Pore Size Distribution and Methane Equilibrium Conditions at Walker Ridge Block 313, northern Gulf of Mexico

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Coexistence of three methane phases (liquid (L), gas (G), hydrate (H)) in marine gas hydrate systems may occur according to in-situ pressure, temperature, salinity and pore size. In sediments with salinity close to seawater, a discrete zone of three-phase (3P) equilibrium may occur near the base of the regional hydrate stability zone (RHSZ) due to capillary effects. The existence of a 3P zone influences the location of the bottom-simulating reflection (BSR) and has implications for methane fluxes at the base of the RHSZ. We studied hydrate stability conditions in two wells, WR313-G and WR313-H, at Walker Ridge Block 313 in the northern Gulf of Mexico. We determined pore size distributions (PSD) by constructing a synthetic nuclear magnetic resonance (NMR) relaxation time distribution. Correlations were obtained by non-linear regression on NMR, gamma ray, and bulk density logs from well KC-151 at Keathley Canyon. The correlations enabled construction of relaxation time distributions for WR313-G and WR313-H, which were used to predict PSD through comparison with mercury injection capillary pressure measurements. With the computed PSD, L+H and L+G methane solubility was determined from in-situ pressure and temperature. The intersection of the L+G and L+H curves for various pore sizes allowed calculation of the depth range of the 3P equilibrium zone. As in previous studies at Blake Ridge and Hydrate Ridge, the top of the 3P zone moves upwards with increasing water depth and overlies the bulk 3P equilibrium depth. In clays at Walker Ridge, the predicted thickness of the 3P zone is approximately 35 m, but in coarse sands it is only a few meters due to the difference in absolute pore sizes and the width of the PSD. The thick 3P zone in the clays may explain in part why the BSR is only observed in the sand layers at Walker Ridge, although other factors may influence the presence or absence of a BSR.