On the mechanism of sonic compressional velocity increase due to gas

Takahito Banno[1]; Kyosuke Onishi[1]; Tada-nori Goto[1]; Hitoshi Mikada[1]

[1] Kyoto Univ.

1.Background and Objective

The results of seismic exploration in the Nankai Trough suggest the evidence of free gas beneath the Buttom Simulating Reflector (BSR). Although it is possible to prospect existence of the free gas by using the crossplot between Vp/Vs and P-wave slowness (Brie.1997), some cases show abnormal tendency beneath the BSR in the compressional sonic velocity in the free gas zone (Mikada et al .2008). In order to explain the cause of this abnormal tendency, and to discuss the existence of the free gas in the formations, we made a bubble model in which the formation water includes bubbles.

2.Logging Interpretation in the Nankai Trough

From the logging data in Nankai Trough, we recognized the methane hydrate concentrated zone. In addition, we found the feature of free gas formation in the crossplot that Vp/Vs ratio distribute in the lower right of the wet sand line. On the other hand, we also found abnormal distribution of Vp/Vs values in the left upper of the wet sand line.

3.Frequency Dependence of the Formation Compressional Velocity Caused by Bubbles

We assume the bubble model based on the hypothesis that this abnormality is caused by bubbles in the formation water. Commander and Prosperetti(1988) derived the frequency dependence of compressional sonic velocity of the formation which contains bubbles in formation water. They used the Keller's equation which describes the radial oscillation of the bubble in liquid. On the basis of their theory, we derived the compressional velocity of pore water with bubbles. Combining the estimated velocity of pore water and that of the formation matrix by using Wyllie's time-average equation, we derived the compressional velocity of formation with bubbles.

4.Result and Analysis

We confirmed the increase of the compressional velocity of the formation containing bubbles could take place. The compressional sonic velocity begins to increase when the frequency becomes higher than the bubble resonant frequency. Under the condition with bubble radius of 0.5mm, void fraction of 1% and porosity of 35%, the compressional wave velocity increases c.a. 1.2 times than that of bubble-free formation. So, we can explain the compressional wave velocity increases of sonic logging that was c.a. 1.2 times than that of normal free gas formation.

5.Conclusion

In this study, we interpreted the logging data in Nankai Traugh, and explained the cause of the high Vp/Vs abnormality in the free gas formation by using the bubble model. Hereafter, we will study the possibility of estimation of gas saturation in condition that Vp/Vs ratio from logging data increases are observed in the free gas formation.

References

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