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# A Chemostratigraphy-Driven Workflow for the Analysis/Interpretation of Unconventional Core

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## ABSTRACT

Inorganic geochemical characterization of stratigraphic successions using empirically calibrated, portable x-ray fluorescence (XRF) spectrometers is increasingly utilized in core analysis, especially in mudstone-rich lithologies that are texturally difficult to subdivide under routine visual observation. Additionally, if analyzed at the scale of rock facies variations, the chemostratigraphic approach often provides a rapidly-defined and quantitative method for subdividing drill core at the sub-well log scale, regardless of overall lithology. A workflow is presented that includes the specifics and limitations of core preparation, analytical conditions, and the implementation of a sample grouping and elemental ranking routine that uses chemostratigraphic results to assign stratigraphic changes in "chemofacies" to the cored succession. The stratigraphic representation of the chemofacies is subsequently used to 1) refine the lithostratigraphic description of the core, 2) assess the relative occurrence of geochemically similar rock types, and, 3) optimize the selection of samples for detailed analyses (e.g., SEM, MICP, triaxial, groundtruthing of well log signatures). A synthetic gamma log is developed from the XRF results (K, Th, U) and linkages to the downhole gamma log are defined. Collectively, XRF and XRD (x-ray diffraction) results from key endmember sampling points along the core are interpreted in order to generate and refine a mineral model at the XRF sampling interval, which is generally 5 cm in mudrock successions. In conjunction with rebound hammer analyses, the chemofacies are used to estimate rock hardness/strength measurements to a finer scale in order to create a highly resolved mechanical stratigraphy that is subsequently used for geomechanical models, and ultimately, frac-simulation modeling. Without rock hardness measurements, the elemental data set can still be used to understand stratigraphic variations in formation brittleness, as various elements possess affinities for soft and hard minerals (e.g., Ca/Al can be utilized as a proxy for the calcite/clay ratio). An additional use of modeled mineralogy from elemental results is to develop hypotheses regarding fluid-mineral interactions along the well bore that may detrimentally impact well development and/or performance over time. An example of the core chemostratigraphy-driven workflow will be provided using several cores from the Permian-aged Bone Spring Formation, Delaware Basin, USA.