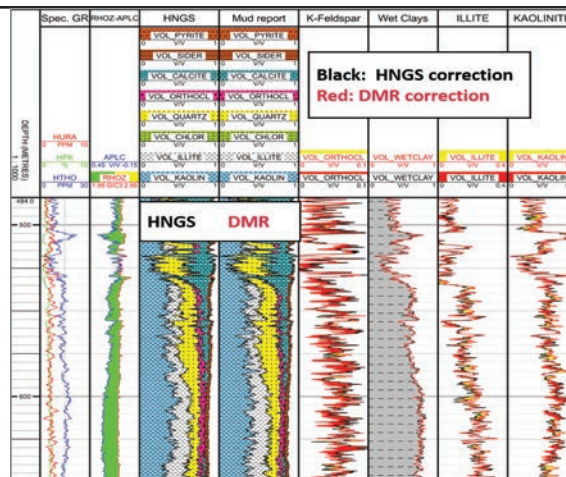


Geolog Multiminerals Helps De-risk a Suitable Disposal Site for Radioactive Waste, On Time and Within Budget

RESULTS

- Geolog™ is being used to improve log data quality control in almost real time, during drilling in a sedimentary basin in Northern Switzerland.
- The 3D structure of the investigated sites is being modeled within Emerson GOCAD™.
- The highly detailed and accurate information about the formations is providing accurate rock characterization relative to budget.



Comparison of multi-mineral interpretations generated with Geolog Multiminerals from spectral gamma-ray indirect measurement (HNGS) and daily mud report (DMR).

APPLICATIONS

Emerson Geolog and GOCAD

CUSTOMER

Nagra and Geneva Petroleum Consultants International (GPCI)

CHALLENGE

Subsurface exploration is not only an essential component in the search for energy sources such as oil, gas or water. It can also be used to solve the problem of long-term storage or disposal of waste, such as CO2 or radioactive waste.

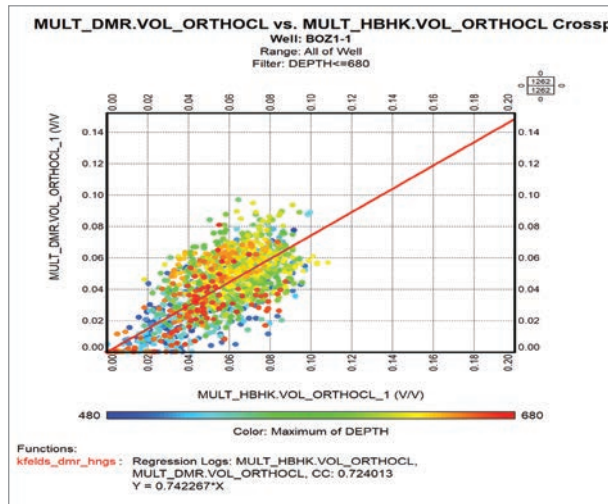
Nagra is a Swiss technical competence center tasked with responsibility for deep geological disposal of radioactive waste. For this project, the company's focus is on the clay-rich, mid-Jurassic Opalinus Clay formation as a potential host rock in Northern Switzerland. The goal of the project is to find a suitable disposal site for the waste. This requires a detailed characterization of the host rock in terms of mineralogy and porosity, based on excellent log quality. This project was performed by GPCI, an independent petroleum consulting firm, and the QA/QC provider for Nagra.

In an exploration project such as this, it is critical to have very accurate and detailed rock characterization of the targeted formations relative to the budget. The Opalinus Clay formation will be an integral part of the disposal concept. The composition of the rock, especially the clay mineralogy, determines its barrier performance. It is therefore necessary to acquire high-quality petrophysical data that can provide a detailed compositional breakdown of the potential host lithologies.

For the most recent boreholes in the exploration project, clay inhibitors (potassium, K-silicate) have been added to the mud system

“With Geolog, we are able to efficiently perform accurate QC, which is important for a project on a reduced budget relative to that of the oil and gas industry.”

