SG05

Tuwaiq Mountain Rock Physics Model

M.S. Bin Gubair* (Saudi Aramco) & A. Bakhorji (Saudi Aramco)

SUMMARY

Three different rock physics models for Tuwaiq Mountain (TQMN) carbonates were built to link the elastic properties of TQMN Formation carbonates to their organic matter content. First, to better understand the effect of the organic matter, an initial model of interpolation between 100 percent organic matter and a mineral point was built using the Hashin-Shtrikman model. The second model, a pore filling model, was built by combining the Hertz-Mindlin and Hashin-Shtrikman models, and the modified Gassmann equation. In this approach the porosity is created using the Hertz-Mindlin and the Hashin-Shtrikman models; the pores are filled with organic matter (as solid fill) using the modified Gassmann equation. These two models were able to predict the measured elastic properties of the formation. Due to the complexities of the pore shapes associated with carbonate rocks, a third differential effective medium (DEM) model was used to induce the porosity to the solid rock with different aspect ratios. The pores were then filled with organic matter using the modified Gassmann equation. The three models were tested for different elastic properties against values measured from sonic and density logs collected from two wells penetrating the formation. The agreements between the DEM model and the data were excellent.

Abstract

Unconventional resources such as shale gas are attracting more attention from geoscientists due to their ever-increasing importance in exploration and production. Locating the sweet spots and quantifying gas plays are two of the significant challenges currently being addressed. Understanding and quantifying the effect of organic matter on the rock's elastic properties will play a crucial role in predicting sweet spots from well and seismic data.

A rock physics model was built to link the elastic properties of Tuwaiq Mountain (TQMN) Formation carbonates to their organic matter content. The mineral fraction of the formation was calculated using Hill's average. Three different rock physics models for TQMN carbonates were then built. First, to better understand the effect of the organic matter, an initial model of interpolation between 100 percent organic matter and a mineral point was built using the Hashin-Shtrikman model (Figure 1). The second model, a pore filling model, was built by combining the Hertz-Mindlin and Hashin-Shtrikman models, and the modified Gassmann equation (Figure 2). In this approach the porosity is created using the Hertz-Mindlin and the Hashin-Shtrikman models; the pores are filled with organic matter (as solid fill) using the modified Gassmann equation. These two models were able to predict the measured elastic properties of the formation. Due to the complexities of the pore shapes associated with carbonate rocks, a third differential effective medium (DEM) model was used to induce the porosity to the solid rock with different aspect ratios (Figure 3). The pores were then filled with organic matter using the modified Gassmann equation.

The three models were tested for different elastic properties against values measured from sonic and density logs collected from two wells penetrating the formation. The agreements between the DEM model and the data were excellent.

Figure 1 Effective medium model, (a) schematic of the model, (b) the workflow, (c) the modeled bulk modulus versus organic matter color coded with TOC.

Figure 2 Pore filling model, (a) schematic of the model, (b) the workflow, (c) the modeled bulk modulus versus organic matter color coded with TOC.

Figure 3 Inclusion base model, (a) schematic of the model, (b) the workflow, (c) the modeled Bulk modulus versus organic matter color coded with TOC.