamma ray logging(GGK-L);
neutron-gamma ray logging(NGK);
neutron-neutron logging (NNK);
spectral neutron gamma-ray logging (SNGK);
spectrometric X-ray radiometrical logging (SPPK);
lateral logging (BK);
lateral scanning logging (BK-S);
electromagnetic logging (EMK);
full wave acoustical logging (VAK);
caliper log (KB);
temperature and resistivity log (TR).

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The equipment AKIPS is compatible with any type of programmable stations.

The apparatus can be operated with any conventional wireline, as well as a stiff wireline or coiled tubing installation equipped with a logging cable.

AKIPS complex can be delivered in two modifications:

•telemetry connecting link module, combined with GK module, to which any of mentioned above modules can be attached from the underside;

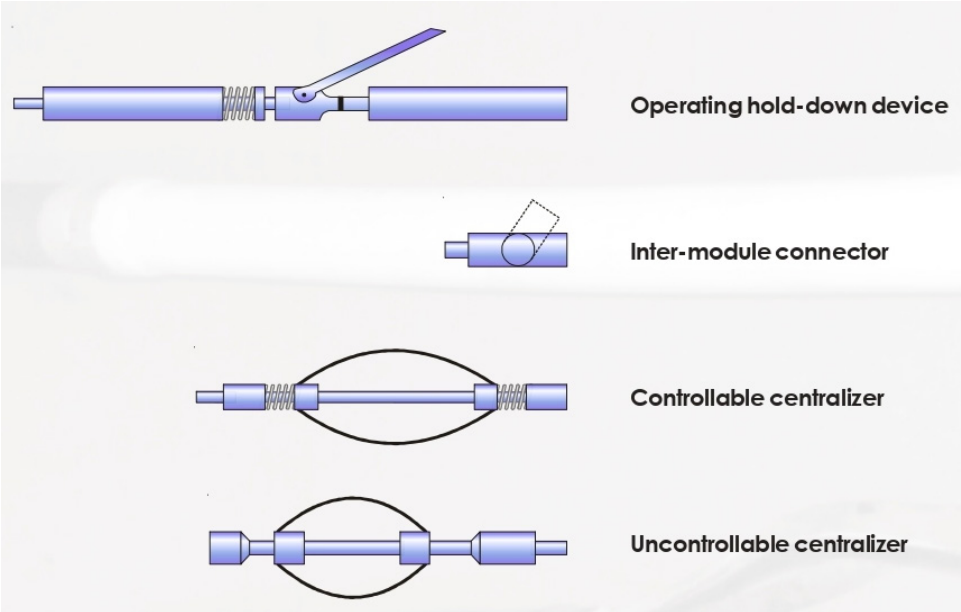
•set of separate downhole tools, which constructively can not be attached.

Delivery completeness:

•Downhole digital modules, controllable centralizers, operating hold-down devices, uncontrollable centralizers, inter-module connectors; facilities for tool calibration, devices for tool servicing, spare parts tools and accessories, certificates, operating manuals, calibration of a primary basic protocols.

•At customer's option supplied interface unit, IBM-compatible computer Notebook, soft-ware controlled powersupply source, technological software

PROCESSING UNIT OF AKIPS-COMPLEX



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BI Universal interface block

is designed to power the downhole tool, data exchange of the surface computer with the downhole tool, with the depth system - depth sensor tags (DMG) and optical disk (OD) on the synchro receiver.

FEATURES and ADVANTAGES

Integrated power supply for downhole tools.

BI has a built wireline simulator (R=60 Ohm) for testing the equipment under laboratory conditions.

It works with PC type Notebook (mobile version) or as part of any computer-controlled logging unit.

It is possible to work with other downhole tools using the «Manchester-2» code.

It is possible to use a powerful external source to supply power to downhole tools.

Available in three versions:

-BI - 200 (designed to work with AKIPS equipment);

-BI MID (designed to work with MID equipment and all its modifications);

- BI AMC-VSP-3-48 (designed to work with AMC-VSP-3-48 equipment and all its modifications).