Rodney Garrard, Project Manager, Nagra



A plot showing impact of the potassium correction on the Multiminerals-computed orthoclase volume, X-axis with HNGS-measured, Y-axis with DMR mud potassium concentration. The difference in mud potassium correction has a drastic impact on the orthoclase volume, consequently low impact on the accurate quantification of the clay content.

to prevent washouts in the shaly formation and allow robust data acquisition. This makes it imperative to accurately correct for the presence of potassium in the drilling fluid, as this impacts the measurements from the spectral gamma-ray (HNGS tool) of potassium and uranium levels. Different levels of correction have been applied in real time by the wireline engineers. In addition, an elemental spectroscopy (ECS tool) closure model was tested to provide a magnesium (Mg) content measurement, which is key for dolomite quantification. Thus, it was crucial to quality control the measure and corrections applied almost in real time; and ensure such wireline data could be used with confidence to characterize the Opalinus Clay and bounding formations.

SOLUTION

Emerson Geolog Multiminer is used shortly after logging acquisition to evaluate the validity and accuracy of these data through the creation and analysis of multiple models. Multiminer is able to solve the following technical challenges:

- Process and QC a very detailed acquisition in a short turnaround time
- Obtain an extremely accurate and detailed multiminer interpretation of the clay formation and check the impact of the new mud formula, to meet the strict requirements for detailed rock characterization.
- Evaluate the potential added value of the Mg measurement in the carbonate series.

The next step in characterizing a potential geological disposal facility is 3D characterization of the site structure. Borehole data, including the lab results from the continuously cored wells, has been integrated with seismic in GOCAD and a 3D geomodel has been generated. This helps to understand the geometry of the rock layers. In future studies, the variability of the rock types at the proposed disposal site can also be analyzed.

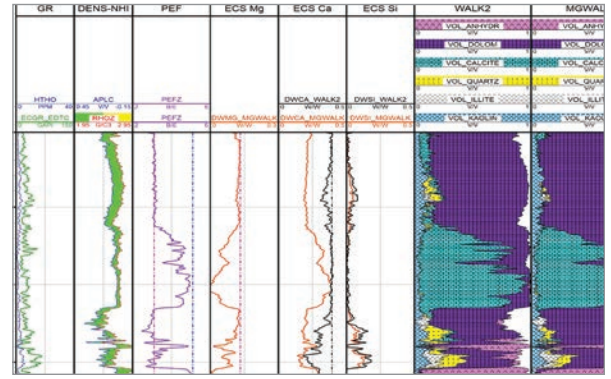
RESULTS

Nagra has been able to successfully characterize the Opalinus Clay and bounding formations. The use of Multiminer models proved the negligible impact of potassium mud corrections on the clay content, and also improved the dolomite volume quantification. The result is a very detailed and accurate characterization of the formation performed at minimal cost relative to budget, which can support the proposal for a radioactive waste disposal site.

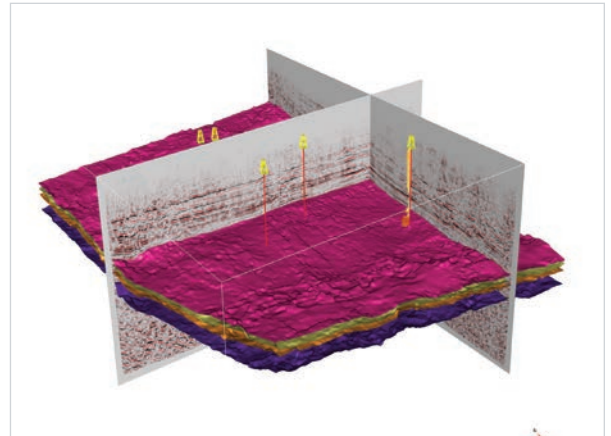
BENEFITS

Geolog Multiminer is used to QC and process the validity and accuracy of the new log data within 24 hours. This enables a quick and detailed assessment of the impact of changes in log acquisition and processing on the required detailed formation characterization. The changes have been validated and applied to the most recent boreholes.

Due to the flexibility, ease of use and efficient data integration of Multiminer (i.e. the ability to integrate HNGS and ECS data), it is possible to perform detailed QC within a multi-mineral interpretation easily, efficiently, and with high accuracy, while dealing with a highly detailed acquisition.



An alternative processing method (MGWALK) was evaluated and used with ECS standard processing (WALK2). Expert, “almost real-time” QA/QC of the wireline data in Geolog and good communication between the teams were critical for assessing logging speed and performing processing at optimum quality.



Structural model: horizons, seismic and drilled wells visualized in Emerson GOCAD