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Rock Mechanical Properties from Logs Petrophysics : Concepts and Results

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The objective of the “geomechanics from logs” (GML) research project is to develop model-driven predictive software for determining rock mechanical properties (specifically rock strength, compressibility and fracability) from other, more easily measured, rock properties (e.g. lithology, porosity, clay volume, velocity) routinely derived from nuclear, resistivity and acoustic logging tools.
To this end, geomechanics from logs seeks to increase fundamental understanding of the primary geologic controls on rock mechanical properties and to translate this new insight into novel predictive tools.

In detail, GML predictors rely on (i) the generation of relational rock mechanical properties databases incorporating QC’d core-based laboratory measurements (both in-house and high-precision published data); (ii) the use of established rock physics models (e.g. friable sand, contact cement models) to investigate theoretical relationships between geologic processes, reservoir environment, rock microstructure and elastic, bulk and transport petrophysical attributes/properties; (iii) the subdivision of database rocks into generic lithotypes (e.g. sand, shaly sand, sandy shale, shale) with common petrophysical attributes/properties; (iv) the use of multivariate statistics to generate lithotype-dependent empirical predictive relationships between mechanical properties and log-derived petrophysical attributes/properties; (v) the estimation of uncertainties associated with predictive function parameters; (vi) the application and validation of mechanical properties predictive tools to well-documented case studies (e.g. sand strength for perforation stability, rock compressibility for reservoir simulation) to test overall performance and quantify uncertainty in predictions.

This paper presents the results of various rock strength, rock compressibility and rock fracability case studies conducted in wells of different stratigraphic age and depositional environment. Overall, GML (i) facilitated a step-change in fundamental (rock physics-based) understanding of complex geologic controls (rock microstructure and reservoir environment) on formation mechanical parameters; (ii) generated predictive algorithms relating core-derived rock mechanical parameters (specifically formation strength, compressibility and fracability) to petrophysical parameters determined directly from logging tools; and (iii) resulted in the implementation of these predictive algorithms and associated uncertainty quantification within log-analysis software.