# A Deep Learning Saturation Imaging Framework to Optimize Reservoir Contact While Drilling

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## Abstract

Active petrophysical geosteering in reservoir formations has become a very promising practice and commonplace to improve formation evaluation and maximize hydrocarbon contact into the reservoirs. Deep electromagnetic based logging while drilling (LWD) technologies have specifically become an attractive solution to distinguish between water and hydrocarbon saturated layers inside a reservoir, optimizing well trajectories with the objective to maximize the well productivity potential. In this work we present a novel deep learning (DL) saturation imaging framework for the optimization of hydrocarbon contact while drilling. The framework utilizes a deep learning convolutional imaging framework in order to analyze 2D cross-section resistivity images that are collected in LWD around or ahead of the bit. The framework automatically determines, from the resistivity images, major features and determines from their DL analysis the water saturation in the cross-section. Furthermore, the DL framework provides recommendations of most prolific well trajectories directions in real-time. The proposed DL framework was examined on a synthetic fractured reservoir case, characterized by a strongly heterogeneous hydrocarbon fluid distribution. Comparing with a geometric base trajectory of a horizontal well, we could adapt the well trajectory by means of real time EM look ahead of the bit data and DL framework. The results significantly maximize the average hydrocarbon saturation values around the wellbore. The DL framework exhibited strong estimation performance, adequate for real-time geosteering. Uncertainty analysis of the case, outlined the improved well performance in multiple scenarios.The developed DL framework represents an innovative approach towards enhancing hydrocarbon reservoir contact and suggest in real-time well trajectories with maximized productivity potential. The method may significantly assist in the interpretation and optimization of the decision making related to geosteering.