



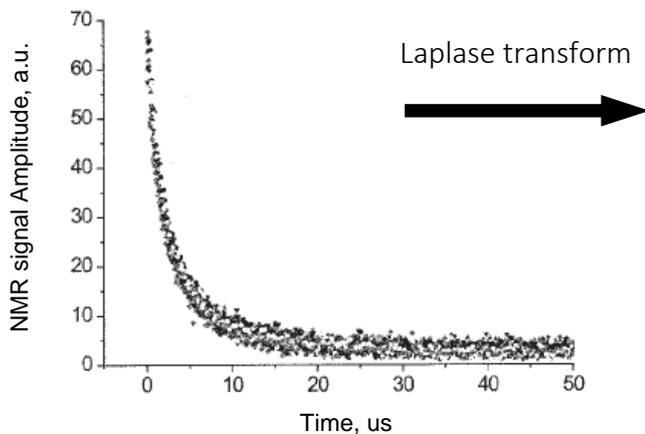
### Analysis of rock cores by pulsed NMR

Properties of rock cores determined by NMR:

- Porosity
- Permeability
- Saturation
- Pore size distribution
- Relative susceptibility to oil, gas and water
- Determination of the relative content of oil / water in cores

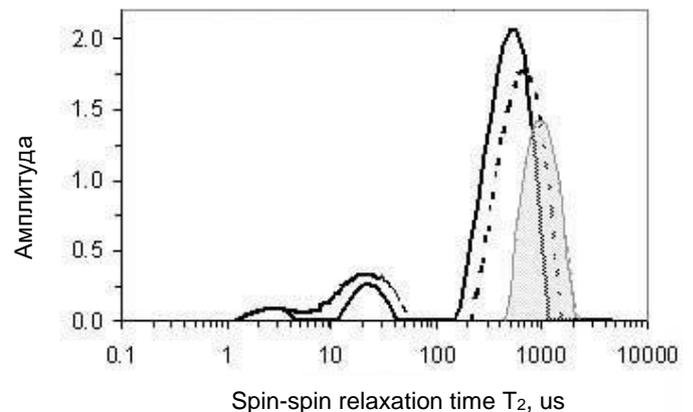
Study of the porosity of cores is the key to determining other characteristics mentioned above that are important for geological exploration, since relaxation times, distribution of relaxation times, pore diameter and their distribution, permeability, etc., are interrelated. Therefore, in the study of cores mainly involved methods are based on the determination of  $T_2$  – characteristic spin-spin relaxation times.

The relaxation decay (Fig. 1) after the inverse Laplace transform gives a picture of the distribution of spin-spin relaxation times (Fig. 2). In accordance with the theory of adsorption, the fluid contained in the pores has different mobility, the minimum in the layer closest to the surface of the pore and the maximum in the center of the pore. Thus, this makes it possible to estimate the pore diameter of the core after calibration using known models, registering the relaxation process, since proton mobility is proportional to  $T_2$ , and this distribution characterizes the pore diameter over the corresponding  $T_2$  and their number in the sample in amplitude.



**Fig.1 CPMG declines of various water-saturated cores**

Laplace transform  
→



**Fig. 2 Distribution of relaxation times after the Laplace transform**

The obtained data is used in geological exploration to predict the accumulation of oil reservoir and oil quality.

The Spin Track NMR analyzer (Fig. 3) is used to obtain this information when studying the water and bitumen saturation of rock cores. The analysis is characterized by high accuracy and reproducibility of data.

The advantages of the Spin Track NMR analyzer are small dimensions, low cost and the ability to measure  $T_2$  spin-lattice relaxation time with a very large number of points, which is a prerequisite for analyzing rock cores. The device is equipped with the latest software that allows studying the distribution of relaxation times, giving direct information about the distribution of pore sizes within one minute. This is an important advantage of the Spin Track NMR analyzer compared to existing analogues.



The spectrometer can be equipped with a classical magnetic system supplied with sensors able to accommodate cores with diameters of 10, 18 or 40 mm, to fulfill generally accepted laboratory standard that is widely used throughout the world.



**Fig. 3 Spin Track NMR Analyzer**



**Fig. 4 Surface NMR sensor**

The second option for equipping the spectrometer is a small-sized surface sensor with a large depth of penetration (Fig. 4). This gives some advantages, for example, when a laptop is equipped with a system, it becomes possible to use a mobile spectrometer in the field and to use non-standard sized samples. In addition, this sensor reduces the hardware cost of a number of modern scientific tasks like measuring the diffusion coefficient and self-diffusion, system viscosity, since no additional pulsed magnetic field gradient is required due to the presence of a constant. An additional gradient block can provide a display of the internal structure of the rock (NMR tomography).

The system is equipped with flexible software that fully automates the process and requires minimal operator participation. The software supports the Windows 7 and later platforms.

The company's development strategy is aimed at meeting the needs of the customer as much as possible, so any configuration and quick revision of the hardware for a non-standard task is possible. Technical and scientific advice is provided.

## Contacts

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