BI-200

BI MID

SPECIFICATIONS

	BI-MID	BI -200
Data transmission format	Manchester-2	Manchester-2
Data transmission speed, MBaud	1/48	1/48
Data receiving rate, in software changeable, MBaud	1/6; 1/12; 1/24; 1/48	1/6; 1/12; 1/24; 1/48
Supply current of downhole tool, mA, up to	200	1000
Voltage margin in the current source, V	100	200
Supply voltage, V/Hz	180-260/50	180-260/50
Energy input power, W, up to	200	300
Dimensions, mm: length width	270 330 75	270 330 120
Weight with a set of cords, kg, up to	6.5	12
Surrounding air temperature, 0C	10-35	10-35
Degree of air saturation, %, up to	98	98
Atmospheric pressure, kPa	60-106	60-106

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GK digital gamma-ray logging and SGK digital spectrometric gamma-ray logging modules (as a part of AKIPS complex)

GK module is designed for power measurement the exposure dose of natural gamma radiation.
SGK module is designed for measurement mass fraction of natural radioactivity K, U, Th elements.
Measurement capabilities: it is compatible in operation to other modules as a part of AKIPS.

SPECIFICATIONS

Maximum operating temperature, °C	70±120
Maximum hydrostatic pressure, MPa	25±60
Module dimensions, mm	
diametr	48
length	800
GK module	
Measurement range of exposure rate, μR/hr	0÷100
Measurement error, %	±15
SGK module	
Mass fraction of naturally radioactive elements, %r	
K	0,1÷20
Th, U	$(10\div100)\cdot10^{-4}$
Measurement error, %	
K	±15÷10
Th, U	±25÷15

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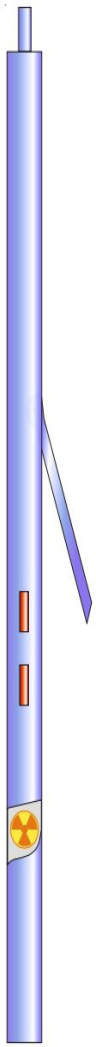
GGK-P Digital gamma-gamma density logging module (as a part of AKIPS complex)

Is designed for volume density measurement by scattered gamma radiation method.
Potential for use as a part of AKIPS comparable with other modules.



SPECIFICATIONS

Volume density measurement range, gr/sm3:	
coal	1...2.7
ore	1.8...4.5
oil	1.8...4.5
Rock volume density measurement error, %, up to	2
Operating temperature range, °C	70÷120
Maximum hydrostatical pressure, MPa	25÷60
Module dimensions, mm:	
diametr	48
length	1800

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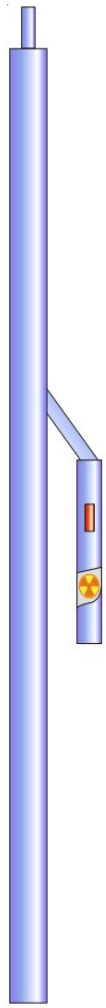
GGK-S Digital selective gamma-ray logging module (as a part of AKIPS complex)

Is designed for measurement effective rock atomic number.
Potential for use as a part of AKIPS comparable with other modules.



SPECIFICATIONS

Effective atomic number measurement error, atomic unit:	
coal	6÷13
ore	6÷22
Rock volume density measurement error, %	2
Operating temperature range, °C	70
Maximum hydrostatical pressure, MPa	25
Module dimensions, mm:	
diametr	48
length	1200

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GGK-L Digital litho-density gamma-ray logging module (as part of AKIPS complex)

Is designed for measurement volume density and effective rock atomic number.
Potential for use as a part of AKIPS comparable with other modules

SPECIFICATIONS

Effective atomic number measurement error, atomic unit:	6÷13
Volume density measurement range, gr/sm3	1.8÷3.5
Effective atomic number measurement error, %	2
Rock volume density measurement error, %	2
Operating temperature range, °C	70÷120
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm: diametr length	 48 1200

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NGK Digital neutron gamma-ray logging and NNK digital neutron-neutron logging modules (as part of AKIPS complex)

Is designed for measurement of equivalent water-filled formation porosity.
Potential for use as a part of AKIPS comparable with other modules

SPECIFICATIONS

Maximum range of water-filled porosity measurement, %	1÷40
Rock volume density measurement error, %, up to	15
Operating temperature range, °C	70÷120
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm:	
diametr	48
length	800

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BK digital lateral logging and BKS digital lateral scanning logging modules (as part of AKIPS complex)

BKS module is designed for measurement of rock apparent resistivity. Existence of several variable-depth probes provides an estimate of rock nonhomogeneity in radial axis.

