Rock Physics Study for Shale Gas Formation Characterization in China

Gang Yu[1] and Yusheng Zhang[2]

[1]BGP
[2]BGP Inc.

Abstract

Our study applied a geophysical well log analysis, rock physics diagnostics, and rock physics modeling to an exploration well log data from a shale gas exploration area in the Sichuan Basin of South China. The study established an unconsolidated model (80% quartz plus 20% clay in the shale gas formation) transform between the acoustic and elastic impedance on the one hand and lithology, porosity, water saturation, clay content, quartz content, and TOC content on the other hand. Through our geophysical well log analysis, we calculated mineral volumes using best available data, total and effective porosity, water saturation, and bulk density and VS prediction where it was missing. For rock physics modelling, the shale gas formation matrix substitution (Clay, Quartz, and TOC) and porosity modeling were performed in this exploration well. Crossplots are also used to analyze the elastic properties of the shale gas formation including VP velocity vs density, Acoustic Impedance (AI) vs total porosity (Φ), AI vs Poisson's Ratio (PR), and VP vs. The results were quality controlled by core sample laboratory analysis data. The Ray-traced synthetics have been generated for the in situ and modeled scenarios for AVA analysis. These transforms will be upscaled and applied to acoustic and elastic impedance inversion volumes to map lithology, porosity, and TOC distribution in the shale gas exploration area.

Based on the GWLA processing and analysis show that measured elastic data is overall of a good quality. Petrophysical inversion within the zone of interest shows good calibration to the main mineral constituents from the core data. TOC calibration within the Wufeng Formation is excellent. Resistivity drops along with increasing of GR in the interval 2,045 m (Baota LM). Increasing GR indicates increasing TOC but decreasing resistivity was interpreted as a low gas saturation zone and some conductive mineral (pyrite). Rock Physics Diagnostic shows that Unconsolidated Model is a reliable model to predict density from VP and Cemented Model is a reliable model to predict VS from VP. Rock Physics Modeling indicates: Adding clay content decreases velocities and increases Poisson's ratio slightly. As quartz increases, the velocities and Poisson's ratio decreases slightly. Increasing TOC decrease velocities, density, impedance, and PR. The increase of porosity decreases velocities, density, impedance, and Poisson's ratio significantly.