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Abstract

Seismic amplitude opens up new opportunities for reservoir characterization. However, seismic elastic properties are affected by many factors including fluid type, porosity, lithology, pressure and temperature. These factors are interrelated, thus changes in any one of them might affect the others. Two Permian carbonate wells were used to investigate the impact of porosity variation on marine amplitude data. The results were used to decouple the effect of pore-fluid from pore-space leading to better seismic interpretation.

Well log data from carbonate formations was used to investigate the impact of porosity variation on the seismic data. As first step, the porosity model was made to understand the variation in density, compressional Vp, and shear velocities Vs logs. Then, different fluid saturation scenarios, including fully brine and gas saturations, were modelled to create new set of density, Vp and Vs logs. To achieve this work, different rock physics models were tested and evaluated. The optimum model was used to obtain reliable seismic elastic properties over the depth interval of interest at the well location, which honor reservoir petrophysical properties. The modeled logs were used to generate seismic synthetic gathers.

In this case study, the modified upper Hashin-Shtrikman proved to be the most reliable model to explain the data. Moreover, it was observed that porosity is inversely related to acoustic impedance. Note, when the rock matrix softens the seismic amplitude becomes more sensitive, which is commonly interpreted as the “bright spot”. Zoeppritz approximation was used to create synthetic seismic gathers. The results of amplitude-variation-with-angle analysis shows that the seismic amplitude responses of the gas case is brighter than the wet case. This result was used as one of the porous rock indicators in the seismic attributes analysis stage. Thus, helping in mapping the good reservoir within the area to improve the future drilling campaign.

We demonstrate how rock physics modeling and analysis may help seismic interpretation and facilitate the understanding of the complex relationship between the rock properties and the elastic properties and eventually linking them in order to reduce the uncertainty in field development programs.