prediction of permeability values from wireline logs Artificial Neural Network (ANN) was used. The results were used to calculate FZI logs and apply derived HFU spatial distribution to build 3D permeability model. After that dynamic model was history matched and authors noted good collaboration of obtained results with history production rates and static bottomhole pressures. Some uncertainties, though were met due to the impact of natural fractures in the reservoir. Authors are planning to improve the simulation model by integrating image logs and seismic attributes.

Amanat Ali Bhatti et al (2020) [3] used HFU approach together with Electrofacies analysis on the Sawan Gas field in Pakistan. Five HFU were identified by calculating RQI ($\varphi_z$) plot, which gives mean FZI values for every Hydraulic Flow Unit. The results were used to determine permeability in Sawan-7 well. After that electrofacies (EF) analysis was used on Sawan-7, Sawan-01, Sawan-09 and Sawan-3B wells. EF analysis was performed using k-mean clustering method. Values of permeability were also estimated in the wells Sawan-07, Sawan-02 and Sawan-3B. The authors note, that results obtained on the well Sawan-3B are doubtful, because of lack of core data to validate them. However, authors conclude that applied techniques were useful in estimating reliable permeability values on the Sawan Gas field in circumstances of limited data.

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# RESERVOIR DRIVE MECHANISM AS A GEOLOGICAL PARAMETER: FURTHER PROSPECTS OF ITS STUDY AND APPLICATION

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The relevance of studying the parameter "reservoir drive mechanism" in terms of energy state is the key parameter in the reservoir development.

The production conditions of petroleum deposit is the expression of the driving forces that ensure the fluids movement to the bottom of producing wells. The reservoir drive is determined primarily by reservoir pressure determining the prevailing type of reservoir energy. For this purpose, reservoir pressure is compared with the hydrostatic pressure (normal). [2]

Indicators forming the basic concept of the production reservoir drive are abnormal high reservoir pressure, interaction of filtration-volumetric parameters and energy reservoir characteristics, and interference between the wells (exemplified by the Yamburg gas condensate field and the Urengoy oil and gas condensate field).

Various fluid systems determine reservoir pressure values. The hydrocarbons and groundwater movement under the formation pressure conditions cause Elysian Fluid Systems (EFS). Typically, this pressure exceeds hydrostatic one. The rock pressure is an acting force in an elision fluid system. In addition, the overlying layers weight, elision processes, and rock compaction rate predetermine the value of reservoir pressure. In geodynamic fluid systems (GFS), formation pressure is not equal and dependable on hydrostatic pressure. Therefore, the main factors determining the pressure are resonance wave processes in the geological medium, caused by deformation, microseismic, electric and magnetic fields. Earth Stresses specify pressure in geodynamic fluid systems. Stresses form deformation-stress zones. Abnormally high formation pressure is characterized by these zones. [3] Reservoir pressure is formed due by overlaying deformation and high frequency wave fields. In addition, there are distinguished closed, semi-closed and open fluid systems characterized by abnormally high reservoir pressure. Such systems with reservoir pressure exceeding rock pressure are termed endogenous systems. The peculiarity of such systems is the overlaying of two anomalies: pressure and temperature.

The object of the given /present study is the Urengoy field. The deposit of this field is not an endogenous. System, as the temperature in some areas decreases (is not anomalous) and refers to the semi-closed geostatic elision fluid systems. The pressure depends on the consolidation degree of the adjacent reservoir rocks and the displaced water volume into the sandstones.

There is an occurrence of geodynamic fluid system in some areas of the strata. Horner's method has been used to determine reservoir pressure in the abnormally high reservoir pressure zone (AHRP):

$$P = \ln(T^{*} + t)$$

Where: $T^*$ - average operation duration before the well shut-in; $t$ - is the time from the beginning of the well shut-in [3].

Based on the results given in Table 1, let us analyze the map of reservoir pressures of the Achimov sequence (Fig. 1). The map data confirm the AHRP zone with closed-elastic reservoir drive in the Urengoyskoe field. In addition, in the depression zone there is a transition from the closed-elastic reservoir drive mechanism to the dissolved gas reservoir drive.

***Table 1***

***Inaccuracy in determining reservoir pressure by Horner's method***

| Reservoir pressure in the depression zone, Mpa | Saturation pressure, Mpa | Reservoir pressures in AHRP area, Mpa | | Deviation of the Horner's method of reservoir pressure values from the accepted, % |
|---|---|---|---|---|
| | | measured values | according to the Horner's method | |
| 20.6 | 21.3 | 60.43 | 61.823 | 1.74 |
| 20.6 | 22.6 | 60.756 | 62.396 | 0.83 |
| 23.3 | 23.2 | 60.973 | 62.324 | 0.94 |
| 28.6 | 24.7 | 61.495 | 62.324 | 0.94 |
| 29.2 | 25.9 | 61.934 | 62.917 | 0 |

