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塩水粘性が超音波伝播減衰に及ぼす影響
Effect of brine viscosity on ultrasonic wave attenuation

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Seismic attenuation is a highly variable physical parameter that depends on confining pressure, porosity, degree of fluid saturation, and variations in fluid properties such as elastic modulus, viscosity, and polarity. In our previous paper, we used partially frozen brine as a solid-liquid coexistence system to investigate seismic attenuation phenomena. Ultrasonic wave transmission measurements on this ice-brine coexisting system were conducted to examine the influence of unfrozen brine in the pore microstructure of ice on ultrasonic waves. From liquid phase to around the freezing point, the presence of a partially frozen brine increases both velocity and attenuation. During the growth of ice from brine, salt cannot incorporate into the ice crystals. As the ice freezes, the salt is rejected and concentrates in the brine; thus, as the salinity increases in the brine filled pores, the freezing point of the remaining fluid is successively lowered and furthermore the viscosity of remaining high salinity unfrozen brines becomes larger and larger. Seismic attenuation related to viscous effect is caused by relative fluid-solid motion is one of the most important attenuation mechanisms. This paper is concerned with the effect of such viscosity on attenuation at ultrasonic frequencies. We observed the variations of a transmitted wave, changing its salinity and quantitatively estimated attenuation for unconsolidated porous material saturated with brine by considering different distances between the source and receiver transducers. The waveform analyses for P-waves indicate that the attenuation increases with increasing salinity (i.e. increasing viscosity). In order to elucidate the physical mechanism responsible for ultrasonic wave attenuation measured at different salinity (i.e. different viscosity), we employ a poroelastic model based on the Biot theory to describe the propagation of ultrasonic waves through partially frozen brines.

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