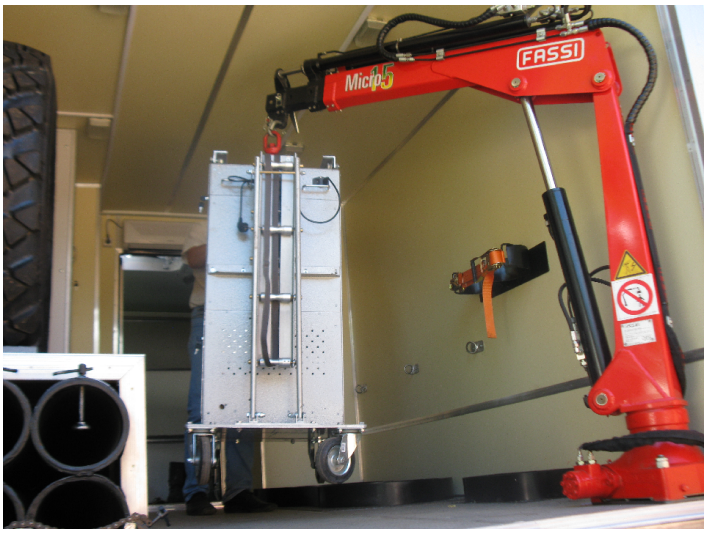
KAZAN (VOLGA REGION) FEDERAL UNIVERSITY

DEPARTMENT OF PHYSICS

Model: Mobile NMR tool «NMR-Kern-8-1».
Purpose: nondestructive prompt logging (rapid method for analysis of the core samples) using nuclear magnetic resonance (NMR) data.
Scope of Application:

- rapid analysis of the core samples taken from prospecting, exploration and producing wells;
- perform of the laboratory petrophysical investigations.



Distinctive features of the tool:

- **mobility,** which allows to include the tool to a standard well logging complex;
- **full-sized cores measurement ability**, which excludes cutting out or destroying the integrity of the samples;
- **express measurements**, which allows timely and correct estimation of gas and fluid loss from the core samples;
- application of all NMR-logging standard techniques;
- **measurements of the self-diffusion coefficients** with using pulsed magnetic field gradient techniques as an additional method which provides new information for the fluid typing;
- research of solid and highly viscous components in the core-samples with using standard **solid state NMR techniques**;
- **high sensitivity of the tool** due to application of a powerful magnetic system with the highly homogeneous field;
- wide range of measured values of transverse nuclear magnetic relaxation times and self-diffusion coefficients;
- **automatic positioning of a core sample** while scanning;
- **automated measurement and data processing system**, which allows real-time calculation of the spin-spin relaxation times spectra while scanning;
- significantly lower cost compared with foreign analogs identical in design.

Measured NMR parameters::

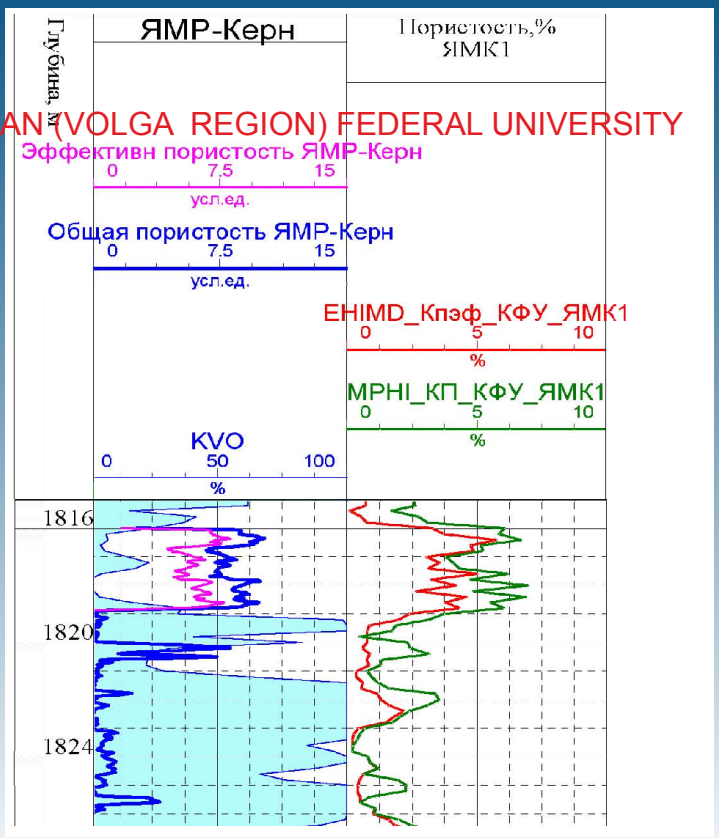
- spectra of the spin-spin (transverse nuclear magnetic) relaxation times T_2;
- spin-lattice (longitudinal nuclear magnetic) relaxation times T_1 T1 for selected bins in the T_2-spectrum;
- self-diffusion coefficients D_s r selected bins in the T_2-spectrum;
- hydrogen ^1H content in a core sample including solid and highly viscous components

