Quantitative Petrophysical Characterization of the Barnett Shale

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The purpose of this thesis is to characterize petrophysical properties of the Barnett Shale from geophysical data in order to predict and identify seismically which facies of the Barnett Shale are most fracturable. The Barnett Shale is characterized by low permeability and a variety of depositional facies. Based on gamma ray behavior it can be divided into fourteen gamma ray parasequences (GRP); corresponding to five in the Upper Barnett Shale and nine in the Lower Barnett Shale (Singh, 2008). In addition, these fourteen GRPs show three characteristic GR log patterns defined as upward decreasing, upward increasing, and upward constant trends. The Barnett section within the area has a thickness of approximately 700 ft, which represents 200 ms in seismic time. Model based inversion was used in order to improve the vertical seismic resolution and to tie in detailed facies core descriptions. The seismic information and vertical well control data played an essential role in the creation of synthetic seismograms to get quality results in the facies model. This work demonstrates that seismic acoustic impedance inversion reveals high heterogeneity in impedance values for the Lower and Upper Barnett section. The underlying hypothesis used in this thesis is that it takes longer for seismic waves to travel through some lithofacies and lesser time through others. Under this criterion, the seismic inversion method was used to analyze the variation in acoustic impedance response among the different gamma ray parasequences. Core studies performed by Singh (2008) show that some facies with high calcite content contain well defined fractures, indicating that they are fracturable. Thus, we expect that those facies with high calcite content and high impedance might potentially be more fracturable than non-calcite mudstones. The correlation of seismic facies with rock facies is key in this research in order to seismically identify parasequences that could potentially be more fracturable. The study also utilizes volumetric seismic attributes, such as curvature, coherency, and inversion, to identify and evaluate faults, fracture lineaments, and other features in and beneath the Barnett section. Finally, this thesis work follows a workflow that allows the identification of facies with low gamma ray and high calcite content (high impedance) in order to identify potentially most fracturable GRPs in the Barnett Shale.