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INSIDE THIS ISSUE

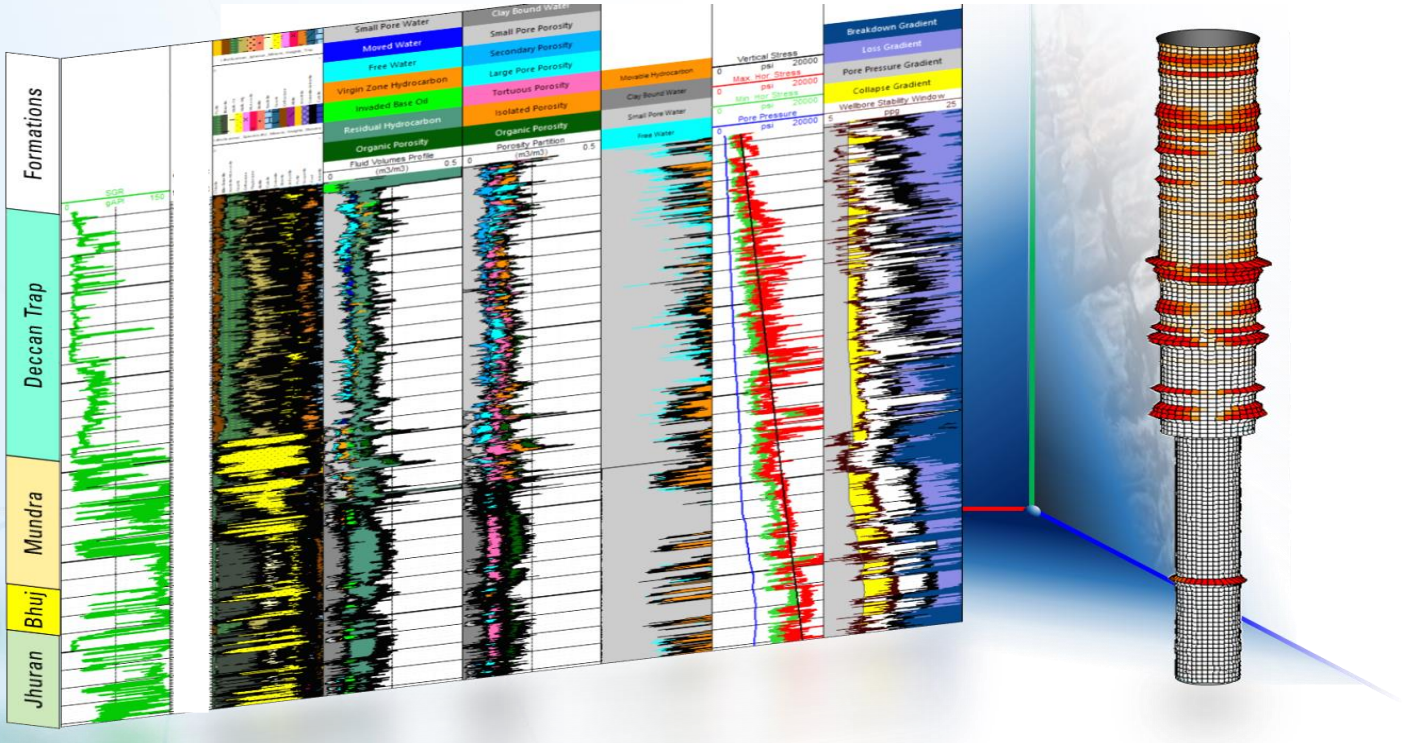
Successful Drilling, Completion and Characterization of Wells in the Gulf of Kutch Jurassic Formations with 3D Acoustic Profiling Data Driven Anisotropic Mechanical Earth Modelling

Joseph Zacharia, Domain Champion for Petrophysics and Acoustics, Schlumberger Wireline

Deep wells in the Gulf of Kutch block have to penetrate through some of the most challenging rock layers to unlock the hydrocarbon prospects in the Mesozoic reservoirs. The challenges don't end with the drilling of 1500m of hard abrasive basalt of the Deccan Trap. Weathered basalt flows, volcanic intrusions, fractured sandstones, tightly cemented siltstones, pyritic shales, abnormal pressures and a complicated and highly anisotropic stress regime test the limits of HPHT well construction and engineering design. Some of previous wells in the region have been plagued with significant NPT due to wellbore instabilities during drilling, incomplete log data acquisition and poor-quality primary cementation.

