# Geolog NMR and Core Analysis Help Model Pseudo-Capillary Pressure and Free Water Levels

RESULTS

- Geolog is being used to review and interpret log data acquired during offshore exploration campaigns in Southeast Asia.

- The characteristics of a clastic reservoir were accurately established using the NMR module in Geolog.

- The range of Free Water Levels (FWL) unidentified in the exploration drilling is being estimated in the Geolog Core Analysis module to build a successful appraisal well drilling strategy.
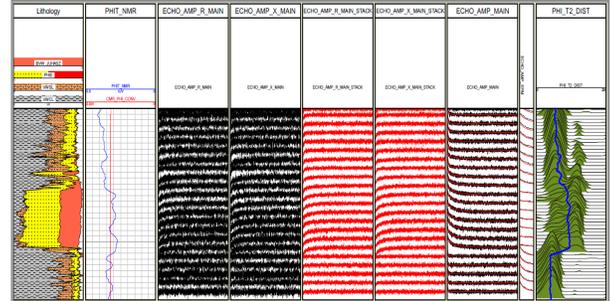
Using Geolog NMR, the raw echo amplitude was stacked to reduce noise and then processed into the final echo train through phase rotation.

APPLICATION
Emerson Geolog™

CUSTOMER
Posco International (PI)

CHALLENGE
Posco International has been actively involved in E&P activities in Southeast Asia since 2000, and has recently discovered a new gas field. Despite the company's experience in this area, it was challenging for them to directly estimate the distribution and amount of gas in the discovery through log and seismic data, as this reservoir had not been previously encountered in the region.

The goal of the project with Emerson was to appraise the potential of the clastic reservoir using available NMR data. As it is considerably shallower and less compact than the main reservoir in a nearby field, this reservoir has very different petrophysical characteristics, requiring a detailed investigation based on the highest-quality log data.

It was challenging to precisely evaluate reservoir properties in this new wildcat well without core acquisition. In such situations, NMR logging can play an important part in characterizing reservoir properties. The unconsolidated nature of the reservoir was preventing core acquisition. Friable core rock samples were acquired but the quality was not good enough to conduct reliable laboratory analysis.

> *"Using Geolog, we were able to find the optimal free water level and develop a cost-effective appraisal drilling strategy"*
>
> **Jungyeon Lee, Petrophysicist**
> **Posco International**
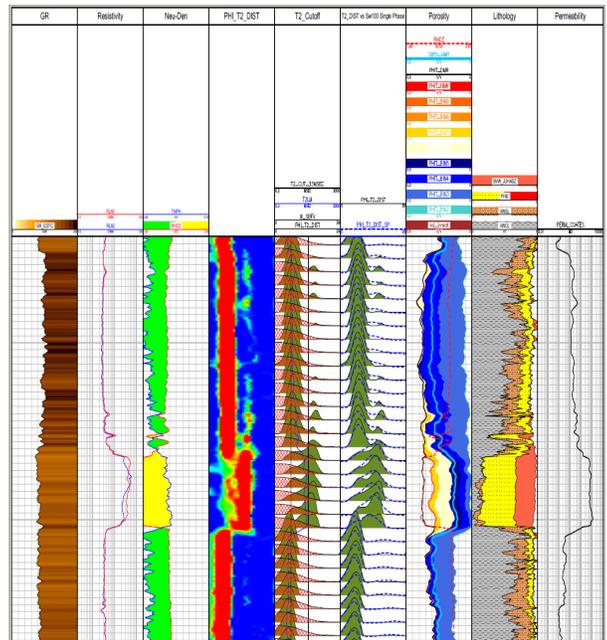
Processed NMR log. Sixth track shows a comparison between the computed T2 distribution and modelled single-phase distribution. PHI_T2_DIST_SP stands for 'single phase' or if Sw=1.

SOLUTION

Posco selected Emerson's Geolog™ formation evaluation system to evaluate the validity and accuracy of NMR data acquired in the well. Using the Geolog NMR and Core Analysis modules allowed the operator to perform the following technical tasks:

- Peer-review the NMR free fluid T2 cutoff and Density-Magnetic Resonance (DMR) porosity from exploration wells.

- Derive pseudo-capillary pressure from NMR interpretation without core, to enhance reservoir characterization.