BKS module is designed for measurement of azimuthal dependence of rock apparent resistivity. Sectionalized central electrode A0 of scanning lateral logging allows to estimate rock azimuth in homogeneity along six directions by means of scanning. Scanning lateral logging is used for determination layer spatial arrangement.

Potential for use as a part of AKIPS comparable with other modules.

SPECIFICATIONS

Measured resistance range, Ohm•m	0,1.....10000
Relative measurement error, %, up to:	
in range 0,1....1 Ohm*m	10
in range 2...20000 Ohm*m	5
Operating temperature range, ºC	70÷120
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm:	
diametr	48
length	3200

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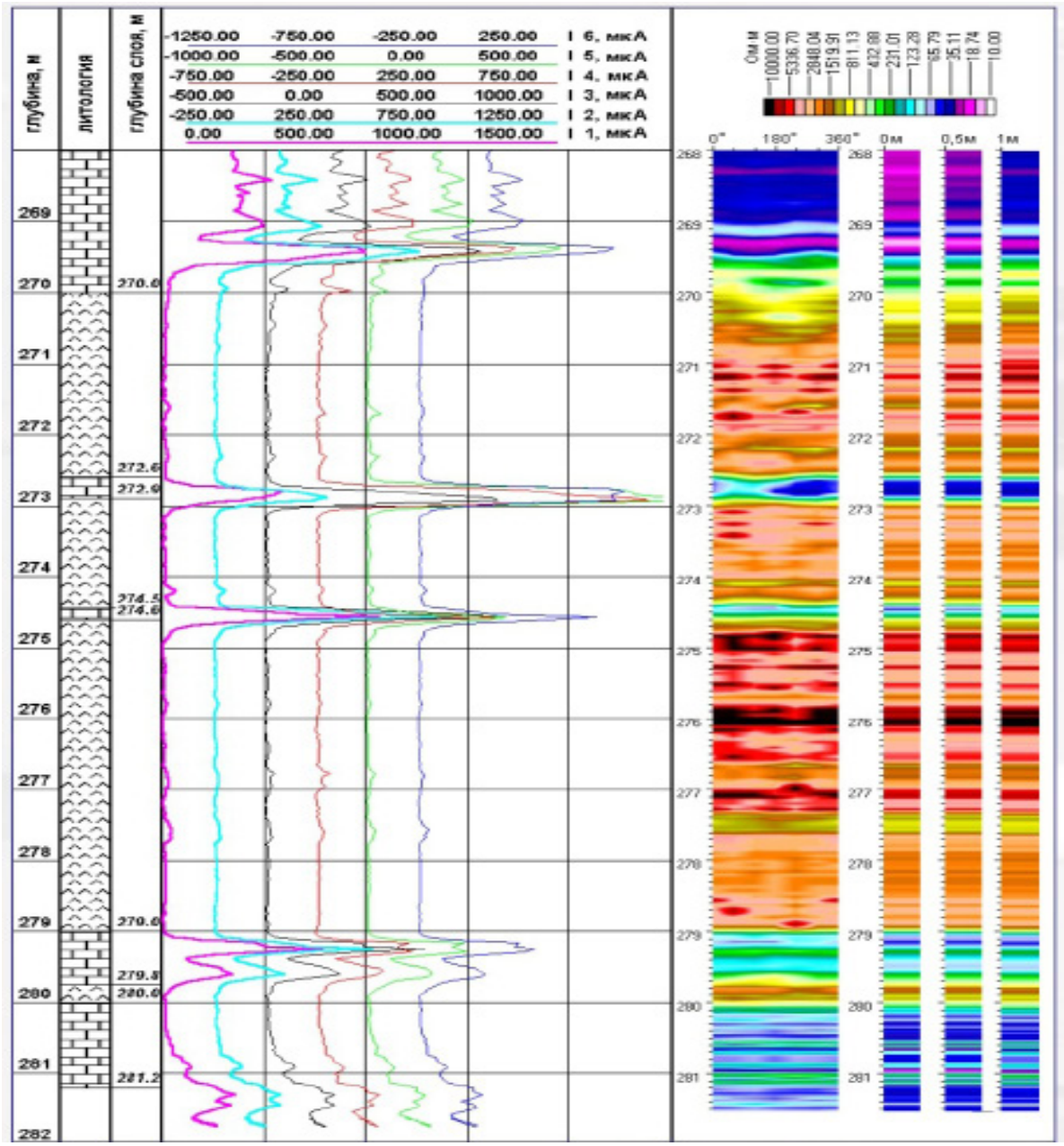
Example of application BK module for an assessment of azimuthal heterogeneity of the reservoir at different distances from the borehole wall



