

## **Application of MRIL-WD (Magnetic Resonance Imaging Logging While Drilling) for irreducible water saturation, total reservoir, free-fluid, bound-fluid porosity measurements and its value for the petrophysical analysis of RT/RM data from the Shah Deniz wells which were drilled in the Khazarian-Caspian Sea of the Azerbaijan Republic**

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Sperry-Sun (Sperry Drilling Services) is the leader in MWD/LWD reliability, has developed the industry's first LWD NMR/MRIL-WD (nuclear magnetic resonance) tool. The MRIL-WD (magnetic resonance imaging logging-while-drilling) service directly measures the T1 component of hydrogen in subsurface rock units while drilling to obtain total reservoir porosity and to dissect the observed total porosity into its respective components of free fluid and bound fluid porosity. These T1 data are used to secure accurate total, free-fluid, capillary-bound water, and clay-bound water porosity of the reservoir sections which can be drilled in the several Runs.

Over the last decade, results from Magnetic Resonance Imaging logs (NMR) have added significant value to petrophysical analysis and understanding by providing total, free-fluid and bound-fluid porosities, combined with fluid typing capabilities. With MRIL-WD very valuable Real-Time or Recorded Memory data/information is now available during or shortly after the drilling operation (formation properties measurement can be taken right after a drill bit penetration), while trip in and trip out as well.

A key point in utilizing MRIL in an LWD environment is motion-tolerant measurements. Recent MRIL-WD logging runs from the Shah Deniz wells located in the Khazarian-Caspian Sea of the Azerbaijan Republic helped to delineate and assess hydrocarbon bearing zones. Acquired results demonstrate how MRIL data can be acquired while-drilling and provide reliable/high quality measurements. Magnetic Resonance Imaging logs at some developments wells have become a cornerstone in formation evaluation and petrophysical understanding. By providing total, free-fluid, and bound-fluid porosities together with fluid typing, MRIL results have significantly added to the assessment of reservoirs. In order to reduce NPT (Non-Productive Time) and save the rig operations time, there is always the desire to obtain logging results as soon as possible, preferably while the drilling of the brand new wells (logging-while-drilling, LWD). The MRIL-WD Tool can accomplish any tasks reliably and in a timely manner thus saving drilling time and reducing the overall risk for the well.

Control of water production and identification of pay zones with high irreducible water saturation are also very important for formation evaluation and petrophysical analysis in oil fields located in the Azerbaijan Republic and also other fields around the world. Sometimes above-mentioned problems can cause delay in completion decisions which will create additional expenses for field management. In many wells, breakthroughs in reservoir characterization have been achieved in directly determining hydrocarbon volumes, net permeability thickness, and hydrocarbon type, thus circumventing the problems associated with obtaining wireline data and the considerable amount of rig time required (so MRIL-WD can considerably reduce the NPT).

Some reservoir zones with relatively low water saturation, which calculated from the other conventional logs, can produce with relatively high percentage of water cut, primarily because much of the water is movable. However, other zones with high calculated water saturation produce water free hydrocarbons. The difficulty in predicting water production can be related with the producing from the complex lithology, which can contain low-permeability, medium- to fine-grained shaly sands. Where grains are small, the formations have high surface to volume ratios that result in high irreducible water saturation and due to this we can see low resistivity values. As a result the use of resistivity logs as pay indicator, sometimes can cause low resistivity pay zones might be overlooked and consequently net field pay could be underestimated.

In the last few years, nuclear magnetic resonance logs have shown great promise in solving problems of formation evaluation that could not be directly resolved with conventional logs. The capability of MRIL-WD can help many

engineers to differentiate between the immovable and movable water in oil reservoirs in many fields. Sometimes MRIL-WD have also been capable of providing better formation permeability than conventional logs, a feature which can save time and expense in well-completion decisions. The RT & RM bound fluid and total porosity measurements can provide a tremendous new insight into the formation evaluation of shaly sands and low resistivity pays.

Unlike traditional porosity devices, which are affected by rock matrix changes, the MRIL-WD tool can be used in complex or mixed lithology sequences and provide measurements of porosity that are lithology independent.