

## Three-phase stability in hydrocarbon vents around the world

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The formation of methane hydrate is dependent upon the in situ temperature, pressure and salinity. Within the pore space of subsurface sediments, pressure and temperature are relatively constant, but, as hydrate forms, the in situ salinity increases significantly. These elevated salinities in hydrocarbon vents around the world result in three-phase stability conditions where water, methane gas, and methane hydrate can co-exist. When a system reaches three-phase stability no more hydrate can form and incorporate gas into its structure. This creates a system where free gas can migrate through the regional hydrate stability zone (RHSZ) and produce hydrocarbon venting.

This study processed resistivity and moisture and density (MAD) data from sites where hydrate was present and used an iterative application of Archie's law to infer the in situ hydrate saturation and salinity. The conditions required for three-phase stability was then determined for each site through the comparison of output molalities from methane gas and methane hydrate equilibrium models.

At ODP Site 1249, taken at Hydrate Ridge, the elevated in situ salinities were directly correlated to increased hydrate saturation. Also, between 15 – 50 meters below seafloor (mbsf), the salinities were greater than or equal to those necessary for three-phase stability, indicating that the system is at equilibrium. The preliminary analysis of the other locations suggests that many methane hydrate systems are at three-phase equilibrium as well.

**Keywords:** methane hydrate, hydrate stability, hydrate saturation, archie's law, free gas migration