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南海トラフ音波検層波形データにおける散乱減衰の評価

Estimation of scattering attenuation using sonic log waveforms at Nankai Trough

鈴木 博之[1*], 松島 潤[1]

Hiroyuki Suzuki[1*], Jun Matsushima[1]

[1]東京大学大学院工学系研究科

[1]The University of Tokyo

Methane hydrates (MHs) that form in marine sediments at water depths greater than a few hundred meters are naturally occurring ice-like crystalline solids composed of methane molecules surrounded by water molecules. Several authors have estimated the amount of MH from seismic velocity data, as MH within sediment pore space stiffens the sediment and results in an increase in seismic velocity. Although seismic velocity is potentially a useful indicator of MH concentration, seismic velocity is also strongly controlled by the microscale MH distribution in pore spaces.
While the presence of MH increases the seismic velocity of the host sediment, recent work on sonic logging data shows that sonic waveforms are also significantly affected by the presence of MH. Recent seismic surveys have shown that the presence of MH in sediments has significant influence on seismic attenuation. The combined use of velocity and attenuation data provides greater insight into the MH-bearing sediments. And, seismic attenuation can be conveniently separated into intrinsic attenuation and scattering attenuation. Scattering attenuation is the diminution in the amplitude of a seismic wave caused by the scattering of energy from a propagating pulse by heterogeneities in the medium of propagation. The mechanism of scattering attenuation is very different from the mechanism of intrinsic attenuation. In the scattering attenuation case, energy is only redistributed to other parts of the wavefield. Scattering attenuation needs to be separated from total attenuation for precise estimation of attenuation value.
The purpose of this study is to isolate intrinsic attenuation from total attenuation at Nankai Trough area for more accurate estimation of seismic attenuation to find the methane hydrate-bearing sediments. Using methods suggested by Kurkjian and Cheang (1986) and Lerche and Menke (1986), we calculated the scattering effect on attenuation and compared them.
Firstly, we estimated total attenuation at Nankai Trough area. The method to be applied for estimating attenuation in this study was the median frequency shift method.
Attenuation can be expressed as the loss of strain energy or wave amplitude in one cycle of waves oscillation. It is a function of frequency, or of the wave number, and is usually represented by the Q factor. Applying a concept of median frequency shift to the amplitude spectrum of the recorded waveforms, we can calculate the attenuation of the formation. Because it depends on an arbitrary reference, the resulting values represent the attenuation relative to this reference. We verified the median frequency shift method by comparing two different correction methods using synthetic sonic waveform data.
Secondly, we calculated scattering attenuation using two methods. One method is the inversion

method suggested by Menke and Dubbendorff (1985). Another is the frequency-wavenumber integration method suggested by Kurkjian and Chang (1986).
To use the inversion method suggested by Menke and Dubbendorf (1985), we assume the total attenuation factors to be linear combinations of the scattering and intrinsic attenuation factors. After introducing some assumptions to these relationships, we can estimate the scattering attenuation and isolate the intrinsic attenuation.
Using the frequency-wavenumber integration method suggested by Kurkjian and Chang (1986), we can calculate synthetic data. To calculate synthetic data, we use a complex velocity with various enhancements such as causal attenuation, complex frequencies, and Filon integration. We estimated scatter attenuation using two methods and compared them.