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EMK Digital electromagnetic logging module (as part of AKIPS complex)

Is designed for magnetic and conducting rock characteristics measurement by register of real and imaginary component of induction electromagnetic field.

CALCULATED PARAMETERS FOR EMK MODULE

The ratio of Ep real component of the complex amplitude magnetic induction of electromagnetic field which is excited by the module in researched environmental to E_0 real component induction of this field in the air

$$\varepsilon p = Ep/E_0$$

The ration of Eα imaginary component of a complex amplitude magnetic induction of electromagnetic field which is excited by the module in researched environment to E_0 real component induction of this field in the air

$$\varepsilon \alpha = E\alpha/E_0$$

POTENTIAL FOR USE AS A PART OF AKIPS COMPARABLE WITH OTHER MODULES

SPECIFICATIONS

Measurement range of Ep, real component, relative unit	10^{-4} - 1
Measurement range of Ea, imaginary component, relative unit	5 10^{-4} - 0.5
Rock volume density measurement error	$\pm[5+0.05*(X_к/X-1)]$
Operating temperature range, °C	70÷120
Maximum hydrostatic pressure, MPA	25÷60
Module dimensions, mm: diametr length	 48 1330

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VAK Digital wave acoustic logging module (as part of AKIPS complex)

Is designed for measurement full acoustic waves patterns.
Potential for use as a part of AKIPS comparable with other modules

SPECIFICATIONS

Measurement of wave patterns from two sound acoustic receiving devices along with equidistant 2 microseconds discretization, mks	32÷2048
Signal amplitude within one wave pattern, dB	96
Gain drift, dB	36
Rock volume density measurement error, %	10^{-4}
Operation temperature range, °C	70÷12
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm:	
diametr	50
length	3500

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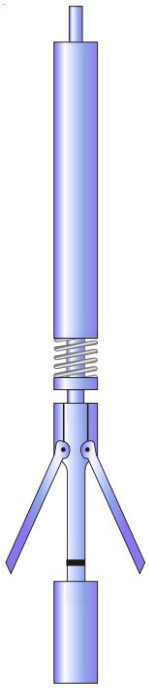
KV Digital caliper log module (as part of AKIPS complex)



Is designed for measurement of well mean-diameter. Opening and closing of caliper arms is realized with the help of a controlled electric motor.
Potential for use as a part of AKIPS comparable with other modules.

SPECIFICATIONS

Well diameter measurement range, mm	200÷300
Well diameter measurement error, %, up to	1
Operating temperature range, °C	70÷120
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm:	
diametr	48
length	1330

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TR Digital thermal log and continuous mud resistivity module (as part of AKIPS complex)

Is designed for measurement of electrical conductivity and temperature of borehole fluids.
Potential for use as a part of AKIPS comparable with other modules.

SPECIFICATIONS

Electrical conductivity of borehole fluid measurement range, Sm/m	0.05÷20
Relative measurement error of electric conductivity, %, up to	±5
Operating temperature range, ºC	70÷120
Maximum hydrostatic pressure, MPa	25÷60
Module dimensions, mm:	
diametr	48
length	810
Weight of module, kg, up to	4

