Influence of Facies Variations on Exploration, Production, and Resource Assessment in Gas-Shale Plays: A Geologic and Petrophysical Evaluation of the Haynesville Shale, East Texas, USA

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The Upper Jurassic (Kimmeridgian to Tithonian) Haynesville shale-gas play has evolved into one of the most prolific shale-gas plays in North America, with estimated recoverable reserves in the hundreds of Tcf, high initial production rates, and each well expected to produce on average 6.5 Bcf. The play has recently expanded from its core area in western Louisiana into East Texas, creating different challenges because of its reservoir facies, production depths, and pressures varying across the Haynesville Shale basin according to preexisting basin configuration and paleogeography. The Haynesville Shale basin is influenced by a carbonate ramp in the west and north and carbonate-dominated islands near the Sabine Uplift, as well as by clastic influx from the north and northeast. This variable basin configuration, combined with second- and third-order sea-level fluctuations, exerts a pronounced influence on the lithology and facies of the shale. The Haynesville Shale was deposited during a second-order transgression, in which carbonates formed on the shelf and preexisting highs and organic-rich shales formed in the basin. The top of the Haynesville Shale productive interval coincides with the second-order maximum flooding surface. Overlying Tithonian Bossier shales and sands represent highstand deposits, with distal parts of the Upper Tithonian Cotton Valley late-highstand siliciclastic wedge downlapping onto the maximum flooding surface. Haynesville facies vary from siliceous mudstones containing up to 80% detrital quartz and clays and TOC average of 2% to skeletal carbonaceous mudstones containing up to 50% carbonates and TOC average of 4% and many variations of the two end members. These variations are based on increased clastic influx from the north, where silica-dominated lithologies are most abundant, and carbonate platforms in the west and south, where carbonate-dominated lithologies are more abundant. Considering variation in lithologies is important for fracture stimulation, production, and petrophysical interpretations because these parameters are affected by varying clay, pyrite, and organic content, potentially skewing porosity, TOC, and resistivity calculations into higher values.