Case Study: Drilling

Middle East

NMR rock typing combines with reservoir mapping while drilling to enhance well placement in carbonate reservoir

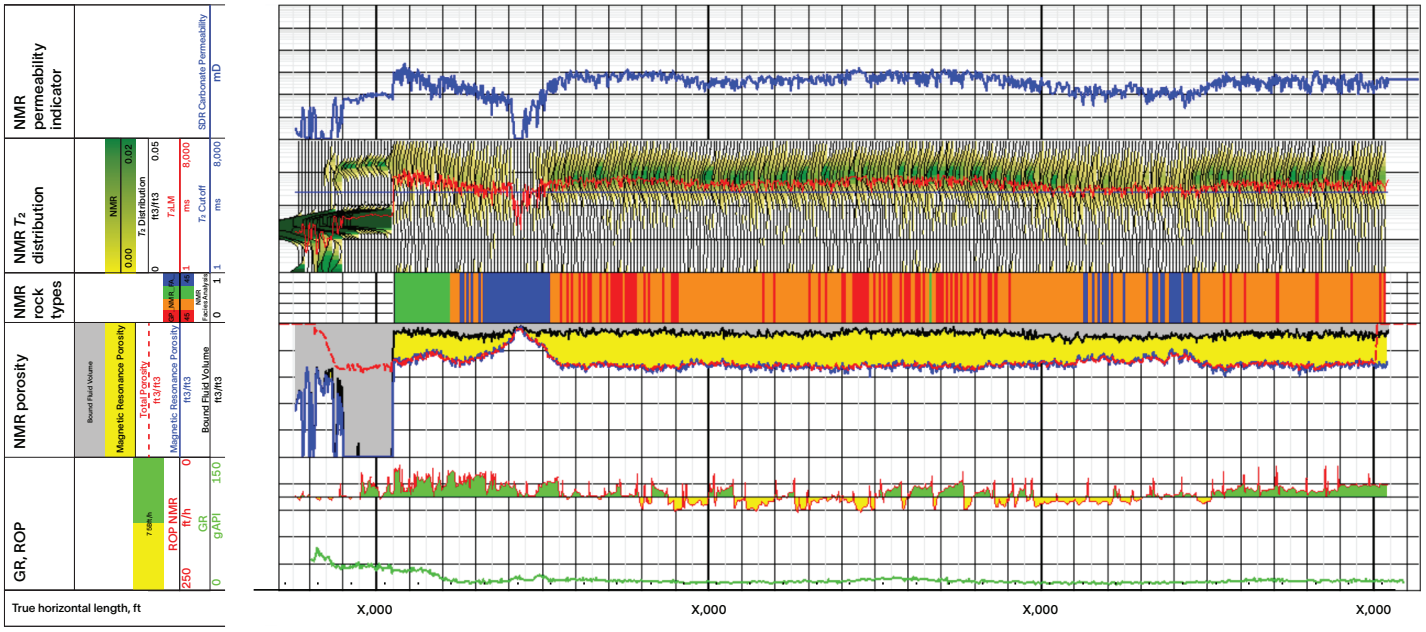
An operator in the Middle East combined NMR rock typing and reservoir mapping while drilling using MagniSphere™ high-definition NMR logging-while-drilling service and PeriScope Edge™ multilayer mapping-while-drilling service. The combination enabled well placement optimization and improved reservoir understanding in a carbonate reservoir, resulting in the successful drilling of three laterals.

