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GUPCO Improves Production by Streamlining Thin-Bed Characterization in the Techlog Platform

Techlog Thin Bed Analysis supports combined workflow for rock types and properties from conventional logs to reliably identify pay zones

CHALLENGE

Improve production from shaly sand reservoirs by better predicting the pore-throat radius to identify pay zones and optimize perforating.

SOLUTION

Design and implement a customized solution using Techlog* Thin Bed Analysis and Python® scripts for rock typing to characterize thin beds through their conventional log response, streamline the determination of permeability and porosity for calculating pore-throat radius, and present the results in comparison with true resistivity responses.

RESULTS

Accurately identified more pay intervals and optimized perforating design on the basis of reliable thin-bed characterization including pore-throat calculations for multiple wells.

"The new customized solution using the Techlog platform allows verifying bypassed hydrocarbon pay as a strong tool to predict thin reservoir beds in low-resistivity pay."

Zarif Elsisi
Senior Petrophysicist
GUPCO

Updating characterization workflows for thin beds

The Gulf of Suez Petroleum Company (GUPCO) is a joint venture between BP and the Egyptian General Petroleum Corporation (EGPC) that focuses on oil and gas exploration and production in Egypt. Its portfolio includes eight operating concessions in the Gulf of Suez, with daily production of more than 78,000 bbl of oil per day.

As part of its work on reservoirs such as Asal, Kareem, and Nubia in the Gulf of Suez, GUPCO wanted to optimize its identification of intervals for perforating. This required updating the company's existing workflows for the unconventional reservoirs and thin beds in these fields.

Identifying and evaluating thin beds using the Techlog platform

Schlumberger experts met with GUPCO to determine that a customized solution, based on the Techlog wellbore software platform and using Techlog Thin Beds Analysis and the Python application workflow interface (AWI), was the most effective approach to meet these challenges.

Techlog Thin Bed Analysis is based on Thomas-Stieber modeling to determine end points for correctly defining the response parameter values, including saturation, for the formation components. The effect of hydrocarbon is corrected for, and inversion curves are output.

The first step for using Techlog Thin Bed Analysis is to identify the minerals, rocks, and fluids present in the formation. These formation components are referred to in terms of fractional volumes. The modeled system consists of

- wet shale, sand, formation water, and hydrocarbons in the uninvaded zone
- mud filtrate and hydrocarbons in the invaded zone.

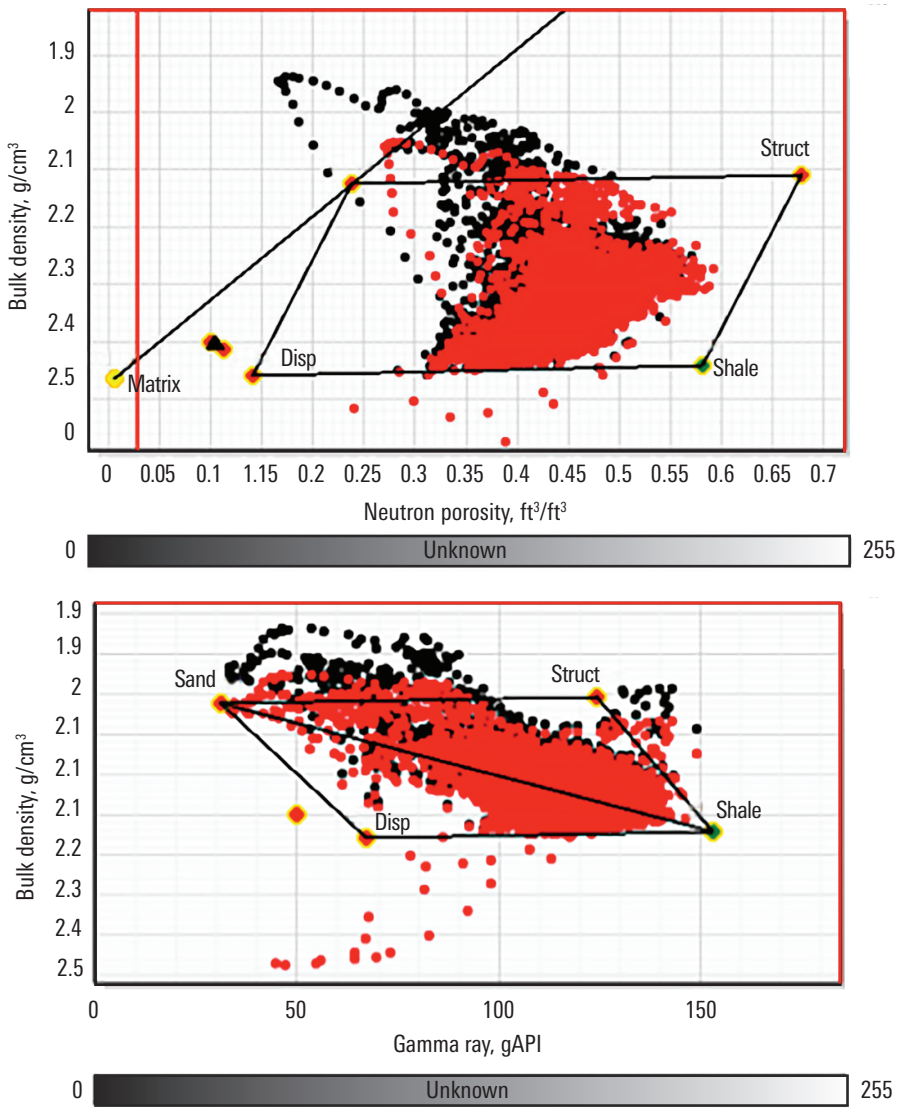
For the sand, shale, and fluid system, the properties of clean sand, pure shale, and the fluid must be defined. This is performed by plotting the log data in a Thomas-Stieber crossplot. Correction to account for hydrocarbon effects determines the porosity for the system. On the resulting plot, the black points represent the original points and the red points are the points obtained after the hydrocarbon correction. From this plot the clean sand and pure shale points are graphically picked for the sand point, shale point, structural shale point, and laminated shale point.

