Estimating Gas-hydrate in Fractured Shale in Krishna-godavari Basin of Eastern Indian Offshore Using Effective Medium Modeling of Sonic Velocity

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The Indian National Gas Hydrate Program Expedition-01 has established one of the richest gas hydrate deposits in the clay-rich marine sediment of Krishna-Godavari (KG) basin in the eastern Indian margin. The pressure cores and resistivity at-bit images exhibit different morphologies of gas hydrate, which varies from complex vein structures (grain-displacing) to invisible pore-filling. The available rock physics models assume isotropic pore-filling gas hydrate and thus mislead the estimation of gas hydrate present in fractured sediments. The anisotropic behavior of sediment in the KG basin provides additional complication. First time, we apply the differential effective medium theory to incorporate grain-displacing morphologies by which gas hydrate is included as vertical ellipsoids with aspect ratios from thin veins to nodules in an elastic anisotropic background. The results from sonic velocities at one hole in the KG basin show the saturations of gas hydrate in the depth range from 60 to 140 meters below sea floor (mbsf) as 35-42, 27-30 and 33-41% of total porosity for three different basic morphologies of gas hydrate such as (i) pore-filling, (ii) grain-displacing and (iii) combination of grain-displacing and pore-filling, respectively. The saturation is highest at ~67 mbsf for any morphology but the estimations differ between morphologies. For pore-filling morphology, the maximum (56%) gas hydrate saturation is 18-22% higher than that of grain-displacing morphology and 2-9% higher than that of the combined morphology.

Keywords: Gas-hydrates; saturations; effective medium modeling; Krishna-Godavari basin