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Q factor of elastic wave propagating in poroelastic medium

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Sonic logging has been widely used for many years to understand physical properties of hydrocarbon reservoirs. For understanding the reservoir characteristic, quality factor based on the Biot's equation is often used. Although the Biot theory considers viscous attenuation induced at the interface between rocks and pore fluids, intrinsic attenuation caused by internal friction in the matrix is ignored. In the present study, we first hypothesized that the effect of the intrinsic attenuation could influence the evaluation of pore fluid properties, i.e., reservoir properties, based on the quality factor. We employ a 2D finite-difference scheme to simulate seismic wave propagation in a poroelastic medium for the confirmation of the hypothesis. The intrinsic attenuation is included in our model by using the filter of frequency-independent quality factor (constant-Q). We compare the results with and without the intrinsic attenuation in our numerical simulations. Our results clearly show that the amplitude and phase of the waveforms are strongly influenced by the intrinsic attenuation, and the calculated quality factors could be seen shifted to show different value from the real value derived from the Biot theory. We conclude that the evaluations of hydrocarbon reservoir based on the quality factor might require the inclusion of the intrinsic attenuation as well as the viscous attenuation.

Keywords: quality factor, poroelastic medium, constant-Q, intrinsic attenuation, viscous attenuation