Calculated and estimated characteristics of the core:

- total NMR-porosity;
- effective porosity (part of the movable fluid);
- NMR-porosity by set of bins (cavernous, effective, capillary, clay porosity);
- permeability estimated from the Timur-Coates model and the model of average energy value of T2 (Schlumberger).

Technical and Operational characteristics::

Diameter of the core sample	-	not more than 116 mm;
The maximum length of the core sample	-	1500 mm;
Resonant frequency (on ^{1}H nuclei):	-	8,21 MHz;
Maximum pulsed magnetic field gradient	-	1 T/m.
Weight of the mobile Tool	-	350 kg;
Dimensions (height/width/depth):		
• in transportation	-	1450 / 950/ 620 mm;
• in use	-	1450 / 3050 / 620 mm;
Core sample positioning accuracy	-	1 mm;
Space resolution along the core sample	-	10 mm;
Ranges of measured parameters:		
• spin-spin relaxation rate (T_2)	-	0,00005÷5 sec;
• spin-lattice relaxation time (T_1)	-	0,01÷10 sec;
• NMR-porosity (φ)	-	0,2÷100%;
• self diffusion coefficients (D_s)	-	10^{-8}÷10^{-12} m^2/sec;
• hydrogen ^{1}H content (in compare with $_2O$)	-	1÷100%;
Scanning time of the 1.5 m core sample with 1 cm scanning step, while only NMR-porosity is measured:		
• with 1 acquisition (accuracy 1%)	-	3 min;
• with 4 acquisitions (accuracy 0.5%)	-	11 min;
• with 16 acquisitions (accuracy 0.25%)	-	41 min;
Scanning time of the 1.5 m core sample with 1 cm scanning step, while spin-lattice relaxation time (T_1) or self-diffusion coefficients (D_s) is measured:		
• через 1 см с 1 накоплением	-	11 min;
• с 16 накоплениями (точность 0,25%)	-	41 min.



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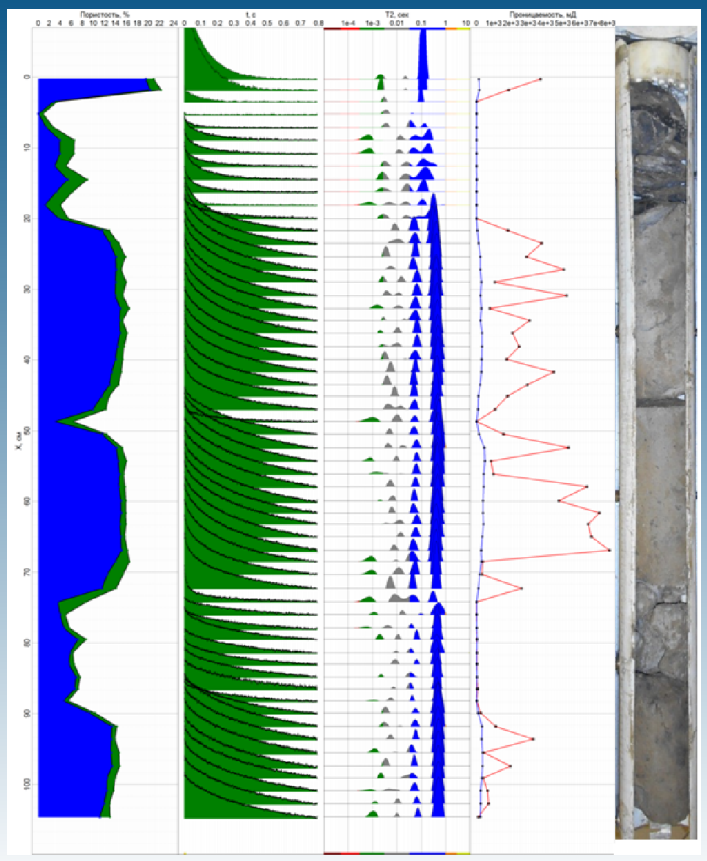

Figures:

- Comparison of NMR logging data recorded by different NMR Tools, and data recorded by "NMR Kern 8-1" tool (left);
- Results of NMR porosity measurement with an estimate of the permeability by Timur-Coates model and the average energy model for the core sample taken from the West Karachevsky deposit (right).

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