Anisotropic Geomechanical Modelling with 3D acoustic measurements was used to decode the tectonic strains, rock mechanical properties and complex stress profile. The Anisotropic Mechanical Earth Model (MEM) was used for the following applications to successfully drill a deep well into the Jhuran formation in the area:

- Understand root causes of complex wellbore instabilities and drilling NPT in offset wells.
- Determine Stable Drilling Mud Weight Windows to drill the well. The well was drilled with minimal NPT due to wellbore instabilities as compared to offset wells.
- Identify fractured intervals prone to drilling fluid losses. LCM pills were systematically placed to successfully case and cement the 12.25" and 8.5" sections within a very narrow mud weight window.
- Engineered drilling bits were customized based on the MEM rock mechanical properties. The engineered bits were able to drill the more abrasive and compacted rocks with higher ROP than offset wells.
- Formation Evaluation was performed by integrating all open-hole data to characterize hydrocarbon bearing pays in the tight Mesozoic sediments as well as the volcanic rocks.



High Quality LWD-NMR in high mud weights for MPD wells

Anjana Panchakarla-Geoscientist, Pawan Deep Singh Bagga-Technical Support Engineer, Baker Hughes

Magnetic Resonance measurements are extremely useful in formation evaluation for estimation of free fluid, permeability and for fluid typing and these measurements have been in vogue with wireline logging suites for more than three decades. With the advancements in LWD, almost all the capabilities of wireline logging are being achieved in LWD domain. The concept of magnetic resonance measurements while drilling has to overcome the difficulties of the drilling environment. The overall principle remains similar to wireline in having a toroidal shape sensitive volume around the tool that lies completely within the formation to avoid borehole effects. Tool motion effects are minimized by applying a small field gradient in the measurement zone and utilizing special tool stabilization in the borehole. Figure 1 shows the general layout of the tool with the permanent magnets around the transmitting and receiving coils with the sensitive volume shown in green.

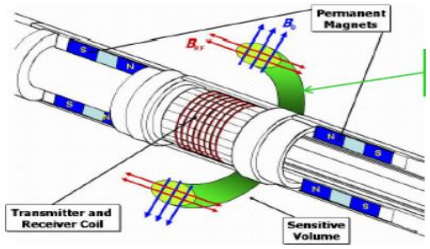


Fig:1 Layout of magnetic resonance while drilling tool

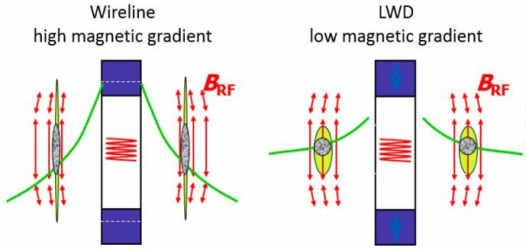


Fig:2 High Gradient WL NMR (Left) & Low Gradient LWD- NMR (Right)

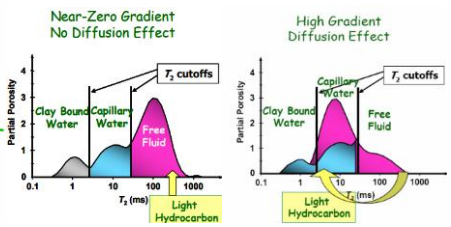


Fig:3 T2 Duistribution for WL (Left) & LWD (Right)

