Schlumberger

TerraTek Services—Mechanical Property Profiling

Facies modeling based on geomechanical properties

APPLICATIONS

- Quantitative assessment of rock heterogeneity and fracture density
- Rapid identification of regions of weakness in hard and soft rock
- Sand strength analysis in completion design—for example, selective perforating, sand management, and placement
- Significant improvement of the predictive capacity and reliability of rock mechanical models for wellbore stability and sanding potential
- Aid to comprehensive understanding of variance in rock strength for hydraulic stimulation design
- Adequate sampling of all facies by enabling picking locations for sidewall core plugs

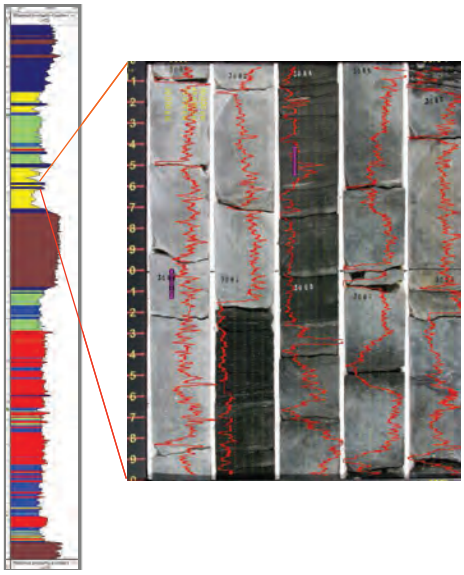
BENEFITS

- Improved reservoir understanding
- More accurate prediction of rock properties
- Full-picture interpretation that can be integrated with other facies-based interpretations
- Fast data delivery to optimize well planning
- Dataset that allows interpretation of the reservoir in addition to the wellbore
- Improved drilling performance with better understanding of wellbore stability

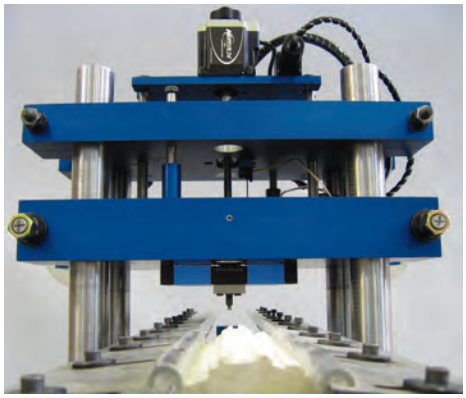
Modeling

Schlumberger TerraTek* rock mechanics and core analysis services provide the information needed to fully characterize reservoir material properties at the wellbore scale. To ensure this delivery, Schlumberger integrates continuous unconfined compressive strength (UCS) measurements from scratch testing with petrologic and geologic core descriptions. This integration also includes performing TerraTek HRA* heterogeneous rock analysis service on log measurements.

TerraTek services for mechanical property profiling provide a facies-type analysis based on integrating log and mechanical property measurements—up to several hundred per inch of core. Integration of this analysis with log data is used to determine the best approach for maximum productivity. Whether the measurements for sanding analysis are used to determine the need for sand control or optimal screen placement or in hard rock for determining the limits of rock strength heterogeneity across the treatment zone (to ensure a complete zone treatment), the mechanical property profile service defines formation heterogeneity for the optimization of well productivity and effective recovery.



Vertical heterogeneity at log scale. Similar rock class colors represent units with similar material properties. The profile overlaying the colors is the measured continuous core strength, but displayed at lower (log scale) resolution. The insert shows an example of a core section where the transition between carbonate units and an argillaceous mudstone unit is apparent.



Profiler core scratch test system. Scratch testing is used to help correctly define facies and heterogeneities that would be difficult to discern by geologic description or log characteristics alone.

