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INTEGRATED CORE ANALYSIS FOR QUANTITATIVE RESERVOIR-QUALITY ASSESSMENT

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The only way to obtain direct measurements of salient properties of reservoir rocks in the subsurface is through analysis of sediment cores. In the light of the huge investments needed to acquire cores, and the growing need of society to predict reservoir quality (RQ), it is remarkable that current protocols in core analysis have not been optimized. The current protocol for routine core analysis (RCA) results in sets of measurements acquired with different analytical techniques at different spatial resolution. The RCA protocol does not include operator-bias evaluation, or integration of continuous sedimentological core description with spot measurements on plugs and thin sections. RCA data rarely have verified uncertainty specifications, thus hampering statistically rigorous extrapolation of spot measurements to the entire reservoir volume. Our approach to integrated core analysis (ICA) directly addresses these crucial problems and aims to take RQ prediction to a new level. The starting point is an innovative mathematical-statistical framework, which enables generation of fully integrated (i.e. multivariate) near-continuous time series of rock properties with quantified uncertainties. This technique relies on embedding spot measurements of traditional core analysis in a big-data environment provided by non-destructive XRF core scanning, which permits successful prediction of standard core-analysis quantities, such as grain density, porosity, and permeability.
Petrographic analysis gives insight into the controls on RQ by identifying the diagenetic fingerprint that shapes the spatial distribution of porosity and permeability in the reservoir. Because thin-section analysis is time consuming and costly, protocols for selection of representative thin sections should aim at maximizing information obtained from small data sets, so as to minimize costs and prevent unnecessary destruction of core material. We present a flexible protocol for representative thin-section selection based on evaluation of RCA data (i.e., poro-perm and grain-density plug measurements), illustrated with a core of a Carboniferous fluvial sandstone reservoir. The results of the petrographic analysis are interpreted in terms of their relations to sedimentological and geochemical signatures. We demonstrate that application of the sample-selection protocol significantly increased the value of RCA data which to date merely served as petrophysical indicators. Through ongoing research within this project, we aim to expand the ICA workflow to include the most important rock properties needed for successful RQ prediction, i.e. petrographic composition and grain-size distribution, which control the diagenetic history of reservoir rocks.

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