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Possibilities of three–component geoacoustic logging at hydrocarbon deposits.

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The geophysical method of oil-gas borehole investigation devised at the Institute of geophysics UB of RAS studies characteristics of geoacoustic emission (GAE) over the frequency range of $0.1 \div 5$ kHz which displays peculiarities of fluid-gas dynamic processes in a volume of geological environment. More over:
1. The second displacement derivative (acceleration) of borehole walls' vibrations is recorded.
2. The three-component system of orthogonal transducers-accelerometers in a protecting casing of a borehole instrument with the diameter of 40-42 mm enabling to divide geoenvironment microvibrations into three directions is applied.
3. Frequency composition of recorded geoacoustic signals is analyzed.
4. Values of measured and calculated parameters representing distribution of signal amplitudes according to three components at four frequency bands are evaluated.
Three-component geoacoustic logging at hydrocarbon deposits solves the following problems:
Estimation of fluid saturation character at a qualitative level;
Detection of fluid flow outside and inside the casing string with division into fluid types;
Detection of fluid flow position in chambers of a cement ring with division into fluid types;
Detection of non-sealed points of borehole equipment;
Location of gas-water, gas-oil ad water-oil contacts;
Study of inflow section in a perforated interval of casing string which determines the boundaries of efficient intervals;
Detection of sections with high absorption of drilling fluid in an open shaft;
Test for leaks of the column (together with thermometry);
Detection of intervals of fluid movement in horizontal direction outside a casing string within seams (it is impossible to determine them by other methods);
Detection of industrial deposits;
Revelation of water-flooded intervals of a hydrocarbon deposit.
Transducers-accelerometers with relative coefficient of transverse conversion not more than 6% allow confident division of signals into three directions. Transverse sensitivity of a transducer is determined by its maximum sensitivity to oscillations in a direction perpendicular to its main axis that is parallel to the surface where it is placed.
The equipment [1] has sensitivity that enables to record an acoustic response of geoenvironment to deformations in the order of 10-8 – 10-11 m. Geoacoustic signals in sedimentary rocks are recorded by three orthogonal transducers-accelerometers of PVT type (piezoelectric vibromeasuring transducer).
Transducers with coefficients of conversion not less than 6-10 μV*s2/mm are installed into a borehole instrument. Amplitude level of signals at different frequency bands is presented in units of recorded acceleration mm/s2. Small amplitude of geoenvironment microvibrations is an additional optimum condition to divide signals from three directions. Thus, signals from three directions are fixed at preset depth in a borehole which makes it possible to compare their amplitude at different frequency bands.
References:
1. Yu. G. Astrakhantsev and A. K. Troyanov, RF Patent No. 2 445 653, 2012.