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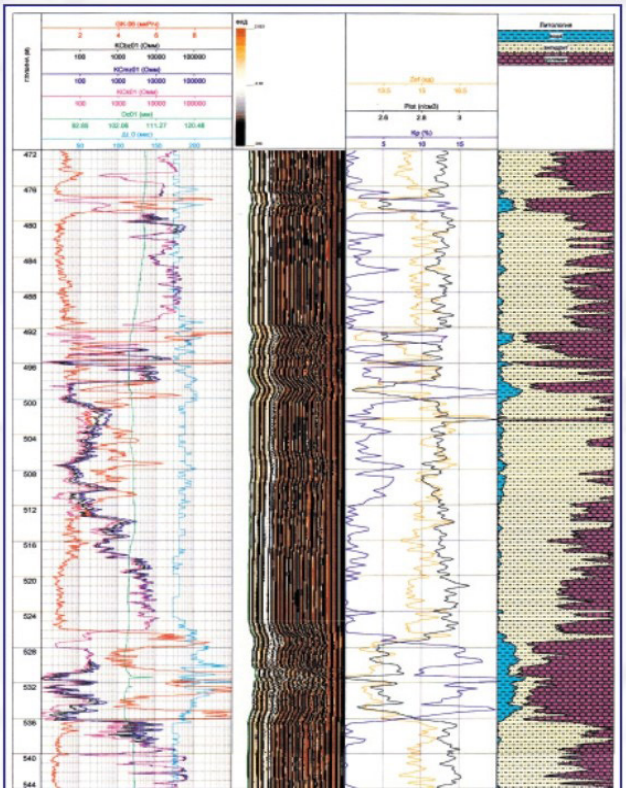
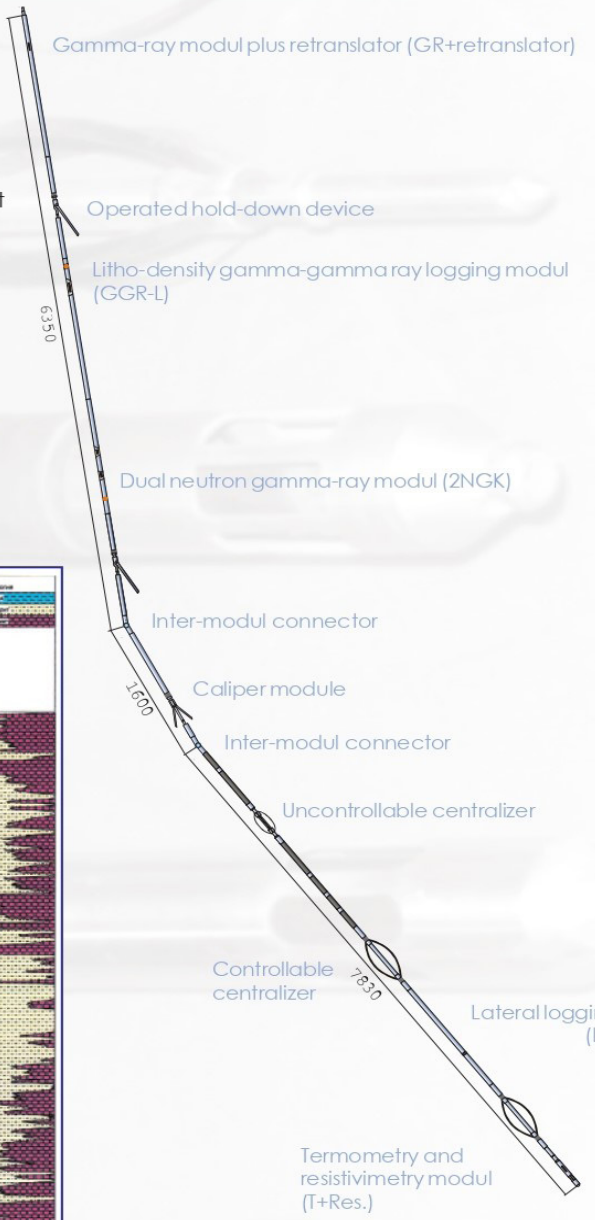
AKIPS-NN-50 Apparatus-and-method complex for directional and horizontal small size wellbores study

Hardware configuration

- **digital modules 48 mm in diameter for:**
  - GR logging (GR+retranslator);
  - GR density logging (GGK-P*) or litho-density logging (GGK-L);
  - neutron GR logging (NGK*) or dual neutron logging (2NNK);
  - full-waveform sonic logging (three-component VAK logging, 1.5 m and 2 m long probes);
  - lateral logging (BK*) or scanning lateral logging (BK-S);
  - caliper measurements;
  - thermometry;
  - resistivimetry;
  - operated centralizers;
  - operated hold-down device;
  - uncontrollable centralizer;
  - Inter-modul connector;
- **lap-top;**
- **interface unit.**

