

Streamlining Log Calibration Workflows By Incorporation of Continuous, Digital Mineralogy Data

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ABSTRACT

Log interpretation models aim to determine subsurface rock properties by combined interpretation of a range of electronic log and lab test datasets. Knowledge of the rock's mineralogy greatly enhances the selection of calibration parameters and reduces model uncertainty. Standard mineralogical techniques including sedimentological core logging, optical petrography and X-ray diffraction yield useful but incomplete analogue datasets that can be difficult to incorporate into larger scale digital workflows and selection of calibration parameters remains challenging. To address this, we present log calibration workflows improved by incorporation of two fully digital Big Data petrographic techniques: short wave infrared spectroscopy (SWIR; SpecCam®) and scanning electron microscope-energy dispersive spectroscopy (SEM-EDS; QEMSCAN®). Using SWIR, the entire core face is digitally imaged, providing a visual and digital mineralogical map of the core. A continuous, sub-millimetre mineral abundance log is generated, with ability to derive detailed carbonate, sulphate and clay mineral information, (i.e. differentiating clay polytypes and their crystallinity). Detailed logs of hydrocarbon and hydroxyl/water content and distribution are also generated. The SWIR data allow optimal selection of SEM-EDS sampling points, which are then used to normalise the continuous SWIR log and provide micron scale textural information. Generated datasets include modal mineralogy, porosity, pore size distribution, pore shape and aspect, grain size and distribution per mineral species, pore lining phases and elemental maps. The combined pore- to core-scale SWIR and SEM-EDS dataset enables more robust determination of petrophysical calibration parameters, improving the log calibration workflow. This methodology will be illustrated with a clastic sequence from the Upper Jurassic Fulmar Formation from well 21/16-2 of the Durward-Dauntless Field, West Central Shelf, UKCS. Examples from this reservoir section will be shown to illustrate methods to calibrate a number of log interpretation models including shale volume from gamma logs, density log porosity models and clay bound water. The fine scale mineralogy data are also used to help build thin bed interpretation models. We will demonstrate methods for upscaling high resolution mineral data to the log scale and its use in evaluating heterogeneity on multiple scales.