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An Experimental Study on the Influence of Fluid Saturation on the Attenuation Coefficient of the First Dilatational Wave in Standard Sand Saturated by an Oil-Water Mixture

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Nonaqueous phase liquids trapped in subsurface aquifers can pose a serious long-term contamination threat to groundwater resources. Efficient mapping of these liquids continues to be a challenging problem in environmental protection and aquifer remediation. The changes in dilatational wave signature due to the properties of the pore fluids have been demonstrate to be able to provide qualitative clues in the use of seismic methods to explore the location and type of NAPLs in shallow unsaturated subsurface zones. An experimental study was conducted to detect the variations in attenuation coefficient of the first dilatational wave with respect to different fluid saturations in standard sand containing two immiscible fluids, oil and water. Our experimental result indicates that the attenuation coefficient has a positive relation with excitation frequency in the range from 1000 to 4000 kHz. It was also found that the attenuation coefficient decreases with an increase in water saturation to attain a minimum value around 80% of saturation degree and then increases with an increase in water saturation, the qualitative tendency of which is in a good agreement with the results obtained by solving the dispersion relation we derived from the two-fluid theory of poroelasticity.