Regional Assessment of the Eagle Ford Group of South Texas, USA: Insights from Lithology, Pore Volume, Water Saturation, Organic Richness, and Productivity Correlations

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ABSTRACT

A comprehensive regional investigation of the Eagle Ford Shale linking productivity to porosity-thickness (PHIH), lithology (Vclay), pore volume (PHIT), organic matter (TOC), and water-saturation (Sw) variations has not been presented to date. Therefore, isopach maps across the Eagle Ford Shale play west of the San Marcos Arch were constructed using thickness and log-calculated attributes such as TOC, Vclay, Sw, and porosity to identify sweet spots and spatial distribution of these geologic characteristics that influence productivity in shale plays. The Upper Cretaceous Eagle Ford Shale in South Texas is an organic-rich, calcareous mudrock deposited during a second-order transgression of global sea level on a carbonate-dominated shelf updip from the older Sligo and Edwards (Stuart City) reef margins. Lithology and organic-matter deposition were controlled by fluvial input from the Woodbine delta in the northeast, upwelling along the Cretaceous shelf edge, and volcanic and clastic input from distant Laramide events in the north and west. Local oxygen minimum events along the South Texas margin contributed to preservation of this organic-rich source rock related to the Cenomanian/Turonian global organic anoxic event (OAE2). Paleogeographic and deep-seated tectonic elements such as the older Sligo and Edwards reef margins and the Frio River fault line controlled variations of lithology, amount and distribution of organic matter, and facies that have a profound impact on production quality. Petrophysical modelingusing Multimin solver was conducted to calculate TOC, Sw, Vclay, and PHIT of the Eagle Ford Group. Thickness maps, as well as PHIH maps, show multiple sweet spots across the study area. Components of the database were used as variables in kriging of isopach maps, and multivariate statistical analyses evaluated the impact of these variables on productivity. For example, TOC and Vclay show an inverse relationship which is related to production where production is lower where Vclay is high. These relationships are displayed in 2D and 3D space across the study area. Mapping petrophysical parameters in both 2D and 3D space across a play serves as tool to predict geologic drivers of productivity across the Eagle Ford taking the geologic heterogeneity into account.