The Thomas-Stieber shaly sand model was originally created to resolve the problem of laminated shaly sand sequences in older South Louisiana fields (Thomas and Stieber, 1975). Conventional methods assume that the correlation between the gamma ray parameter and the shale volume is a direct relationship. The Thomas-Strieber method expects a correlation between the varying gamma ray responses and the shale geometry because shale can exist in three different forms in sand: dispersed, laminated, and structural. The five main assumptions of the model are that

- Only two rock types are considered: high-porosity clean sand and low-porosity pure shale.
- Different shale types have the same mineralogy in the investigated interval.
- Shale and sand grain densities are assumed comparable. The gamma ray is equal to the number of radioactive events, the shale fraction is a function of the volume, and the radioactive events are proportional to the volume.
- Background radiation is assumed to be constant.
- The count yield does not change as rock types are intermixed.

The gamma ray and density porosity log are solved to determine the sand fraction, sand porosity, and shale distribution, which makes the model optimal for evaluating shaly sands that contain a mixture of mostly laminated and dispersed shaly material. The Techlog Thin Beds Analysis module uses the Thomas-Stieber scheme to parse a shaly sand into fractions of laminar shale and dispersed shaly sand. The resulting fractions are used to deconvolve the apparent average resistivity into the average resistivities of the laminar shale and dispersed shaly sand. The porosity is then corrected using the fraction of the shale bulk volume, and the saturations are computed for the average dispersed shaly sand layers by using the standard Archie, Waxman-Smits, and normalized Waxman-Smits-Juhasz methods.

The first stages of Techlog Thin Beds Analysis require using the total porosity system. This model has been validated in turbiditic, deltaic, and aeolian depositional environments. The advantage of this method is that it makes it possible to distinguish zones in a highly laminated sand where the shale resistivity dominates the apparent resistivity, which biases conventional resistivity-based analysis to obscure zones that might produce hydrocarbon.



The red points on crossplots of bulk density versus neutron porosity (top) and gamma ray (bottom) are corrected for hydrocarbon effects to determine four fractions of laminated shaly sands.

Schlumberger petrotechnical experts worked with GUPCO to optimize key areas of its wellbore analysis workflow using Techlog Thin Beds Analysis for calculating permeability and the pore-throat radius R35 for comparison with the true resistivity.

Improving understanding to optimize well perforation

The new workflow using Techlog Thin Beds Analysis enables GUPCO engineers to plot and correlate data in the same multiwell log viewer and display formations in a lithologic model outlining porosity, hydrocarbon content, and computed permeability. This combined display supports faster comparison and improved quality control, as well as greater confidence in the formation evaluation.

GUPCO can now quickly and reliably identify and evaluate thin beds for multiple wells. As a result, GUPCO can more accurately define pay zones and intervals for perforating and improve the perforating design, which saves the company time and money while still basing the analysis on a conventional wireline logging suite.

Thomas, E.C., and Stieber, S.J.: "The Distribution of Shale in Sandstones and its Effect upon Porosity," *Transactions of the SPWLA 16th Annual Logging Symposium,* New Orleans, Louisiana, USA (June 4–7, 1975), paper T.

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