

Distribution of Sedimentary Heterogeneities in Proterozoic Shale-Plays: Insights from Multi-Realization of Stratigraphic Models of the Velkerri Formation (Beetaloo Basin, Northern Territory, Australia)

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Abstract

In the past 20 years, the oil and gas industry has shifted its interest from largely conventional to unconventional resources. In exploration of shale plays, the challenge resides in finding sweet spots with high hydrocarbon content and good reservoir producibility. The prospectivity of targeted intervals is closely related to the organic content, thermal maturity, porosity, permeability and brittleness of the reservoir which, in turn, are mainly controlled by sedimentary facies, mineralogy and thermal history. The Northern Territory of Australia presents a colossal potential for unconventional hydrocarbon exploration in the Beetaloo Basin with the primary target being the Mesoproterozoic Velkerri Formation. The challenges of unconventional resource exploration in the basin are exacerbated by age of the shales (ca. 1.4 Ga), complex geological history and the paucity of data to accurately map key elements of petroleum system. The aim of this study is to improve our understanding of the sedimentary heterogeneities (e.g. organic richness, mineralogy) in the Velkerri Formation and discuss their controls using stratigraphic forward modelling. Based on regional data describing paleogeography of the basin during the Proterozoic as well as seismic and well data depicting thickness and organic richness of the various intervals, we built a 3D stratigraphic model of the Velkerri Formation. This model restores

the stratigraphic evolution of the basin in the Proterozoic and fits the organic distribution observed in key wells. However, as data available to build and calibrate the model are limited, a wide range of simulations with different input parameters will fit the calibration data equally well. Therefore, we generated multiple realizations of the model, varying the input parameters within an acceptable range. Through varying input parameters, we studied the sensitivity of model results (e.g. organic-richness, silt content) to stratigraphic parameters (e.g. basin restriction, sediment source location, primary productivity) in different location of the basin. Then, through generating multiple realizations of the stratigraphic model we present a probabilistic distribution of the shale's key properties in the basin. Overall this study shows that heterogeneities in organic content in these Proterozoic shales are characterized by the complex interaction between, organic primary productivity, bottom water oxygen levels and detrital sedimentary inputs.