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ИССЛЕДОВАНИЕ ПЕСЧАНО-АЛЕВРИТОВЫХ ПОРОД ДЛЯ ОПРЕДЕЛЕНИЯ ИХ УПРУГИХ ХАРАКТЕРИСТИК

THE MIDDLE JURASSIC`S CORE EXEMPLARS RESEARCHING FOR SPECIFYING OF THEIR ELASTIC CHARACTERISTIC

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Usually for processing of well logging data so called "core-core" dependencies are widely utilized, which are derived from core analysis under atmospheric conditions when no reservoir conditions are taken into account. In this work the practical study of core samples using the high-pressure system AutoLab 1500 (USA KORTEST) has been conducted under conditions, approximate to reservoir conditions. Application of "core-core" dependencies under such conditions has enabled the author to determine P-wave and S-wave propagation velocities, modulus (E), Poisson's coefficient, shear modulus G, volume compression coefficient It had an influence on the efficiency and accuracy of the method of quantitative interpretation of sonic logging results, allowed to adjust the data logging and to apply determined elastic characteristics of rocks for designing and optimization of various technical operations in a bore whole, such as hydraulic fracturing

Обычно, для обработки данных каротажа скважин, широко используются так называемые зависимости «керн-керн», которые являются производными от анализа керна в атмосферных условиях, когда условия залегания пласта не учитываются. В этой работе, практическое изучение керна с использованием системы AUTOLAB высокого давления 1500 (США KORTEST), было проведено в условиях, приближенных к условиям естественного залегания пластов. Применение зависимостей "керн-керн" в пластовых условиях позволило нам определить скорости распространения Р-волны и S-волны, модуль упругости (Е), коэффициент Пуассона, модуль сдвига G, коэффициент объемного сжатия. Он имеет влияние на эффективность и точность метода количественной интерпретации результатов акустического каротажа, позволяет корректировать данные при регистрации и применять полученные упругие характеристики пород для проектирования и оптимизации различных технических операций в стволе скважины, например, такие как гидроразрыв пласта и другие

Introduction

Nowadays, so called "core-core" dependence is widely utilized for processing of well logging data. This dependence is obtained under atmospheric conditions and does not take into account reservoir conditions.

The efficiency of the method of quantitative interpretation of sonic logging results, designing and planning of various technological actions in bore holes (e. g. hydraulic fracturing), and assessment of stress conditions of different massifs are in a considerable degree determined by the degree of knowledge of elastic characteristics of rocks (propagation velocities of pressure (Vp) and shear (Vs) velocities, Young's modulus (E), Poisson's coefficient, shear modulus μ, volume compression coefficient) under conditions approximate to reservoir conditions.

Methodology

The research has been conducted using the high-pressure system AutoLab 1500 (USA KORTEST). Petrophysical properties of 35 core samples extracted from the Severniy Berdakh field (Usturt, Uzbekistan) from the productive intervals (2211-2416 m.) of sandstone and siltstone formations have been analyzed. The open porosity of this formation is in the interval of 2.12 to 15.81%. The experiments have been conducted under the following conditions: effective pressure – up to 50MPa, temperature – $20^0$to 100^0C for to water saturation conditions – complete and partial (residual water saturation).

Applications

The following wave propagation velocities have been derived under full saturation with 10% solution of NaCl:

- for pressure waves (Vp) - within 2960-5260 μs, the interval time of 190 to 338 μs accordingly.
- for shear waves (Vs) - within 1724-3049 μs, the interval time of 328 to580 μs accordingly.

Empirical dependence T= f(kp) which has been derived on the basis of available elastic and storage properties of sandstone and siltstone rocks under

various thermobaric conditions is expressed as following (Figure 1):

- Atmospheric conditions (Vp) $\Delta Tp = 10{,}3Kp + 168$ $r^2 = 0{,}91$ (1)
- Reservoir conditions (Vp) $\Delta Tp = 8{,}2Kp + 168$ $r^2 = 0{,}96$ (2)
- Reservoir conditions (Vs) $\Delta Ts = 17{,}9Kp + 312$ $r^2 = 0{,}96$ (3)

Conclusions

The dependence of elastic properties of sandstones and siltstones versus coefficient of open porosity has been derived using the P-wave and S-wave propagation velocity data under thermobaric conditions, close to reservoir conditions, and applying them in the elastic theory equations (Figure 2 (A, B, C, D). The correlation relationship between the porosity coefficient and Poisson's coefficient has not been determined in the study.

