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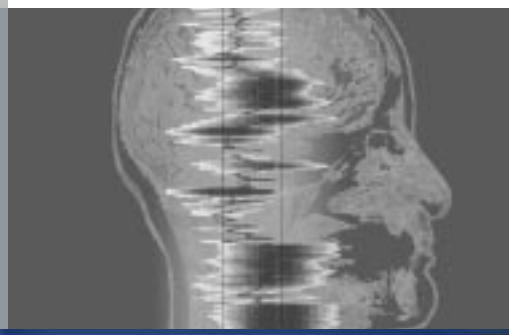
CMR-MDT



Cost-effective solutions

CMR-MDT benefits

- Independent confirmation of reservoir producibility
  - – Permeability
  - – Fluid identification
  - – Fluid contacts
- Improved efficiency
  - – Optimized MDT operations
  - – Single logging run capability

A combination of the CMR* Combinable Magnetic Resonance and MDT* Modular Formation Dynamics Tester tools provides independent complementary information on reservoir producibility. These answers—permeability, fluid identification and fluid contacts— optimize decisions on well tests and reservoir exploitation. Savings are realized in operating and rig time when both tools are run on a single wireline- or pipe-conveyed descent.

Answers in combination

Permeability

CMR data give a continuous interpretation of reservoir permeability and determine the best location to set the MDT tool. Subsequent MDT data confirm and refine the initial CMR interpretation. The combination of data from these two independent sources gives an enhanced permeability evaluation over the entire reservoir section.

Fluid identification

Data from CMR, resistivity, density and neutron logs, combined with MDT pressure measurements and fluid samples, yield positive identification of formation fluids (see example on following page). Real-time optical fluid analysis from the MDT tool provides in-situ crude oil typing for estimates of gas-oil ratio, API gravity and coloration. There is minimal contamination before sampling because the OFA* Optical Fluid Analyzer module allows uninterrupted monitoring of the flowline fluids and therefore optimal filtrate cleanup.

Fluid contact

Changes in the CMR log reflect the tool response to different formation fluids, and the MDT tool provides pressure gradients. These two independent measurements of fluid type confirm gas, oil and water contacts.

Improved efficiency

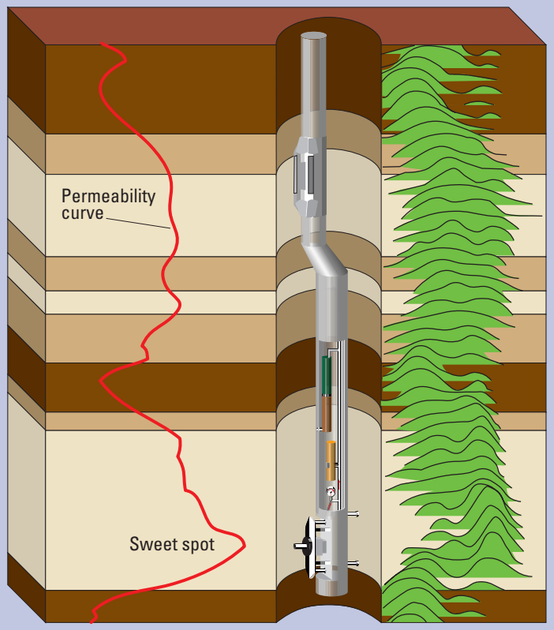
Optimized MDT operations

The CMR bound- and free-fluid answers can be used to determine the best points for obtaining MDT formation pressure measurements and samples. Time savings are significant and greatly improve the efficiency of sampling operations. Less time spent in sampling lowers the probability of deteriorating well conditions and stuck tools.

