Stratigraphic Analysis of the Lower Grayburg Formation in Last Chance Canyon, New Mexico: Utilization of High-Precision Geospatial Mapping and Surveying Technologies

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The lower Grayburg Formation is a Middle Permian, mixed siliciclastic-carbonate on the rim of the Delaware and Midland basins that is well exposed in Last Chance Canyon, Guadalupe Mountains, U.S.A. Previous sequence stratigraphic work in the Grayburg recognizes the Grayburg Formation composite sequence onlapping the San Andres composite sequence. However, this onlap has only been vaguely documented and described in a regional sense (10's km) using the "paradigm" or "universal" model of an onlap in sequence stratigraphy. This research questions this "paradigm" model of how the Grayburg onlapping wedge developed during deposition at the flow-unit scale (100's m). The main objective of this study is to use geospatial technologies (i.e., Light Detection and Radar (LIDAR) and Differential Global Positioning Systems (DGPS)) to build a three-dimensional (3-D) geographic model of the lower Grayburg Formation that can be used to define the structural orientations, thickness variations, and stratal geometries. This can then be used in conjunction with field observations to better define the higher-resolution depositional processes of the lower Grayburg Formation's onlapping wedge .

Digital mapping techniques yielded over 10 million high resolution (5-20 cm) LIDAR points of the Last Chance Canyon topography and ~900 GPS positional measurements for three stratigraphic marker beds (i.e., "Big Brown", "Meter Brown", and "Hayes" sandstones). This data was combined with Shuttle Radar Topography Mission (SRTM) data and used to construct both digital elevation model (OEM) and triangular irregular network (TIN) surfaces of the study area. These models were then used to build elevation, slope, aspect, and isopach maps. Traditional techniques resulted in identification of six lithofacies. Lithofacies 1 is the deepest and is interpreted to represent a subtidal environment, while lithofcaies 6 is the shallowest and is interpreted to represent a supratidal environment. A tide-dominated coastal system conceptual geologic model of the lower Grayburg Formation was constructed and used to define an idealized facies cycle that represents an upward shallowing parasequence package that was initiated with deposition of lithofacies 1 and terminated with deposition of lithofacies 6. There are variations in the cycle facies stacking patterns that are present within the study area and are interpreted to be caused by tidal-ravinement surfaces and truncation. Finally, a panoramic photograph of the northeast wall of Last Chance Canyon is interpreted and results in capturing sandstone bodies both truncating carbonate mudstone and amalgamating on the updip side of the study area.

By combining LIDAR and DGPS technologies the lower Grayburg Formation's subtle dip anomalies were identified and used to determine current day structural dip and "true" depositional dip. Isopach maps defined the wedge shaped geometry of the lower Grayburg Formation and helped orient facies transitions in a basinward direction. Field observations aided in identifying variations in facies stacking patterns within the lower Grayburg Formation and are interpreted to be directly influenced by tidal-ravinement surfaces and truncation that result in updip thinning of parasequences and amalgamation of sand bodies. By combining digital mapping and traditional outcrop techniques the lower Grayburg's onlapping wedge is interpreted to represent a much more geologically complex system than the stately onlap.