Generally, NMR tool designs with two different radial magnetic field gradients as shown in Fig2. Red: transmitter and receiver coil, radio-frequency field, BRF; blue: magnets; green: magnetic field strength as a function of radial distance from the tool. The high gradient design (left) is very susceptible to lateral vibrations during the course of an echo train acquisition causing the measured T2 to be shortened. This configuration is appropriate for wireline T2 data acquisition where no vibrations are expected. The low or near-zero gradient design (right) is much more tolerant against lateral motions, which is suitable for Logging while Drilling scenario. With high radial gradient field, lateral vibrations could cause the measured T2 to be much shorter than expected. This configuration is indicated forT2 wireline applications, but not for T2 LWD. With a near-zero gradient field, vibrations are much less likely to influence the T2 log as shown in Fig3. The formation being measured remains for the most part within the zone of investigation. This configuration is ideal for T2-LWD.

The Magtark technology of M/s Baker Hughes was deployed in an exploratory well in the Tripura onland location with the objective to explore the Hydrocarbon potential of Bhuban formations. Drilling these formations entails significant complications including very high pore pressures, fractured formations, multiple losses & stuck pipe incidents and reactive shales among others, leading to generally high NPT and more importantly, poor low data acquisition. To address this issue, it was planned to drill the subject well using the Managed Pressure Drilling (MPD) technique. Further, well complications and high mud weight which is required to drill in this area add another dimension in the difficulty in acquiring good WL data for further decisions. In this regard, Baker Hughes LWD Services proposed for the Triple Combo acquisition along with NMR services in this well. From a formation evaluation point of view, reservoir evaluation is challenging owing to low contrasts. Although Middle Bhuban is a well-known gas bearing formation, lack of minimum data like effective Porosity, permeability adds to complexity in formation evaluation. Good quality data was acquired using LWD NMR in very high mud weights upto 17.5ppg, in MPD conditions. Matrix independent porosity along with partial porosity information was provided in real time, which was helpful in optimization of formation testing points. Continuous Permeability index information in real time, was extremely critical to identifying the low contrast reservoirs, and gave the information on fluid flowing capability. Partial porosity information along with t2 spectrum has added the value in real time decisions. While previous drilling campaigns were dependent on low quality wireline data acquisition, the key differentiator in this case proved to be LWD-NMR. Based on the data provided by real time LWD NMR deployment, significant formation evaluation decisions were taken.

