Gas Hydrate Concentration Estimates in the Krishna-Godavari Basin from Electrical Resistivity and P-wave Velocity Logs, India NGHP Expedition-01

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During the India National Gas Hydrate Program (NGHP) Expedition 01, a series of Logging-while-Drilling (LWD) and conventional wire-line logs were acquired at several sites across the Krishna-Godavari (KG) Basin. Several approaches exist, each making specific assumptions with respect to how gas hydrate forms in sediment pore space. The preferred methods are effective porosity reduction, using a no-hydrate reference velocity (an empirical approach), and effective medium modeling using a gas hydrate in-frame rock physics model. Uncertainties in the effective porosity reduction approach are related are mainly from the calibration of the porosity-velocity relation, whereas uncertainties in the effective medium modeling stem from the choice of mineral assemblage used in the model. For both methods, the mode by which gas hydrate forms in sediment pore space represents a significant uncertainty. In this study we utilize porosity logs (neutron, density-porosity), electrical resistivity, P- and S-wave velocity logs to compute gas hydrate concentrations for selected sites. Standard Archie analyses are used (Picket Plots) to estimate concentrations from electrical resistivity. The measured in situ pore-water salinity and geothermal gradients are used to determine the baseline pore-water resistivity. P-wave and S-wave velocities are also used to estimate gas hydrate concentrations through comparison with trends determined using the effective medium rock-physics modeling. Combined observations from these analyses show that gas hydrate concentrations are overall relatively low (< 10% of the pore space) in the sites of the KG Basin analyzed. However, several intervals of increased concentrations were observed e.g. at Site NGHP-01-05 (Sh=35-40% in two discrete zone between 70 and 90 mbsf), and Site NGHP-01-03 (Sh=15-20%, in two zones between 168 and 198 mbsf). These log-analyses are then used to perform seismic impedance inversions of seismic profiles crossing the drill sites. The impedance inversion allows lateral extrapolation of the log-data with careful calibration of the seismic data through synthetic seismogram generation and depth-matching of key horizons.

Keywords: Gas hydrates; Krishna Godavari Basin; electrical resistivity log; Archie analysis; P-wave velocity logs; effective medium modeling; seismic inversion.