Reduced Risk and Faster Time to Results in an Arab D Carbonate Well Using Predictive Analytics with Geolog and Python

RESULTS

- Use of Geolog's Python loglans helped the customer obtain more accurate estimates of volumetrics, for reduced risk.
- The enhanced workflow efficiency increased productivity and reduced time to results by up to 50%.
- The reservoir simulation from this model will be used to develop a strategy to maximize production and recovery of the reservoir.

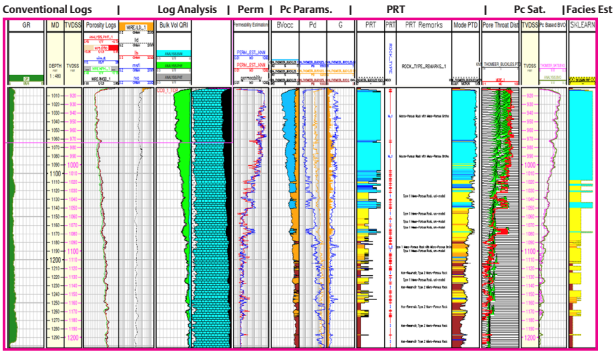

Figure 1. Carbonate Reservoir Characterization using Python in Geolog

APPLICATION

Emerson Geolog™ using Geolog's Python Loglan Programming Language

CUSTOMER

Crested Butte Petrophysical Consultants, Inc.

CHALLENGE

The customer's challenge was to employ a full pore system characterization workflow on an Arab D carbonate well located in the Middle East. The goal was to apply a proven workflow[1] totally within Geolog.

Most Arab D reservoirs are composed of a high percentage of macro porous reservoir rock with meso porous grains (Clerke's M_1 Petrophysical Rock Type (PRT)) that result in very high recovery factors. The meso porous grain portion of this PRT spontaneously imbibe the water flood front and expel most of their oil. Only through full pore system characterization can the distribution of the M_1 PRT be understood and recoveries from this PRT estimated, resulting in very high recovery.

SOLUTION

The methodology chosen followed the customer's user-defined Clerke's[2] Rosetta Stone Arab D Carbonate core data. Thomeer capillary pressure parameters were used as calibration data for this study. These calibration data are automatically called and loaded in the Python routines for petrophysical property estimates. In a typical field study, all wells with useable log data are employed in the final field study, and the same techniques developed in Geolog will also be applied at the 3D static model level as well as in reservoir simulation studies.

"This Arab D Carbonate Reservoir Characterization Workflow is a fit-for-purpose workflow that allows full pore system characterization of the reservoir for accurate volumetrics, and an initial 3D model to be used in reservoir simulation.

Geolog's new Python programming capabilities allow us to capitalize on the leading-edge Python techniques being developed by data scientists throughout the world and employ them in our own workflow in Geolog."

Craig Phillips
Crested Butte Petrophysical Consultants, Inc.

For more information:
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The Geolog workspace allows the user to design and follow a well-defined workflow that interrogates the well log data and then characterizes the complex carbonate reservoir. The first part of the workflow uses Python's Altair to interrogate both the well log and calibration data. Geolog Multimin is used for the log analysis. It is essential to use reservoir specific core-calibrated, Permeability and Thomeer Capillary Pressure parameter data to make any petrophysical property estimates. Python kNN is used to estimate petrophysical properties and determine the most likely Petrophysical Rock Types (PRT) for each level in each well of the field. Another Python package called Sklearn is also employed to predict facies[3]. We use our PRTs for facies in this example.

Finally, Python is used to model the Bulk Volume of Oil from log analysis using the kNN estimated Thomeer capillary pressure parameters, field PVT properties and height above the Free Water Level (FWL) elevation. This is a capillary pressure-based water saturation model for the reservoir that can also be applied at the 3D model level.

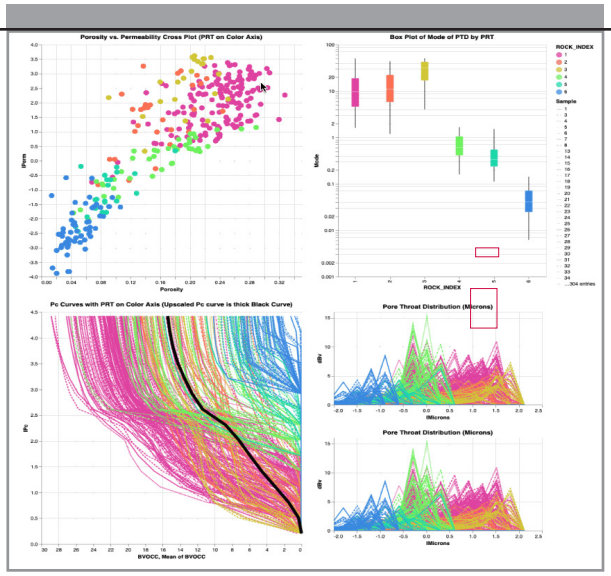

Figure 2. Altair used to interactively Interrogate calibration data

RESULTS

The workflow is now easily deployed in Geolog, and the process has been used in numerous complex carbonate field studies throughout the Middle East. This is a proven technique for characterizing a complex carbonate reservoir, as customers add their own calibration data to the workflow.

BENEFITS

Use of Geolog's Python loglans resulted in an efficient, proven carbonate full pore system characterization workflow that reduced time to results by up to 50%. The customer was able to rigorously apply the calibration data to obtain more accurate estimates of volumetrics, for reduced risk.

Geolog users have always had access to multiple customization and extension tools that enable them to deploy their own workflows within Geolog. The ability to use their own Python techniques and libraries in Geolog is a huge step forward that can be applied to all petrophysical characterization work. Most of the techniques presented in this study are totally transparent to the user (no black box) and Python routines can be easily followed to understand how they are applied. The workflow can be modified for different reservoirs using reservoir-specific calibration data, resulting in accurate reservoir volume estimations.

[1] *Phillips, E. C., Buiting, J. M., Clerke, E. A, "Full Pore System Petrophysical Characterization Technology for Complex Carbonate Reservoirs – Results from Saudi Arabia", AAPG, 2009 Extended Abstract.*

[2] *Clerke, E. A., Mueller III, H. W., Phillips, E. C., Eyvazzadeh, R. Y., Jones, D. H., Ramamoorthy, R., Srivastava, A., (2008) "Application of Thomeer Hyperbolas to decode the pore systems, facies and reservoir properties of the Upper Jurassic Arab D Limestone, Ghawar field, Saudi Arabia: A Rosetta Stone approach", GeoArabia, Vol. 13, No. 4, p. 113-160, October, 2008.*

[3] *Hall, Brendon, "Facies classification using Machine Learning", The Leading Edge, Volume 35, Issue 10*

RESOURCES

www.emerson.com/Geolog

The Python tools discussed above are available here: https://github.com/Philliec459?tab=repositorie

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