SEISMIC ROCK PHYSICS OF THE MIocene CARbonates: A CASE STUDY FROM THE CENTRAL LUCONIA PROVINCE, SARAWAK

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Due to increasing importance of oil and gas recovery and the growing realization that Luconia carbonate reservoirs are more heterogeneous than assumed in the past, rock physics analysis was employed to get better understanding on the relationship between the seismic properties of reservoir rocks (i.e. velocity, density, rigidity) and their production properties (i.e. facies, porosity, fluid type and saturation, pressure).

Based on the analysis of 40 selected core samples from two fields in Central Luconia Province, the followings conclusions can be drawn:

1. For general discrimination of tight and more porous facies, the best elastic property to be used is Lambda-Mu-Rho and Vp. Tighter facies associates with higher Lambda-Mu-Rho and Vp. Conversely more porous facies associates with lower Lambda-Mu-Rho and Vp.

2. For details facies-based discrimination of the porosity types (i.e. chalky/mouldic limestone, sucrosic dolomite, argillaceous shale, tight limestone), the best elastic property to be used is Mu, Rho, S-Impedance and Vs. Log data cross-plot analysis shows that the use of Vp, AI and density are also possible but with more ambiguity.

3. For lithological discrimination, the Vp, AI and density can be used. However, the best result is obtained when S-Impedance, Mu or Mu-Rho are assigned.

4. For brine, oil and gas pore-fluid discrimination, the best elastic properties are Mu and Mu-Rho. Brine has the biggest Mu and Mu-Rho values, followed by oil and gas.

5. The type of matrix is generally calcite, whereas dolomite acts as grains. The abundance of pore types in descending orders is mouldic, vuggy, intercrystalline and fracture pores.

6. For pore and effective pressures identification and monitoring, the most sensitive elastic property is Vp. The presence of two gradients of pressure changes indicates the possibility of dual porosity.

7. For porosity determination, Vp and AI can be used. Bigger porosity associates with lower Vp and AI. Conversely, lower porosity associates with bigger Vp and AI. The Vp and AI can be obtained by applying Post Stack AI Inversion.

8. The time-lapse seismic analysis shows that time lapse seismic is feasible to be employed to monitor the changes of water saturation and pore pressure. The decrease of water saturation degree and the increase of pore pressure will slower the seismic wave velocity, extend the travel time and decrease the amplitude of first break.
9. Log cross-plot analysis reveals that Vp and AI can be used to discriminate lithology and pore fluids. The Vp and AI of carbonates are higher than the shales. The Vp and AI of water are higher than the gas.

10. AVO analysis shows that Vp-Vs relationship is linear and the best-fit equation lines will be different at different pressure conditions. Increase of pore pressure will decrease the Vp and Vs linearly. Conversely, the increase of overburden pressure will linearly increase the Vp and Vs. The Vp-Vs gradient change resulting from the change of pore pressure is bigger than the change due to overburden pressure.

11. AVO class cross-plot analysis shows that the type of carbonate AVO is class III. However, brine and gas condition cannot be discriminated using AVO intercept and gradient since their values are overlapped.