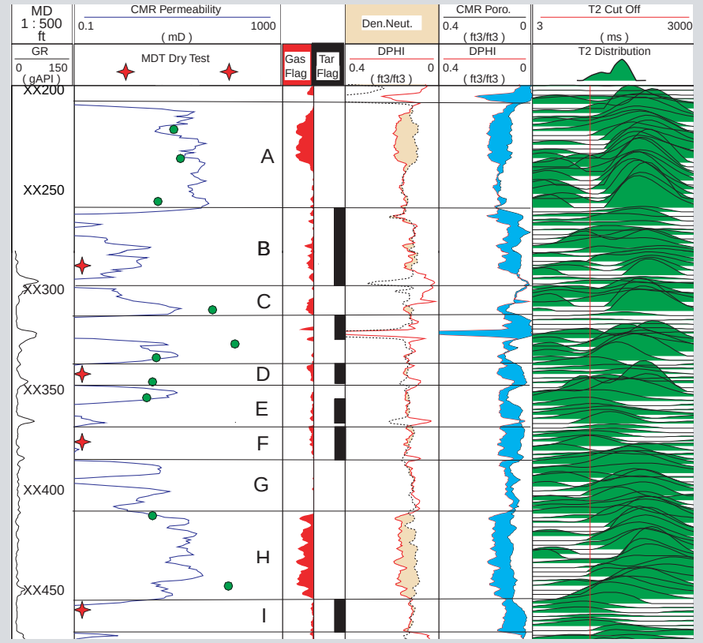
Single logging run

One run is eliminated and efficiency is improved when the MDT and CMR tools are combined in one trip, even though they are operated sequentially, not simultaneously.

The CMR high-resolution permeability indicator identifies permeability streaks in this laminated sand-shale sequence for sweet spot positioning of the MDT tool.



CMR and MDT data resolve a complex gas, oil and tar system.



Evaluation of reservoir producibility

In this well drilled with oil-base mud in eastern Venezuela, it was important to confirm the presence of gas, oil and tar. The CMR-MDT log verified the fluid type inferred by the density-neutron data.

The CMR and density-neutron data confirmed gas in Zones A and H. The other zones had no density-neutron crossover (interpreted as oil), but several had a CMR porosity deficit (identified by the blue shading on the log example). The CMR porosity deficit, as compared to the density-neutron porosity, was attributed to the presence of tar in Zones B, D, E, F and I. The resistivity log showed no contrast between the tar and hydrocarbon zones in this oil-base mud environment.

The MDT pressure points independently confirmed the presence of tar. All four pressure tests attempted in the tar zones resulted in dry tests. In contrast, all pressure points attempted in the gas or light-oil zones produced good pressure and mobility readings.

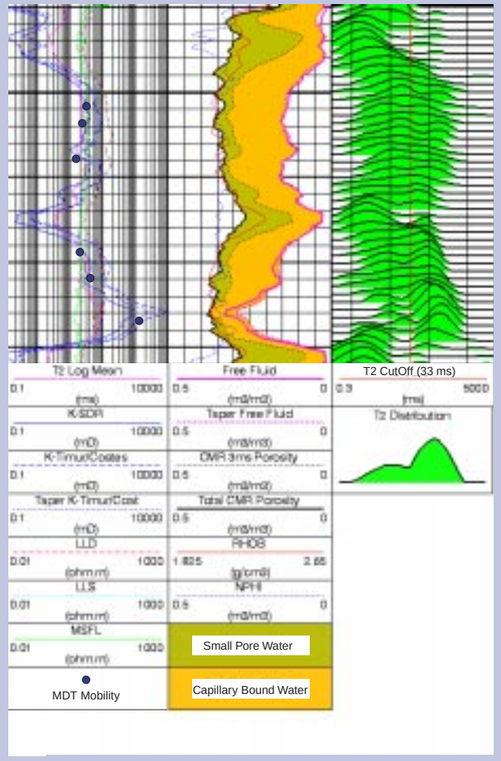
The CMR-MDT log together with the triple combo data provided a conclusive petrophysical analysis of this complex gas, oil and tar system.

Improved efficiency

In an offshore China well, six successful pressure tests were made and three samples were recovered in an environment where MDT testing had been problematic in the past.

The logging challenges included an unconsolidated shaly sand formation with little variation in the resistivity and density-neutron porosity curves. The CMR bound- and free-fluid porosity curves have good definition, easily identifying the more permeable intervals. The MDT points were selected on the basis of the higher permeability areas (low bound-fluid volume), thereby avoiding the low-permeability zones and potential probe plugging.

CMR log data successfully streamline MDT operations in this difficult sampling environment.



CMR-MDT Specifications	
Single-probe MDT tool with pumpout module, OFA module and 1-gal sample module	
Length†	66 ft [20 m]
Weight†	1650 lbm [748 kg]
Temperature rating	350°F [175°C]
Pressure rating	20,000 psi [138 MPa]
Minimum hole size	6.25 in.; 5.875 in. with good borehole conditions
Maximum hole size (with MDT kit)	19 in.

†Combination weight and length vary with MDT configuration. Gamma ray and telemetry are included. CMR tool is 14 ft [4.3 m] long and weighs 300 lbm [136 kg].

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