Continuous strength measurements

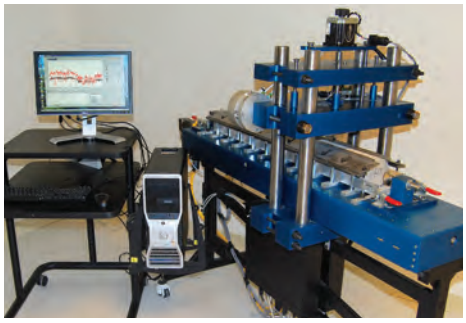
The profiler core scratch test system is patented technology for continuous measurements of rock UCS by cutting (scratching) the rock surface. These measurements include evaluating the normal and tangential forces required to create continuous cohesional (i.e., shear) failure along the rock surface under conditions of a constant depth of cut and constant cut velocity. From these measurements, the energy required per unit of volume of rock cut (specific energy) is determined. For Coulomb rocks, the specific energy for cohesional failure and the unconfined rock strength are directly related, and thus the latter can be calculated along the core length. Data gained from scratching significantly improves the evaluation of rock heterogeneity and thus the construction of mechanical models for wellbore stability applications.

TerraTek Services—Mechanical Property Profiling

FEATURES

- Continuous, high-resolution UCS measurement over the entire cored interval, creating a continuous log
- Integration of direct core measurements with log measurements
- Convenient geomechanics-based facies analysis
- Fast, efficient process that delivers data in a matter of days
- Rock class analysis designed to be extended to offset wells
- High-resolution platform for geomechanical evaluations of in situ stress and wellbore stability

The system provides core-scale continuous measurements of rock strength, allows quantitative assessment of rock heterogeneity and fracture density, and rapidly identifies regions of weakness. The mechanical property profile service integrates these continuous strength measurements with petrologic and geologic attributes for improved evaluation of rock texture, composition, and lithotype variation. It allows defining scaling relationships of mechanical properties, from plug size to core size to well size. The service integrates these attributes with dominant rock classes along the length of the core and the wellbore.



Core scratch test system and scratch test results on screen. The depth of the scratch on the core's surface indicates rock strength (red curves), which can be correlated to rock mechanical properties.

The continuous strength data is taken digitally and is depth-corrected to conventional log data. This data provides an easy, high-resolution integration with TerraTek HRA service and petrophysical log data, such as density, compressional, and shear information from sonic and even image logs.

Heterogeneous rock analysis

TerraTek HRA service is used to evaluate the variability of log measurements as a function of depth, create a pattern of these combined responses and identify the occurrence of identical data patterns along the interval of interest. Results from the analysis define all existing fundamental, nonredundant rock classes with distinct material properties.

Evaluation of log data using TerraTek HRA service provides a mathematically precise, objective, and robust methodology for defining rock classes with distinct material properties. The analysis is a mathematically based methodology that can be used on exploratory wells, where no previous definitions of the various rock types exist. In these cases, the analysis provides differentiation between the various reservoir and seal units without explicitly differentiating producing and nonproducing intervals. The principal advantage of TerraTek HRA service in these circumstances is the accurate identification of the extent of a region to be cored.

TerraTek HRA service is used to show heterogeneity at log scale and to discriminates zones of consistent mechanical behavior within heterogeneous media. Results from this analysis are used for selecting core samples (or rotary sidewall plug locations), giving the most efficient sampling plan for heterogeneous formations, and allowing the identification of the units with best reservoir quality and fracture containment potential.

Uncored wells

Rock class tagging allows the comparison of log responses in a well (e.g., an uncored well) with log responses and associated reservoir properties in a reference well (e.g., a cored and adequately characterized well via laboratory testing or scratching, if available). This form of tagging uses definitions from the reference well to assign rock classes to comparison well logs. It also produces an error curve that evaluates the degree of compliance between the two wells. Good compliance indicates a strong correlation between the two wells and associated rock classes and a strong similarity in material properties. Poor compliance between some sections or the entire section between the two wells indicates the presence of new (nonrepresented) facies. Rock class tagging between wells and compliance analysis help monitor changes in thickness and location of previously defined rock classes between wells. Tagging also helps identify new facies requiring coring and laboratory characterization.

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