Effects of Pore Fluid on Seismic and Elastic Properties of Reservoir Rock of Injra-01 Western Potwar, Pakistan

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Abstract

The Potwar Sub-basin holds large volumes of sandstone reservoirs that presenting a wide range of porosity and permeability characteristics. Based on seismic interpretation, Injra-1 was drilled in Jurassic formations. Although, some oil and gas shows encountered but the well was declared abandoned due to lack of reservoir character. A rock physics model is used to study reservoir character and the effect of pore fluid on the seismic and elastic properties of the reservoir rock. We observed that pore fluids strongly influence the seismic properties of fluid saturated rocks. The densities, bulk modulus and velocities of pore fluid vary with composition, pressure and temperature. We used a combination of thermodynamic relationships, empirical trends, new and published data to examine the effects of pressure, temperature and composition on these important seismic properties of gases, oil and brines. We believe that in-situ conditions and pore fluid composition yield more accurate values of these fluid properties than were typically assumed.

The densities and bulk modulus of oil and gas increase with the increase in molecular weight and pressure and decrease with temperature. Higher gases have greater densities, velocities and moduli as compare to lighter gases. As a result, the sound wave velocities in fluids and ‘P’ and ‘S’ wave velocities in the reservoir rock also increase with pressure and decrease with temperature. In lighter gases, we estimate that gas to oil ratio also increases with increase in pressure. The results drawn in this work may facilitate to the seismic interpretations to minimize the risk of drilled dry holes and enhance to hydrocarbon discovery. The bulk modulus, density and velocity in light gas and light oil increases with pressure at constant temperature. In case of water and brine, bulk modulus, densities and velocities are also directly proportional to pressure. Brine has higher values of observed physical properties at same temperature and pressure, as compared to fresh water. At constant temperature, pressure and water saturation, increase in saturation of gas decreases the bulk modulus, effective density and P-wave velocities of fluid whereas the S-wave velocity increases with gas saturation.