Controlling Factors on Pressure-Velocity Relations in Shale Gas Reservoirs

Jingyi Guo, Adewale Amosu, Min Li, Yuefeng Sun
Texas A&M University

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Abstract

Understanding of pore pressure formation in shale is very important for shale gas exploration and production. Acoustic properties have been used for reservoir pressure estimation, which is however influenced by many factors, such as mineralogy, porosity and pore structure, in addition to pressure. From laboratory acoustic measurements under pressure, we investigated the major factors controlling elastic velocities in dry samples from marine shale formations in Sichuan Basin, China. Clay (mostly illite), quartz and calcite are three dominant minerals in the studied datasets consisting of more than 70 samples with a range of porosity from 1% to about 20%. Velocity measured on all samples increases with pressure from 10 to 55 MPa. Kerogen has similar density and acoustic properties to pore fluid. For a given pressure, velocity decreases as a combined factor of porosity and TOC content increases. In the porosity range of 1-6% with a similar TOC content, samples with high calcite content have highest acoustic velocity; samples with high clay content have relatively lower velocity than calcite-dominated shale samples; and the acoustic velocity is lowest in high quartz-content samples which also have high TOC content in the studied depositional environment. Pore structure strongly controls acoustic velocity variation with pressure. Both compressional and shear velocities increase more sharply with pressure in samples containing micro-crack than others, since pores with low aspect ratio in low-porosity rock samples are very sensitive to pressure changes and close first as pressure increases. The result shows great influence of rock properties on acoustic velocity variations with pressure. Rock physics models could be further used to better estimate pore pressure with a good knowledge of relationships

between mineralogy, porosity/TOC content and pore structure in shale gas reservoirs.

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