Seismic Characterization of the Mississippian in South-Central Kansas

George P. Tsoflias[1], Yousef Fadolalkarem[1,2], and W. Lynn Watney[3]

[1]Department of Geology, The University of Kansas, Lawrence, KS, USA (tsoflias@ku.edu)
[2]Currently Saudi Aramco
[3]Kansas Geology Survey, The University of Kansas, Lawrence, KS, USA

Abstract

Mississippian chert reservoirs are highly heterogeneous and unit thicknesses are typically below seismic resolution. This work examines the utility of seismic AVO analysis and impedance inversion for prediction of Mississippian reservoir thickness and porosity. In the Wellington Field south-central Kansas, the Mississippian is microporous cherty dolomite and exhibits downward gradational porosity decrease resulting in a corresponding increase in seismic velocity. Analysis of post-stack 3D seismic data showed the expected response of a gradational transition (ramp velocity) where thicker reservoir units corresponded with lower reflection amplitudes, lower frequency and a 90-degree phase change. Reflection amplitude could be correlated to reservoir thickness and model-based inversion porosity predictions agreed with well control but failed to delineate reservoir boundaries from adjacent formations. Pre-stack gather analysis showed that porosity zones of the Mississippian reservoir exhibit Class IV AVO response. The AVO Intercept-Gradient crossplotting analysis was guided by well control and modeled data that helped differentiate the porous reservoir from the background trend. Simultaneous AVO inversion was used to estimate P- and S-Impedances, which along with formation porosity logs and post-stack seismic data attributes were incorporated in a multi-attribute linear-regression analysis for reservoir porosity prediction. We obtained good agreement between predicted (inverted) porosity logs and original porosity logs within the Mississippian reservoir with an overall cross correlation of 0.90. The reservoir was delineated across the 3D volume and was clearly differentiated from adjacent formations. This work demonstrates that advanced seismic interpretation methods, such as AVO analysis, simultaneous inversion and multi-attribute regression, can be used successfully for characterization of the Mississippian.