Karst in Subsurface Middle Paleozoic Rocks in the Arkoma Basin

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Abstract

Seismic attribute analysis, guided by well data, enables quantifying and mapping stratigraphic features caused by erosion or by karstification in late Ordovician-early Devonian Hunton Group strata in the Arkoma Basin in eastern Oklahoma. The Hunton Group is a major historical oil and gas producer in Oklahoma, and today, the overlying Woodford Shale is the most economically important drilling target of the Arkoma Basin; however, in the Arkoma Basin of eastern Oklahoma, relatively few wells have penetrated the Hunton Group, and little is known about its stratigraphic character and distribution. Our study reveals that these strata are more widespread than previously thought. Well data and seismic isochron mapping in the Red Oak petroleum field show isolated ~40-m thick lenses of Hunton rocks, on average measuring 3 km in diameter, with a surrounding halo of karsted rock. The Hunton lenses can be explained in two ways: 1) isolated remnants of incomplete erosion of the Hunton Group during Middle Devonian time (pre-Woodford unconformity); or 2) Hunton rocks sagged into sinkholes caused by karstification and collapse of underlying rocks (Viola or Bromide carbonates) where they were preserved. Using formation tops from a well data set correlated with attribute and structure maps derived from a 3D seismic volume, we identify three characteristics: 1) absent Hunton seismic markers, indicating that Hunton rocks were completely removed, 2) the Hunton contacts, indicating where a seismically visible section of Hunton rocks remains, 3) absent Hunton but with a thin horizon included within underlying carbonate strata interpreted to be what was an incipient karst zone, which is consistently adjacent to areas containing Hunton rocks. We show that the thickness of the overlying Woodford Shale, the most economically important hydrocarbon target in the Arkoma Basin, is related to karstic and erosional thinning of the underlying Hunton carbonates. Constrained interpretation of 3D seismic data reveals the economically significant association of thinned Hunton and thickened overlying Woodford Shale.