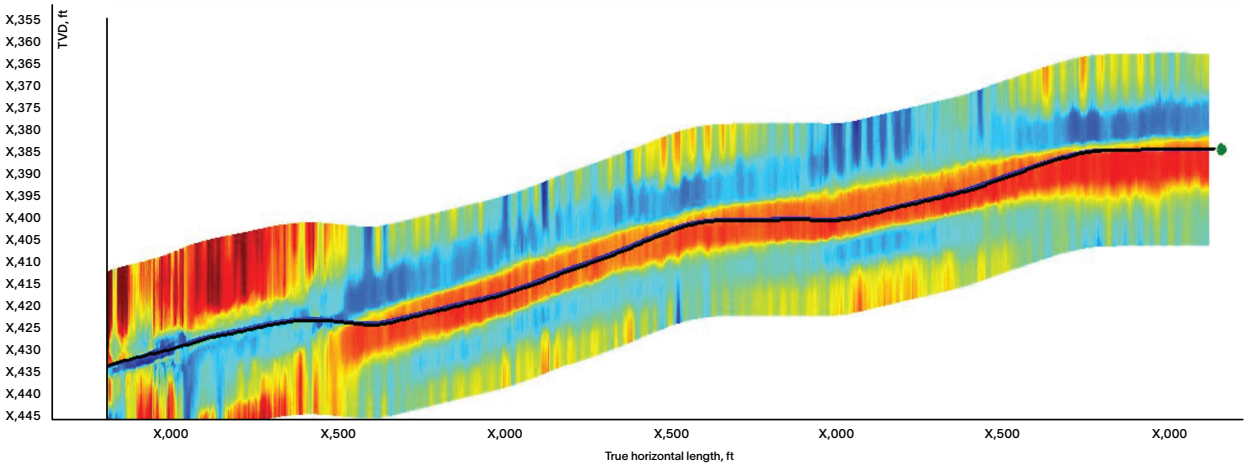
The challenge

An operator in the Middle East planned to drill a trilateral well in an 80-ft carbonate reservoir made of thin layers composed of different rock types, quality, and permeability. The objective was to land in a layer of only 7-ft TVD thickness that was expected to be the most porous and permeable zone of the reservoir. Permeability and facies variation were expected along each lateral section.

The solution

MagniSphere service and PeriScope Edge service were proposed as the optimal LWD solution. Deep azimuthal resistivity images from PeriScope Edge service enable precise geosteering inside a reservoir structure. However, the EM resistivity-derived images deliver limited information about the reservoir quality, particularly in carbonates where large pore size variations are common.





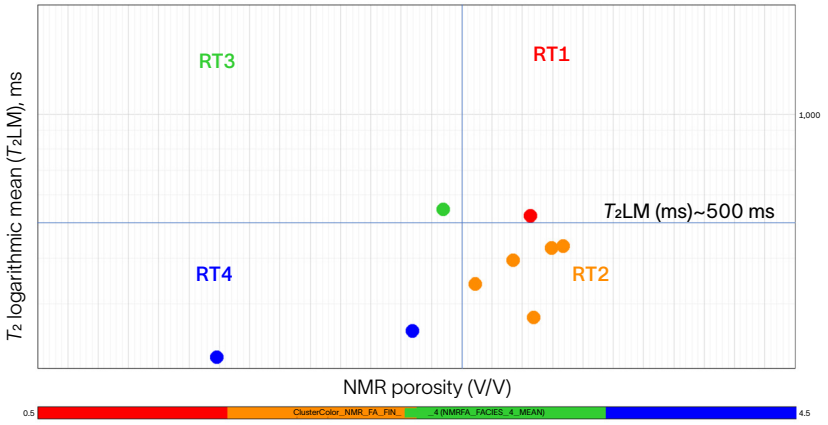
A PeriScope Edge service inversion combined with MagniSphere service NMR interpretation enhanced rock typing in the horizontal well.

Combining PeriScope Edge service images with MagniSphere service NMR measurements enables linking the reservoir structure with rock types while optimizing well placement.

LWD NMR data generated four petrophysical rock types (RT) while drilling. RT1 had good porosity and long T_2 components, indicating large pores; RT2 had good porosity, but medium T_2 components, indicating smaller pores; RT3 had medium porosity with long T_2 components. RT4 had medium or low porosity and medium or short T_2 components, indicating the worst facies. The first step in obtaining these RTs was to run factor analysis (probabilistic method used to tie in a large dataset to a smaller number of underlying components) on the NMR data. This method typically produces between 9 and 11 factors and associated porofluid facies. These are further reduced to 4 to streamline interpretation.

The results

The first well was geosteered with deep azimuthal resistivity images and NMR measurements. The well penetrated the first reservoir layer where the NMR indicated RT3, with a high permeability indicator. After about 500 ft of drilling, the operator identified the target reservoir layer below the wellbore and steered the well into it, where the NMR initially identified RT2. Coupling the reservoir structure from the deep azimuthal resistivity inversion with NMR rock typing, the NMR confirmed that the upper section of the second layer had the best rock type (RT1). On the basis of this finding, the second and third laterals were placed in the upper side of the same reservoir layers. Those three laterals were successfully executed with an excellent net-to-gross ratio.



LWD NMR data generated four petrophysical rock types while drilling to guide successful well placement. RT1 had good porosity, long T_2; RT2 had good porosity, medium T_2; RT3 had medium porosity, long T_2; and RT4 had medium or low porosity, medium or short T_2.

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