Paradigm®

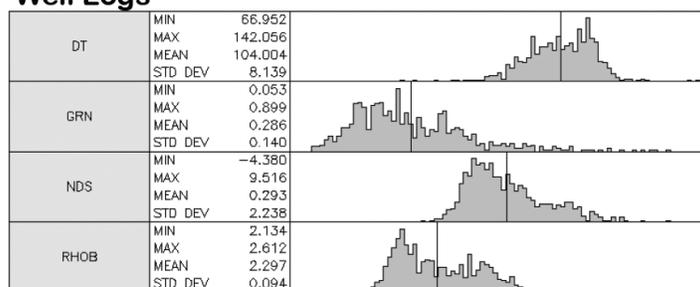# Performing Accurate Permeability Predictions

The Challenge

A national oil company in the Middle East was unable to perform consistent permeability estimation in their key reservoirs. This caused great uncertainty in the fluid distribution estimates, impacting their reserve calculation and recovery factor.
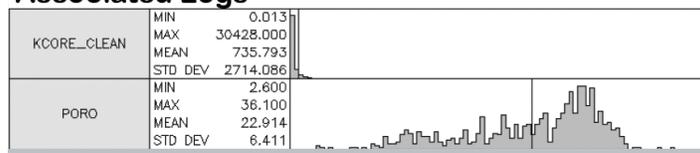
The Assessment

Petrophysicists were attempting to use data from a number of different data sources and techniques that led to inconsistency in the permeability prediction. The data included special core analysis, wireline logs, well test and production results. Integrating these four data types simultaneously in prediction techniques is problematic due to their different sample rates and sources.

Data Sources	Type of Measurement	Limitations
Wireline logs	Downhole and continuous	Borehole effect and indirect property measurement
Wireline formation tester	Downhole, with unlimited flexible sampling	Borehole effect and only discrete sampling
Core analysis	Reservoir rock at surface and a variety of analysis types possible	Plugs can be unrepresentative and expensive
Well test	Direct observation of reservoir flow behavior	Interval measurement with an averaged result

Well Logs

DT	MIN	66.952	
	MAX	142.056	
	MEAN	104.004	
	STD DEV	8.139	
GRN	MIN	0.053	
	MAX	0.899	
	MEAN	0.286	
	STD DEV	0.140	
NDS	MIN	−4.380	
	MAX	9.516	
	MEAN	0.293	
	STD DEV	2.238	
RHOB	MIN	2.134	
	MAX	2.612	
	MEAN	2.297	
	STD DEV	0.094	

Associated Logs

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KCORE_CLEAN	MIN	0.013	
	MAX	30428.000	
	MEAN	735.793	
	STD DEV	2714.086	
PORO	MIN	2.600	
	MAX	36.100	
	MEAN	22.914	
	STD DEV	6.411	

▲ Sample of multi-data input.

The Solution

Multi-resolution, graph-based clustering is a technique that allows data of various scales to be used simultaneously. Paradigm™ Geolog® Facimage applies this technique to this kind of data set. Facimage looks for unique attributes of each data source and creates a relationship among data sources during clustering. The workflow consists of:

1. Recognizing the different sources

2. Applying the same logic to all four sets of clusters separately or together

3. Creating one cluster with lookup tables
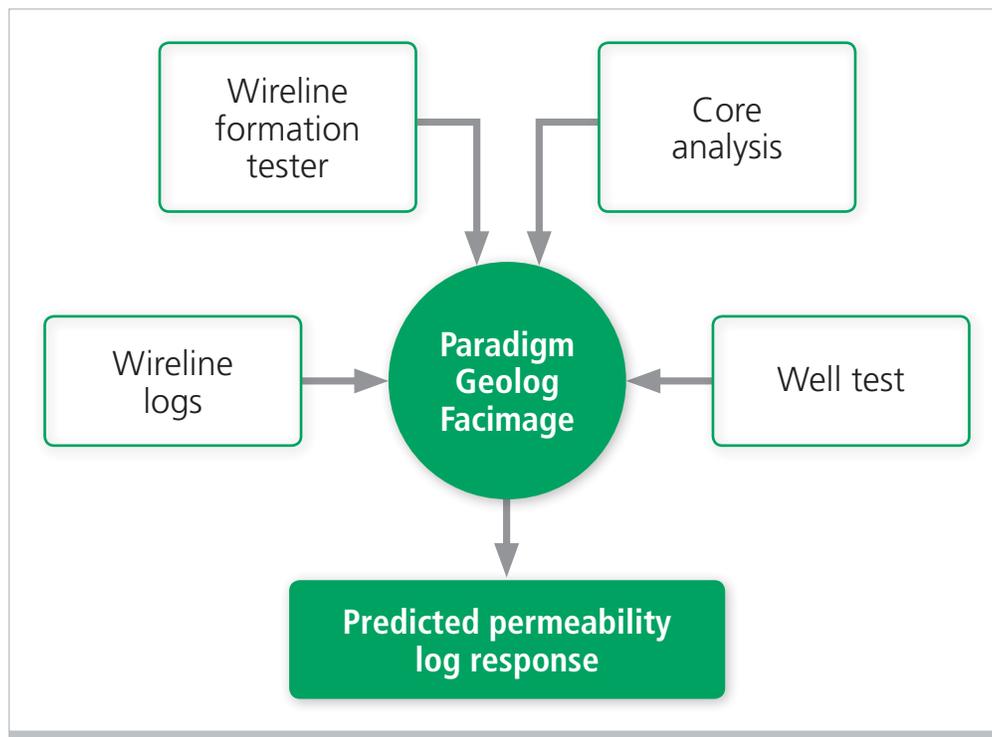
▲ The output is a reliable and repeatable permeability estimate.

The Result

- **Consistent and repeatable**

  The permeability prediction from Facimage was more precise than traditional transform-based permeability estimate methods The client was able to create a continuous permeability log and validate it against core descriptions. Using this data, reservoir simulation runs became more reliable, allowing for a better planning process for production rates and facilities.

- **Global recognition**

  Since its commercialization in 2002, more than 300 people have received direct training in multi-resolution, graph-based clustering from co-inventor Phillipe Rabillier (in partnership with TOTAL). Repeated training requests by oil companies worldwide is a clear sign of its success.
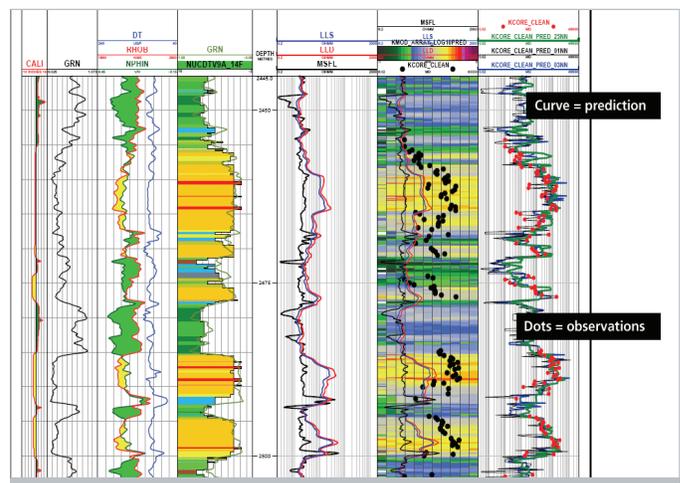
▲ Displaying array of multi-predictions from multi-data input in Geolog Facimage.