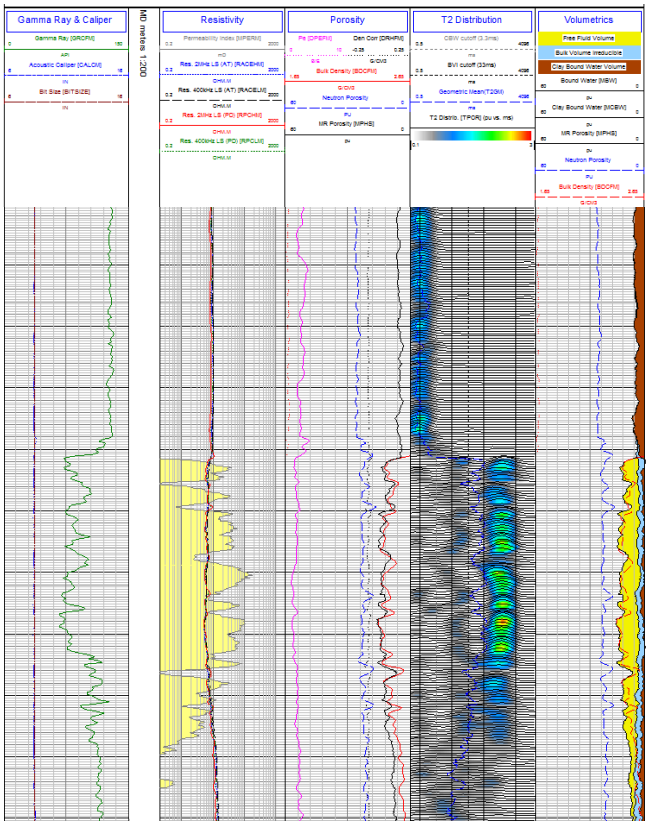


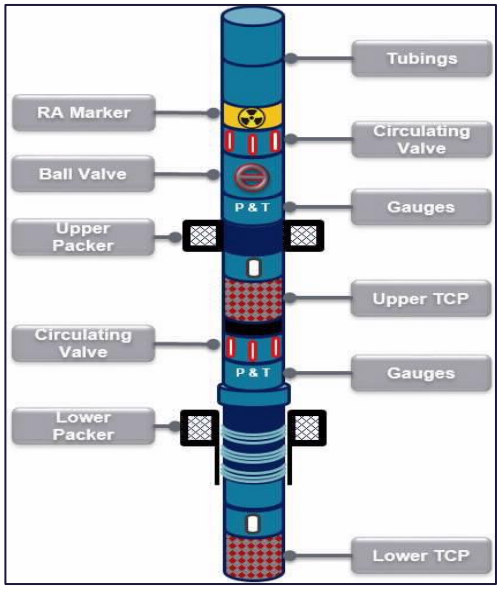
Fig:4 MAGTRAK with porosity & T2 Distribution for the well XXX

Dual-zone Testing Saves Rig Time and Reduces Operational Cost

Vikash Kumar, Technical Sales Manager, Expro North Sea Limited, Mumbai

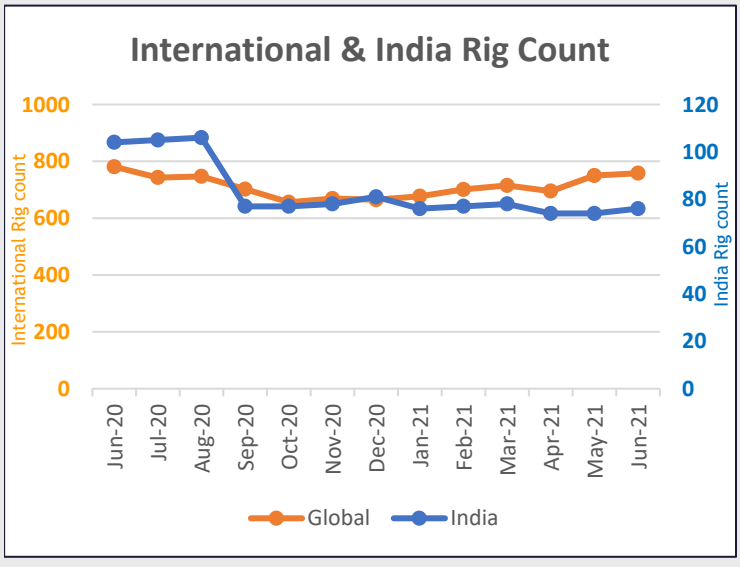
DST has been an important tool in E&P industry to establish comprehensive reservoir characterization and production capabilities of the reservoir. The industry has evolved from open-hole DST to cased-hole wireless DST over decades, seeking efficient and cost-effective ways to test a reservoir. Wireless enabled, dual zone DST allows to test two different reservoirs independently in a single DST run. This saves significant rig time by eliminating one complete DST run. It also allows isolation of the first zone from the second for discreet testing and then allows commingling of the zones if desired.

