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Upscaling Machine Learning Classification of Austin Chalk and Eagle Ford Group Chemofacies from High-Resolution X–Ray Fluorescence Core Characterization

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ABSTRACT

Research presented here is focused on: (1) developing a workflow to upscale thin bed heterogeneity observed in core to the wireline log scale, and (2) using core based measurements to characterize horizontal drill cuttings. It remains a challenge to integrate large core datasets (i.e., x–ray diffraction, porosity, permeability, bulk grain density, organic matter pyrolysis, thin section, scanning electron microscopy, and lithofacies). It is particularly challenging to upscale core based measurements to wireline log measurements and drill cuttings analyses. Data presented here includes the integration of measurements from 25 cores of the Eagle Ford Group and Austin Chalk Formation. The Upper Cretaceous Eagle Ford Group and Austin Chalk Formation are marine mudrock systems and unconventional reservoirs that extend across Texas and Louisiana. Typical of mudrocks in general, these rocks are composed of thin interbedded layers of marly chalks to calcareous-siliciclastic mudstones that vary in degree of lamination, bioturbation, mineralogy, organic-matter richness, porosity, and permeability. Although thin beds are typically below the two-foot resolution of wireline log instruments, there presence (or absence) may be important to the performance of unconventional wells. Here we report the results from a chemofacies deep neural network classification system trained on semi-supervised x–ray fluorescence core-based training datasets augmented with visual lithofacies descriptions. Six chemofacies are identified for the Lower Eagle Ford Group, and eight chemofacies for the Austin Chalk Formation across the play. Rock attribute data from core plug measurements including TOC, mineralogy, grain density, and porosity, all of which ultimately control reservoir quality, are integrated into this chemofacies classification system. The median value for each attribute for each chemofacies is reported. Using this approach, the probability and abundance of key chemofacies can be modeled from x–ray fluorescence of drill cuttings, and high resolution core-based attribute profiles can be used to train wireline logs.

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