** by agreement with the Customer*





Example of AKIPS-NN-50 complex using while investigating a directional well

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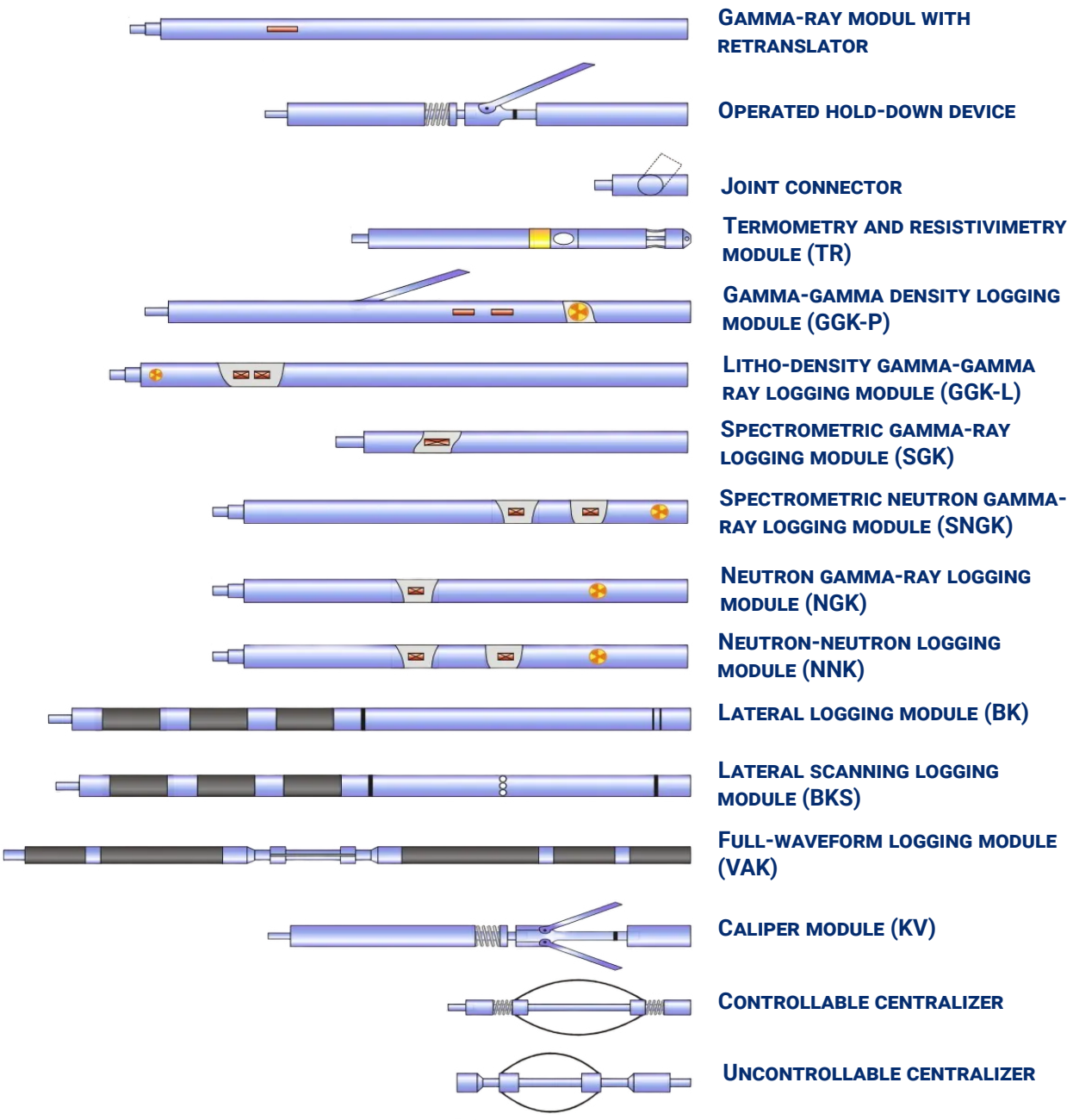
AKIPS-oil complex element set



- Gamma-ray modul with retranslator
- Operated hold-down device
- Joint connector
- Termometry and resistivimetry module (TR)
- Gamma-gamma density logging module (GGK-P)
- Litho-density gamma-gamma ray logging module (GGK-L)
- Spectrometric gamma-ray logging module (SGK)
- Spectrometric neutron gamma-ray logging module (SNGK)
- Neutron gamma-ray logging module (NGK)
- Neutron-neutron logging module (NNK)
- Lateral logging module (BK)
- Lateral scanning logging module (BKS)
- Full-waveform logging module (VAK)
- Caliper module (KV)
- Controllable centralizer
- Uncontrollable centralizer