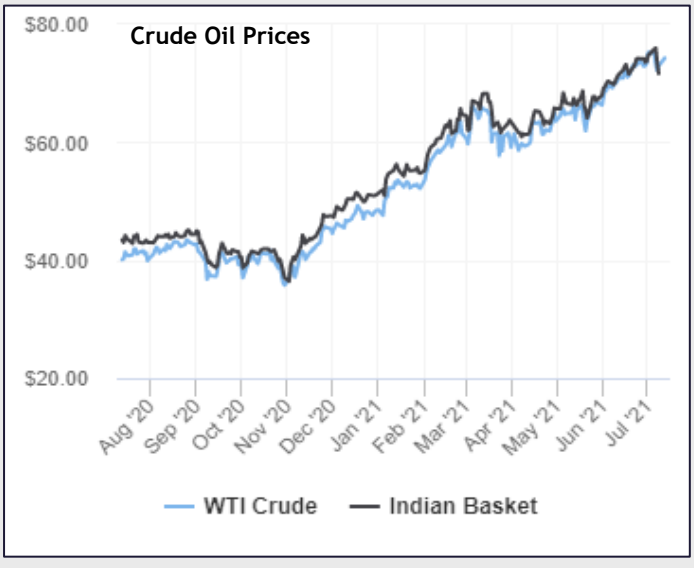
Dual zone DST was done in an exploratory well in Western Offshore, India to test two different objects in Panna Sandstone and Bassein Limestone and establish the individual potential of each object. The two zones are 40 m apart in 9-5/8" casing. The lower zone was perforated underbalance using a wireless firing head, then tested independently. Once the flow studies were performed, the lower zone was isolated for final build-up using an acoustically operated sliding sleeve. Within 4 hours, the upper zone was perforated in underbalanced condition. Acid stimulation was also performed on the upper zone through dual zone DST string to improve the zone productivity.



Pre-job planning was key to the successful execution of this first dual zone DST in India. This included TWOP (Test Well On Paper) meetings to ensure all steps were properly orchestrated. It also included SIT (System Integration Test) where form-fit-function of all downhole components were confirmed for compatibility The job was executed by Expro, with zero NPT and zero HSE scores. This is especially important given the complex makeup of the BHA, which included wireless transmitters and receivers, conventional DST tools, two packers (each require separate manipulation to position two set of perforating guns on depth) and acoustic valves in between, for isolating the two zones.

During the job, downhole pressure and temperature data was transmitted via satellite to the client office to enable real time decision making, optimizing the time allowed for testing, thus saving costly rig time. Although the main objective of DST remained the same, the use of dual zone DST helped the client to improve operational efficiency (time/ cost savings) and maintain the highest level of operational standards with safety and the environment being paramount





Virtual Technical Session on 29th May 2021

A virtual technical session was held on 29th May 2021, wherein two technical presentations were given by the Speakers, session was attended by 100+ participants online across locations. President of the chapter Mr. M K Tewari welcomed the gathering. The first lecture on "Carbonate Petrophysics with applications to Western Offshore Basin, India" was delivered by Mr. K Vasudevan, Former ED- Basin Manager WOB ONGC. The presentation brought out that Carbonate reservoirs exhibit great heterogeneity in nano to seismic scales and hence present many challenges in petrophysical evaluation. Integration of high-resolution image logs and NMR logs, supported by advanced core analysis are highly recommended in characterization of carbonate reservoir system. The presentation was followed by lively discussions on the topic. This was followed by another technical presentation on "IriSphere Look-Ahead-While-Drilling Service" by Mr. Chandan Majumdar, Petrophysics and Geosteering Expert, Schlumberger. The presentation and the following discussions explained how IriSphere service provides deep directional measurements to accurately detect formation features ahead of the bit and land wells while managing drilling risks, optimizing casing placement and coring location.

***Mr. K Vasudevan, Former Executive Director** – Basin Manager Western Offshore Basin, ONGC Mumbai. He has authored / co-authored 37 technical papers published and presented in various National and International Fora. He has Specializations in Basin Analysis, High Resolution Sequence stratigraphy, Structure and Tectonics in Fold belts and Passive margin basins, Carbonate Reservoir characterization and Petroleum Economics.*

***Mr. Chandan Majumdar is a** Geosteering & Petrophysics specialist (M/s Schlumberger) with more than 15 years of work experience in oil & gas sector. He has Versatile exposure and hands on experience spanning across different execution stages of logging (from data acquisition to interpretation), Drilling (mud logging, direction drilling, Geosteering) & projects appraisal. He has authored / co-authored 39 technical papers published and presented in various National and International Fora.*

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