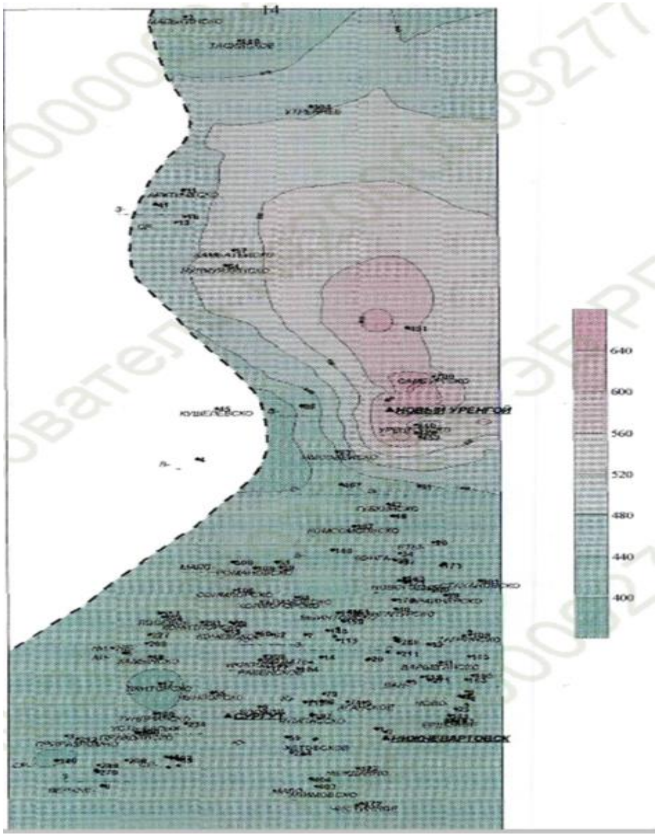


***Fig. 1 The reservoir pressure map of the Urengoy field (the Achimov sequence)***

Let us consider the porosity & permeability properties filtration-volumetric characteristics (FVC) of the Yamburgskoye gas condensate field. This system is represented by continental aleurolite-siltstone, often-loose rocks with subordinate interlayers of clays and coal. [1] Considering this characteristics, we may study the permeability of rocks depositing to the gas-water contact (GWC) (Fig. 2).

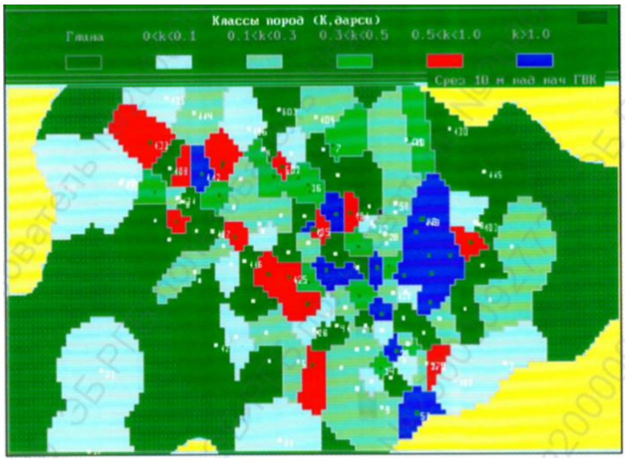


***Fig. 2 The rock permeability of the Yamburg field section at the depth of 10 meters from the GWC surface***

Due to the GWC influence on the rock porosity by flooding and destruction of the rock structure, there is a marked predominance of clay and a class of low porous rocks. Although the thickness itself has good FVC, especially in sandstones and aleuroliths. In general, high FVC found throughout the field. Since flooding determines the GWC rise rate and causes the reservoir pressure to drop, specifies the time of possible well flooding, which can be determined by the dependence of the gas-water condensate rise rate on the permeability of:

1) V=0.002+0.731 Kpr - for porous rock < 500 mD
2) V=0.048+0.153 Kpr - for porous rock > 500 mD

Since the Senoman occurrences have high permeability (> 500 mD), the second formula should be used. Thanks to this, we can make up graph of the lithological structure according to the rocks permeability, the dynamics of the GWC rise and the reservoir pressure decline of the cluster wells (Fig. 3).

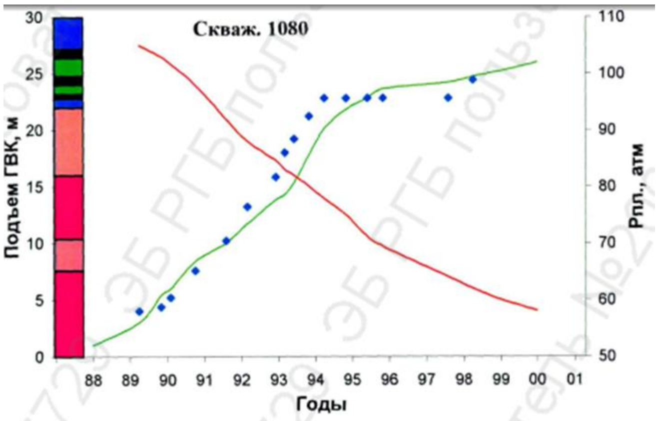


***Fig. 3 Lithological formation, dynamics of GWC rise and reservoir pressure decline***

According to the graph, it can be concluded that the permeability increase leads to the GWC rise rate and, as a result, reservoir pressure decline accelerates. There is a transition in the reservoir energy characteristics from the elastic-water pressure to the water pressure state [4].

By studying these indicators affecting reservoir pressure - the main parameter of reservoir drive mechanism - it is possible to evaluate the reservoir energy characteristics and predict its further changes. It is also important to note the methods for regulating the reservoir drive mechanism. In the Urengoyskoye field, it is necessary to set the compensated fluid withdrawal to maintain the closed-elastic reservoir drive. In the Yamburgskoye field, it is necessary to reduce the number of wells in the cluster in order to reduce the GWC rise rate and increase the reservoir pressure to its approximate initial values. This assists in maintaining the elastic reservoir drive mechanism.

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