A Core-Based Synthesis of Litho/Chemofacies, Mineralogy, and Geomechanical Characteristics of the Permian-Aged First Bone Spring Sandstone, Delaware Basin, Eddy Co., New Mexico

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Abstract

It is reasoned that, because mineralogy plays a key role in both the geochemical composition and the geomechanical characteristics of strata, mineralogical estimates derived from elemental analysis can be utilized to estimate the mechanical characteristics of reservoir rock. One way of testing the validity of the above statement is to make geomechanical, geochemical, and mineralogical measurements at or very near the same spatial scale across a spectrum of lithofacies. While geomechanical (scratch testing) and geochemical (XRF-based chemostratigraphy) measurements can be undertaken at or near the same scale on a core face, it is economically infeasible and time prohibitive to make direct measurements of mineralogy at the same scale (using XRD). Thus, given an understanding of the range in mineral composition of reservoir rock derived from a small but representative suite of samples, a mineral model that closely accommodates the full compositional range of the succession can be derived. Furthermore, depending upon the modeling approach, the mineral model can be a slave to elemental stoichiometry or to a more complex approach (e.g., neural network), with the use of both approaches potentially providing greater insights to non-unique mineral solutions and overall model weaknesses. In an effort to generate a more cohesive understanding of geochemical, mineralogical, and geomechanical findings in the context of lithofacies associations, an integration of descriptive and quantitative data types from a 130-foot cored section of the Permian-aged First Bone Spring Sandstone, Delaware Basin, was undertaken. Both geomechanical and geochemical testing of the core were performed at or near the millimeter scale. The overarching purpose of the study is to outline a series of related workflows that incorporate the use of geochemical results derived using ED-XRF (energy-dispersive X-ray fluorescence), x-ray diffraction (XRD), micro-rebound hammer (MRH), and scratch test technology. The texturally diverse, highly heterolithic stratigraphic interval of the First Bone Spring Sandstone, which collectively represents laminated to highly bioturbated sandstones, siltstones, and mudstones are presented in order to define the importance of normalizing the scales of geochemical and geomechanical measurements. One of the ultimate goals of the study is to demonstrate the potential of, and the limitations associated with, using modeled mineralogy derived from paired XRF-XRD measurements to reproduce measured simple geomechanical characteristics of cored strata. Also demonstrated is the effect of inconsistency in sampling frequency for the geochemical and geomechanical techniques and how this impacts the ability to successfully model geomechanical changes using geochemical inputs.

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