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Assessing the role of natural fracturing by multiscale geophysical investigation

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Abstract

The article presents an estimation of tectonic fracturing role in terrigenous and carbonate blocks containing hydrocarbon deposits. Geological and geophysical datasets of different scale were used to characterize the fracturing of rocks. The good convergence is found between the orientation of natural fracturing by formation microimagers in wells, three-dimensional surface seismic survey, microseismic monitoring of hydraulic fracturing propagation and regional lineament analysis by satellite imagery. The article contains examples of comparison between the direction of maximum horizontal stress axis and stress state and the direction of horizontal wells and fluid flow. New factors of unsuccessful multistage hydraulic fracturing operations in carbonate rocks are considered in the context of natural fracturing systems' kinematics. Complex data analysis of the fracturing at different scales allowed to divide fracturing systems basing on the kinematics. It is shown that the method of structural and geomorphic lineament analysis detected on the satellite images allows to determine the orientation of regional stress field axes for the platform areas with small number of geological outcrops. It is found that during the hydraulic fracturing the main fracture is developed following the system of tectonic fractures and the propagation of the fracture tip is not linear - the fracturing follows both the shear and tensile cracks. It is suggested that the reorientation of the principal stress axes within one field is associated with gently sloping low-amplitude tectonic deformation. The main fundamental conclusion obtained as a result of studies is a justification of the leading role of modern tectonic stress field in the fracturing kinematics. The practical conclusion is a necessity of a selective stimulation of fractured rock blocks to achieve the maximum production for the redeveloped of oil fields.

Keywords

Fracture, Hydraulic fracturing, Microseismic monitoring, Remote sensing, Well logging, World stress map

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