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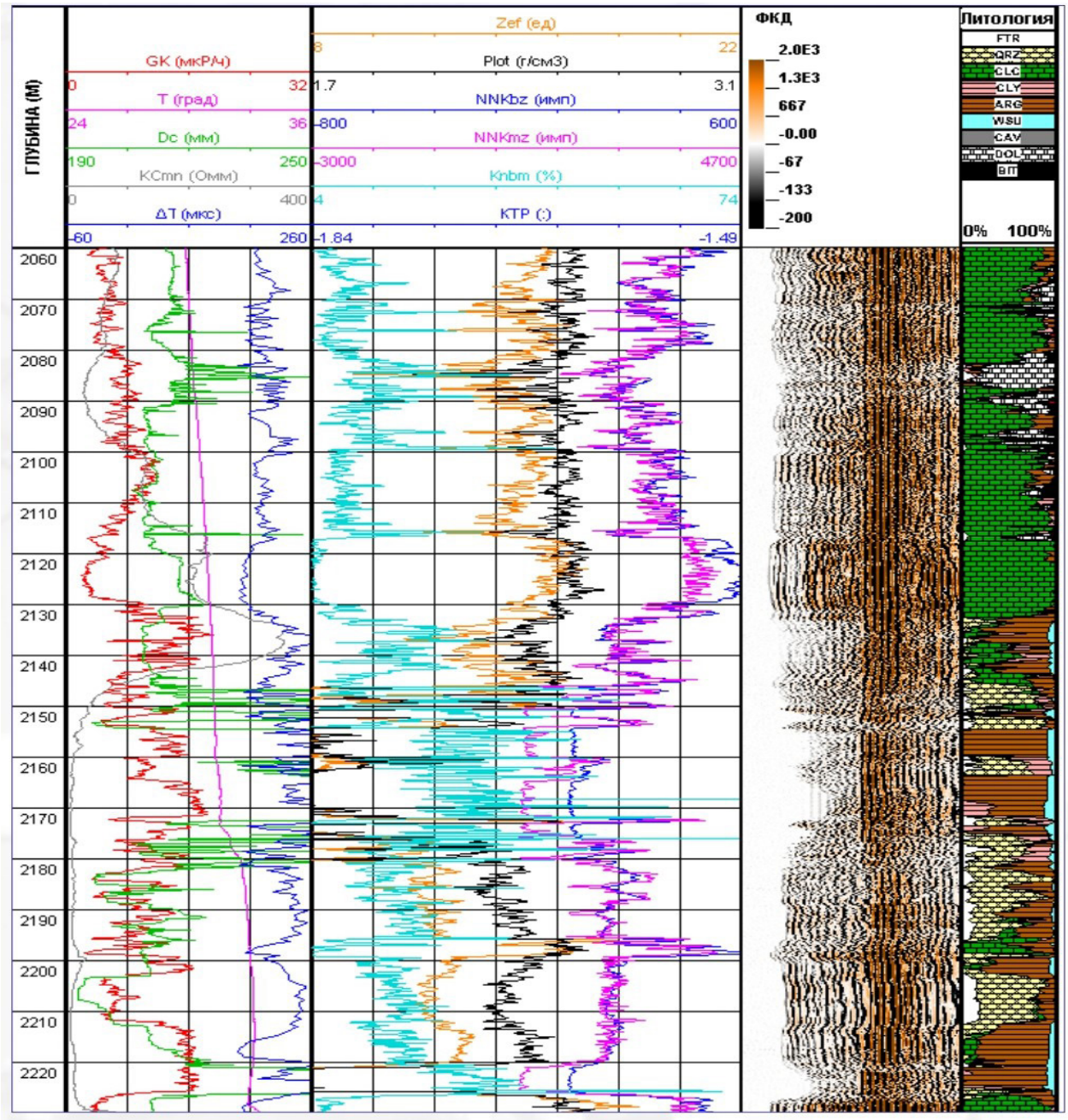
AKIPS-oil complex application example



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