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Physical property analyses using pressure cores recovered from the Ulleung Basin, East Sea, Korea

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Natural gas hydrates dissociate rapidly when they are recovered using conventional cores due to the depressurization during recovery. Pressure coring technology enables the recovery of natural gas hydrate-bearing sediments at near in-situ pressures. During the Second Gas Hydrate Drilling Expedition in the Ulleung Basin (UBGH2), pressure cores were successfully recovered from the Ulleung Basin, East Sea, Korea. Successfully recovered pressure cores were scanned to obtain for X-ray images, gamma density, and P-wave velocity. The sediments could be categorized into four groups according to the hydrate occurrences and sediment type: 1) mud without hydrates, 2) sand without hydrates, 3) mud with grain-displacing hydrates, and 4) sand with pore-filling hydrates.

The P-wave velocities generally increase with increasing bulk density in sediments, and both specimens without hydrates show such trends between the bulk density and the P-wave velocity. However, mud with grain-displacing hydrates show a reversed bulk density-P-wave velocity relationship. Gas hydrates push the sediment grains, when grain-displacing hydrates form, resulting in a lower bulk density [1]. Consequently, in regions with grain-displacing hydrates, sediments with higher hydrate saturations exhibit lower bulk density and higher P-wave velocity, showing a reversed density-P-wave velocity relation. In pore-filling hydrate-bearing sands, the P-wave velocity is mostly governed by hydrate saturation and shows minor trends with bulk density due to the small density difference between hydrate and pore water that hydrates are displacing.

The P-wave velocity trend with hydrate saturations for pore-filling hydrates follows pore-filling model at low hydrate saturations and gradually deviates from pore-filling model toward cementation model as hydrate saturation increases [2]. These models are applicable to homogeneous hydrate distribution within pores and are not suitable for modeling grain-displacing hydrates although grain-displacing hydrates more or less follows pore-filling model and Biot-Gassmann type model.

References:

[1] Lee J. Y. et al. (2013) Mar. Pet. Geol. 47: 85-98
[2] Lee J. Y. et al. (2010) J. of Geophys. Res. 115, B11105, doi:10.1029/2009JB006670.