- Review pore-size distribution, build the most appropriate saturation height model, and assess the FWL of the reservoir.

A fluid substitution was sequentially conducted in building pseudo-capillary pressure (Pc) without core, which is key for defining reservoir characteristics. The correlation between the log-derived water saturation and the saturation height model generated by NMR pseudo-capillary pressure was performed. FWL uncertainty was identified through various saturation height models, and the information was applied to the drilling strategy in appraisal and development wells.

RESULTS

The Geolog NMR 1D/2D processing and interpretation module was used to process and interpret the NMR T2 cutoff and build pseudo-capillary pressure curves. This vendor-independent module allowed Posco to re-process raw echoes delivered by the logging vendors, and interpret the processed NMR results along with all other integrated well logs. Geolog Core Analysis helped build a 3D saturation height model, and estimate the most feasible free water level from a reservoir of the wildcat well that hadn't previously intersected in the region.

BENEFITS

Successful exploration is a prerequisite for project success, but a precise technical evaluation must be performed to support it. Using Geolog NMR and Core Analysis, Posco International was able to successfully characterize the target reservoir sand. These modules help the operator to understand reservoir characterization, and recognize uncertainty and the impact of the estimated FWLs. Geolog's flexibility, customizing capability, and user-friendly interface helped the user analyze the borehole step-by-step, reducing working time. The results obtained were an important starting point for creating an appraisal program for the new gas discovery and strategizing the next drilling campaign.
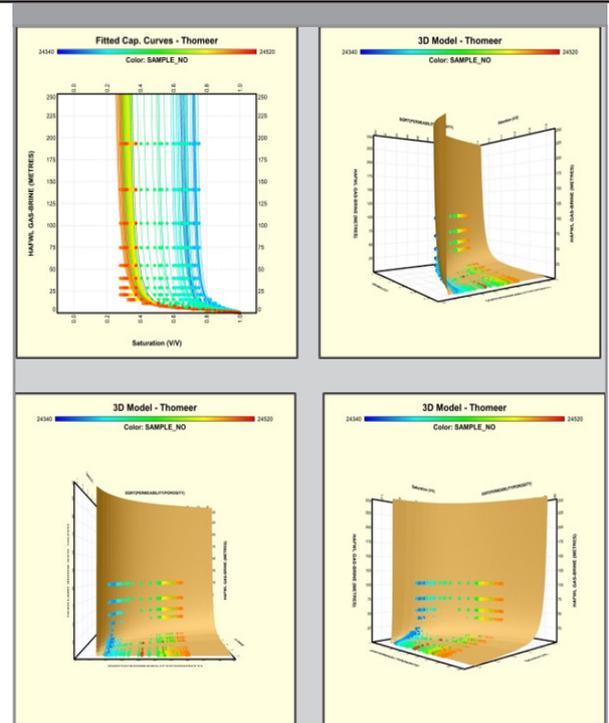
Modeled pseudo-capillary pressure curves at 3 different angles. A saturation height function was created in Geolog from this model.
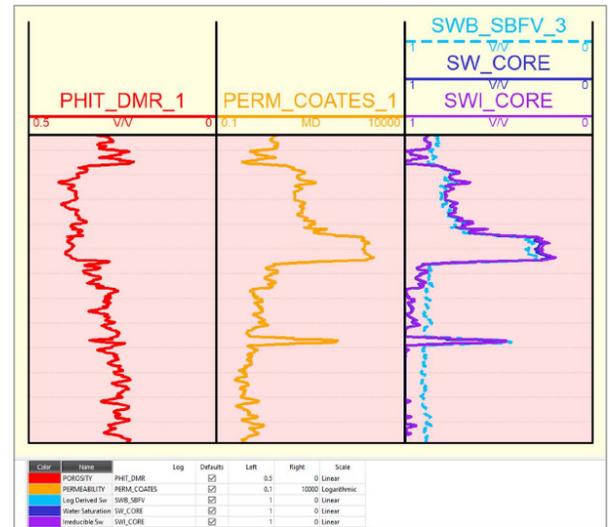
The Geolog FWL solver in the saturation height model was used to compute a FWL by dragging the FWL line up and down on the screen, on-the-fly. FWL was estimated by adjusting SW_CORE until a good match with SWB_SBFV (NMR bound water saturation) was found.

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