

Chemofacies and Lithofacies in the Lower Wolfcamp Group, Type Locality in the Glass Mountains, West Texas

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Abstract

One of the most prolific unconventional targets in the Permian basin is the Lower Wolfcamp Group comprised of organic-rich mudstone interbedded with carbonate beds, and classified as a mixture of source rock to tight rock plays. Along the southern flank of the Delaware Basin, in the Wolfcamp Hills of the Glass Mountains, West Texas, Upper Pennsylvanian to Lower Permian units are well exposed, providing an analog to study unconventional reservoirs of the Wolfcamp Group and decipher stratigraphic variability in a carbonate platform slope to basinal depositional setting. This study recognizes unique geochemical signatures for mudstone from the Cisco Group and within the Wolfcamp Group in the outcropping sections, and sequence stratigraphic surfaces that extend regionally into the subsurface. Chemofacies and lithofacies characteristics of the stratigraphic units were determined by X-Ray Diffraction (XRD), Energy Dispersive X-Ray Fluorescence (ED-XRF), and hand-held Spectral Gamma Ray (SGR) measurements, in addition to petrographic analyses. The Upper Pennsylvanian Cisco Group is composed of interbedded mudstone, calcareous sandstone and phylloid algae mounds that are unconformably overlain by a thick succession (450 ft, 137 m) of interbedded carbonate conglomerate, skeletal grainstone - packstone, and siliceous and carbonate mudstone, of the Lower Wolfcamp Group. Unconformably overlying this unit, above the mid-Wolfcampian unconformity are approximately 100 feet (30 m) of cobble and boulder carbonate clast conglomerate. Compositionally, three mudstone facies are identified from the oldest to the youngest: 1. siliceous mudstone, with muscovite, illite and minor carbonate content,

corresponding to the Cisco Group. This facies is interbedded with calcareous and dolomitic sandstone with some feldspar content and elemental zirconium enrichment. 2. Siliceous mudstone, with muscovite and illite clays, but carbonate is not present in the lowest part of the Wolfcamp. 3. The youngest mudstone in the uppermost section of lower Wolfcamp Group is calcareous, with 10 to 35% carbonate content and the remaining composed by quartz and clays. The geochemical data and lithofacies aid in identifying the Pennsylvanian - Early Permian and the Mid-Permian unconformities, the most important stratigraphic surfaces in the study area. Maximum flooding surfaces, are indicated by the shift from debris flow and slope carbonate bed-sets to marine mudstone.