Influence of the Early Paleozoic Structures on the Permian Strata, Midland Basin: Insights From Multi-Attribute Seismic Analysis

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Abstract

The Permian Basin covers an extensive area in Southeast New Mexico and West Texas. The Permian Basin, containing numerous vertically stacked producing intervals mainly of Permian age, is one of the most important petroleum-producing regions in the United States, with a cumulative production of more than 33 billion barrels as of 2019. Our study area, which is covered by 460 square miles of seismic surveys, lies on the eastern margin of the northern Central Basin Platform (CBP) and extends Midland Basin to the East. Different structural geologists have noticed that the study Pre-Permian structures, including: the Precambrian Basement, Abilene Gravity Minimum (AGM), the Texas lineaments, Grenville front, and Marathon-Ouachita Orogeny, of the northern CBP can provide insights into the tectonic evolution and help to interpret the structural style of the Permian Basin. The Precambrian basement provides the structural framework, controls the nature and location of the primary Paleozoic structures for the majority of continental area. The Grenville Front as well as the Texas lineament set up the basement architecture for future movement along the Andrews Shear Zone (ASZ) and faults that NW throughout the Midland Basin. In past, more commonly geoscientists, have used well log, 2D seismic data to study the fault trends, strike-slip movement, and other lateral relations. 3D seismic surveys, help create the complete stratigraphic horizons, and significantly improve the structural interpretation. We compute seismic attributes such as coherence, curvature and aberrancy, using seismic survey. Then, we extract the seismic attributes along the Woodford surface. We observed several strong lineations, trending in two primary

directions, on curvature and aberrancy attributes. The trend 1 lineation aligns with the ASZ on the northern margin of the survey and the trend 2 lineation is oriented N 65° W truncating against the CBP. We found a strong correlation between these trends and the orientation of fractures seen on the FMI logs. We use the information to understand the paleo-stress directions, and predict the most likely orientations of fractures. Our study gives an insight on the timing of the uplift of the CBP and movement on the ASZ. The lineations are caused by small flexures, and previous studies based on simple seismic attributes did not image such structures with clarity. Aberrancy and curvature enhance such flexures and were able to display the lineations as strong anomalies.