WELL LOG ANALYSIS FOR METHANE HYDRATE SATURATION EVALUATION: HIGH-RESOLUTION AND ROCK PHYSICS

Abstract:

Evaluation of formation petrophysical property is an essential work for any type of reservoir characterization including methane hydrate (MH) reservoirs. The conventional workflow is sometimes difficult to apply in MH formations because of the unique characteristics of MH deposition. Archie's law with a resistivity measurement has been widely used, and a method based on nuclear magnetic resonance (NMR) is another well-known approach for MH saturation evaluation. However, there is always uncertainty stemming from the limited vertical resolution and the quality of measurement due to the borehole conditions. Here, we demonstrate evaluating MH saturation in a study area using two other approaches: 1) formation resistivity derived from a borehole image log to understand MH saturation in high-resolution and 2) formation sonic log based on the rock physics model.

MH formation reservoirs are composed of fine-grained, thinly bedded, silty sandstone and siltstone, which were deposited in a turbidite setting in the study area. The conventional resistivity log is affected by the thickness of formation layers, which is lower than the vertical resolution of the logging tool measurements. To overcome this challenge, we derived a high-resolution formation resistivity log from the processed borehole image log and succeeded in precisely evaluating MH saturation of each layer. The result showed higher MH saturation in thinly bedded formation and consistent result in the relatively thick formation compared to the result from conventional resistivity log.

The acoustic property of MH is faster than that of the formation fluid because MH is deposited as ice-like hydrocarbon under in-situ conditions. Thus, the sonic well log shows a relatively fast signal where MH is deposited. Several rock physics models have been proposed for MH formation in past studies. In this study, we used the simplified three-phase Biot-type equation with a sonic log to evaluate MH saturation, and the results are comparable to the MH saturation computed by the conventional resistivity log. This result will be a key input for the further seismic-scale rock physics study.

Bio:

Yuki Maehara is a Senior Petrophysicist with Schlumberger based in Tokyo, Japan. He joined Schlumberger in 2012 as a Petrophysicist and has been leading log analysis consulting projects and drilling business in Japan since 2016. He holds a Bachelor of Science from Tokyo Institute of Technology and Masters in geophysics from The University of Tokyo in Japan. He serves as the vice president of membership of JFES-SPWLA from 2019.