The empirical equations are the following:

- Young's modulus – porosity $E = 76{,}1Kp^{0{,}34}$ $r^2 = 0{,}97$ (4)
- Shear modulus – porosity $G = 25{,}91/e^{0{,}06kp}$ $r^2 = 0{,}97$ (5)
- Coefficient of volume compression $K = 0{,}2_2Kp + 1{,}12$ $r^2 = 0{,}97$ (6)

Determined relationships are recommended to be used for:

1. Practical application in quantitative interpretation of the results of sonic logging, DTp, DTs, Sonic waveform logging;
2. Designing of hydraulic fracturing operations (e. g. hydraulic fracturing);
3. Assessment of stress conditions of different massifs.

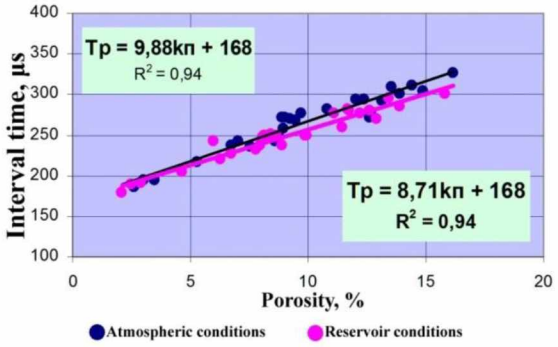
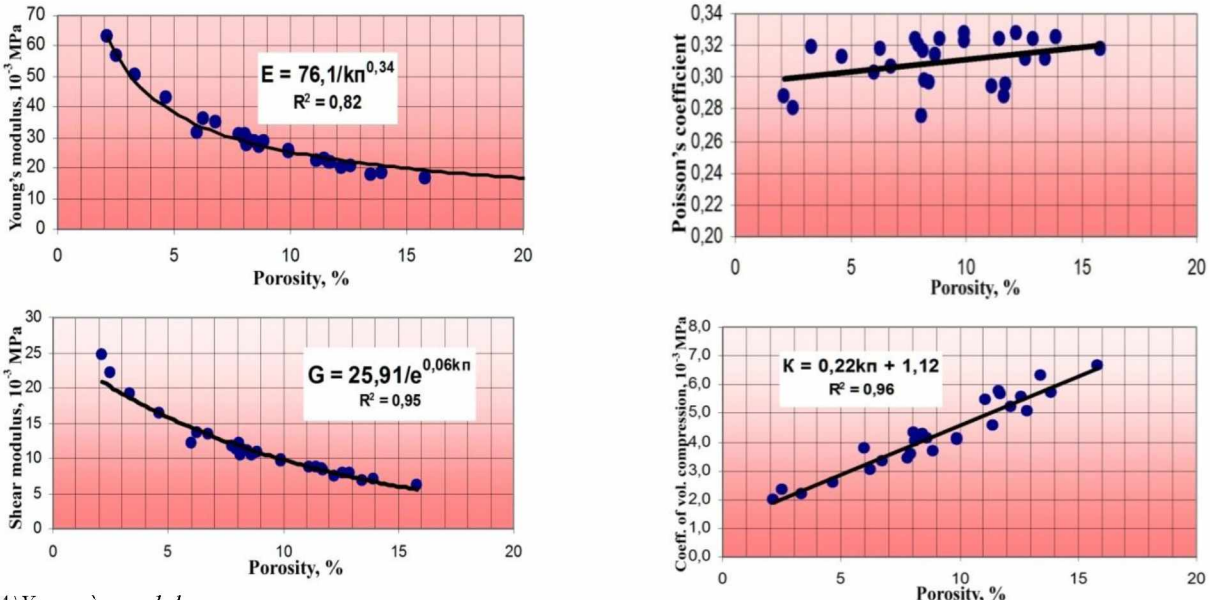


Figure 1. *Relationship of wave propagation interval time and coefficient of open porosity for sandstones and siltstones under various thermobaric conditions.*



A)Young`s modulus
B) Shear modulus
C) Poisson coefficient
D) Coefficient of volume compression

Figure 2. *Relationship of elastic parameters of carbonate rocks and porosity coefficient*

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