MATURE FIELDS

CASE STUDY

# Operator Uses Real-Time Magnetic Resonance to Assess Rock Quality in Clastic Formations

## 4¾-IN. MRIL®-WD™ LOGGING-WHILE-DRILLING SENSOR DELIVERS $T_1$ DATA TO ENHANCE RESERVOIR UNDERSTANDING OF A MATURE FIELD

MIDDLE EAST

### CHALLENGES

- Evaluate clastic reservoir within which rock quality cannot be suitably assessed using conventional data sets
- Mitigate impact of drilling-related vibration common during real-time assessment of magnetic resonance data sets

### SOLUTION

Sperry Drilling collaborated and engineered a drilling solution, including:

- 4¾-in. MRIL®-WD™ magnetic resonance imaging logging-while-drilling (LWD) sensor to provide partial porosities and permeability for petrophysical analysis
- Pre-defined $T_1$ cutoffs to enable rock quality assessment
- Density and neutron measurements from the following Sperry Drilling tools, configured within a Geo-Pilot® 5200 rotary steerable system bottom hole assembly:
  - ALD™ azimuthal lithodensity sensor
  - CTN™ compensated thermal neutron sensor
  - ADR™ azimuthal deep resistivity sensor

### RESULTS

- Excellent correlation between MRIL-WD porosity and conventional porosity analysis
- Rock quality assessment from combination of partial porosities and permeability profile used as input into completions design
- No detrimental impact on $T_1$ data quality resulting from drilling vibration and hole washout

### OVERVIEW

An operator in the Middle East wanted to evaluate an oil-bearing clastic formation composed of both shaly sands and clean sands with major grain size variations, using an oil-based mud. Historically, the operator had faced challenges in evaluating the rock quality via conventional logging-while-drilling (LWD) technologies. This was due to the variations in particle size within the reservoir not being associated with measurable changes in lithology using gamma ray, resistivity, density and neutron tools. Nuclear magnetic resonance (NMR) logs had previously been used in both the exploration and field development phases in several fields in the area for formation evaluation. However, the $T_1$ data while drilling method of determining rock quality in slim holes (in this case, 6⅛-in. diameter) in clastic formations had not yet been attempted.

