Gas Giant: The Haynesville and Bossier Shales of East Texas and Northwest Louisiana

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The Upper Jurassic (Kimmeridgian to Lower Tithonian) Haynesville and Bossier Shales of East Texas and Northwest Louisiana may be classified as one of the shale-gas giants in North America, having high IPs and overpressure, steep decline rates, EURs estimated at 6 to 20 Bcf per well of each formation, and play resources estimated together in the hundreds of trillions of cubic feet. The Haynesville has seen new production records in 2019 with 10.5 Bcf/D because of implementation of the latest hydraulic fracturing techniques aided by a proppant increase of ~250%, longer laterals (>7500 ft), more economic gas prices and the proximity to a vast pipeline net and LNG facilities that came online in 2016. This comprehensive review of the Haynesville and Bossier formations will provide an understanding why this giant shale play is so prolific considering its paleographic setting, favorable shale facies, evolution of maturation, and regional tectonics.

Haynesville and Bossier Shale deposition was influenced by basement structures, local carbonate platforms, and salt movement associated with the opening of the Gulf of Mexico basin. The deep basin was surrounded by carbonate shelves of the Smackover/Haynesville Lime Louark sequence in the north and east and local platforms within the basin. The basin periodically exhibited restricted environment and reducing anoxic conditions, as indicated by variably increased molybdenum content, vanadium, and organic content in shales. These organic-rich intervals are concentrated along and between platforms and islands that provided restrictive and anoxic conditions during Haynesville and part of Bossier times. The mudrock facies range from calcareous-dominated facies near the carbonate platforms and islands to siliceous-dominated lithologies in areas where deltas prograded into the basin and diluted organic matter (e.g., northern Louisiana and northeast Texas). These facies are a direct response to a second-order transgression that lasted from the early Kimmeridgian to the Berriasian. Haynesville and Bossier shales each compose three upward-coarsening cycles that probably represent third-order sequences within the larger second-order transgressive systems and early highstand systems tracts, respectively. Best reservoir properties are commonly found in facies with the highest TOC, lowest clay, highest level of maturity, and highest porosity. Most porosity in the Haynesville and Bossier is related to interparticle nano- and micropores and, to a minor degree, by porosity in organic matter with an average of 11%. The formation is highly overpressured and the free gas content is enhanced by high porosity and gas density.

A 3D basin model to establish the thermal and maturation history of the Haynesville basin was constructed using state of the art basin modeling software incorporating facies dependent lithology variations, erosion events, salt migration and diapirism. The area has been subject to three major tectonic uplift events each increasing heat flow slightly indicating a likely igneous control. Overpressure was likely related to maturation of organic matter, disequilibrium compaction, and burial. The modeled burial and maturation distribution show deeply buried, overmature parts of the Haynesville in the East Texas Salt Basin while the Haynesville on and around Sabine Uplift is mainly in the wet gas window. This also puts the most favorable areas for shale-gas potential to be located on and around the area of the Sabine Uplift.