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# A new adaptive identification and predicting system of sweet spots and their production potential in unconventional reservoirs

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The key issue of unconventional reservoirs is to identify their high production potential zones (so-called "sweet spots") in order to optimize the number and locations of new wells to be drilled. Sweet spots might be considered as naturally fractured sub-reservoirs with a limited volume and a large area through which oil from surrounding layers can move slowly by diffusion, gravity, and pressure deference. The sub-reservoirs can be created artificially, but it is also required to recognize the appropriate place of hydraulic fracturing.

For "sweet spots" mapping in unconventional reservoirs, the results of core study, image logging together with seismic survey interpretation, and well data analysis are usually used. During upscaling the well production potential data for the overall reservoir, the challenge arises of how a limited amount of information from a finite number of points (wells) can be extrapolated to an infinite number of polygon points (the overall reservoir), since it is impossible to increase the amount of information only by means of mathematical transformations. To increase the prediction fidelity, it is suggested to use the alternative forecasting techniques. The main limitation of the traditional deterministic approach is that it attempts to connect the well and seismic data by rigid functions. Perhaps such functions do not exist or they are too complicated to be formalized. In this paper, we present an alternative adaptive system that incorporates artificial intelligence in a form of fuzzy logic algorithms, which are able to establish relatively free correlation between the well and seismic data in order to measure, map, and predict how new wells will perform in unconventional reservoirs.

In our approach, artificial Intelligence uses 14 geological parameters representing the structural position, stratigraphic thickness, net pay thickness, net to gross ratio, permeability, porosity, initial oil saturation, etc. Since it is unknown in advance to what extent a specific geological parameter affects the production potential of any reservoir zone, 4 production parameters (such as the maximum and average oil rates, the water oil ratio, and the oil decline rate) are also analyzed on a well by well basis. Our approach integrates all available field measurements into the 3D full-field adaptive geological and hydrodynamic models. By means of such models, a dimensionless score for the presence of sweet spots and their production potential is then mapped throughout the studying reservoir.

Through a case study of an unconventional Permian - Carboniferous carbonate reservoir with heavy oil of the Usink field located in North - West European Russia, we demonstrate that the variation in correlation between predicted and actual productivities of new wells can be explained by the presence and the extent of the identified sweet spots and their reserves available for production. The major results of this process are a sweet spots distribution map throughout the reservoir and a large number of examples with statistical comparisons among new wells that justify the generated map.