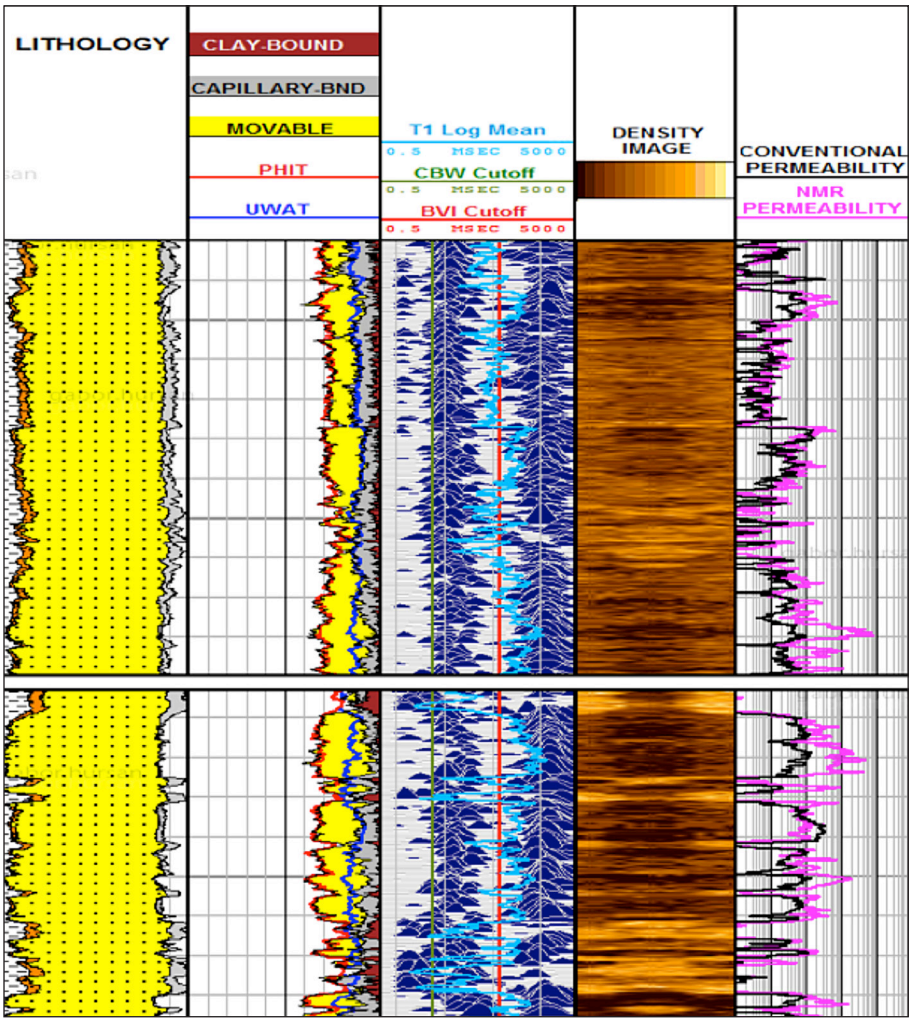
Sperry Drilling had worked with this operator before to verify the value of $T_1$ data for real-time petrophysical analysis in carbonate reservoirs in 6⅛-in. hole sections. Following successful deployments, they decided to evaluate the value of $T_1$ data in clastics in combination with density and neutron measurements from the Sperry Drilling ALD™ and CTN™ tools, and deep-reading resistivity measurements from the ADR™ tool, within a Geo-Pilot® 5200 rotary steerable system bottom hole assembly. This engineered drilling solution maximized the customer's asset value with more reliable data for better decision-making with regards to completion design.

### PARTIAL POROSITIES AND PERMEABILITY PROFILE HELPS OPERATOR MAXIMIZE ASSET VALUE

Working in close collaboration, the Sperry Drilling team and the operator determined the optimum tool setup and operating parameters via the MRIL®-WD™ Job Planner. By selecting 6 ms and 140 ms cutoffs to split the $T_1$ relaxation spectrum, the petrophysical analysis was able to discern porosity to clay-bound water, capillary-bound water and free-fluid volumes. The NMR porosity showed excellent agreement with the conventional porosity assessment from ADL and CTN LWD measurements. Permeability was then calculated using the Coates equation, which showed streaks that represent the best rock quality, which does not necessarily conform with the porosity measurements, emphasizing that porosity alone cannot be used to determine reservoir quality. The combination of partial porosities and permeability profile helped the operator enhance reservoir understanding and was used as input into the completion design for the well.

## VIBRATION-TOLERANT $T_1$ DATA PROVIDES CONFIDENCE FOR WHILE-DRILLING APPLICATIONS

Throughout the LWD operation, significant vibration and hole washout was identified. The Sperry Drilling engineered solution comprised of the $T_1$ data acquisition method and the MRIL®-WD™ tool design, minimized impact on data quality from lateral vibration commonly associated with this drilling environment, and the impact of borehole enlargement. From a comparison between real-time data and memory data, as well as comparing data from two different tools while re-logging a section of the well without drilling-associated vibration, the operator observed excellent correlation among all data sets. By confirming the validity of the $T_1$ data sets, the operator gained confidence that the measurements could be used to enhance reservoir understanding in future while-drilling formation evaluation applications.




*Petrophysical analysis based on MRIL-WD $T_1$ while-drilling data in two reservoir sections. The volumetrics track shows data for clay-bound water (brown), capillary-bound water (grey) and free fluids (yellow). The permeability profile (magenta) in track 5 was later used as input into the completions design.*

This case study includes data from technical paper SPWLA-2018-LL, prepared for presentation at the SPWLA 59th Annual Logging Symposium held in London, United Kingdom, June 2018.

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