

Evaluation of Heat Induced Methane Release from Methane Hydrates. J.R. Leeman¹, M.E. Elwood Madden¹, T.J. Phelps², C.J. Rawn², ¹School of Geology and Geophysics, University of Oklahoma 100 E Boyd, Norman, OK, melwood@ou.edu ² Oak Ridge National Laboratory, Oak Ridge, TN

Clathrates, or gas hydrates, structurally are guest gas molecules populating a cavity in a cage of water molecules. Gas hydrates naturally occur on Earth under low temperature and moderate pressure environments including continental shelf, deep ocean, and permafrost sediments. Large quantities of methane are trapped in hydrates, providing significant near-surface reserves of carbon and energy. Thermodynamics predicts that hydrate deposits may be destabilized by reducing the pressure in the system or raising the temperature. However, the rate of methane release due to varying environmental conditions remains relatively unconstrained and complicated by natural feedback effects of clathrate dissociation.

In this study, hydrate dissociation in sediment due to localized increases in temperature was monitored and observed at the mesoscale (>20L) in a laboratory environment. Experiments were conducted in the Seafloor Process Simulator (SPS) at Oak Ridge National Laboratory (ORNL) to simulate heat induced dissociation. The SPS, containing a column of Ottawa sand saturated with water containing 25mg/L Sno-Max to aid nucleation, was pressurized and cooled well into the hydrate stability field. A fiber optic distributed sensing system (DSS) was embedded at four depths in the sediment column. This allowed the temperature strain value (a proxy for temperature) of the system to be measured with high spatial resolution to monitor the clathrate formation/dissociation processes. A heat exchanger embedded in the sediment was heated using hot recirculated ethylene glycol and the temperature drop across the exchanger was measured. These experiments indicate a significant and sustained amount of heat is required to release methane gas from hydrate-bearing sediments. Heat was consumed by hydrate dissociated in a growing sphere around the heat exchanger until steady state was reached. At steady state all heat energy entering the system was consumed in maintaining the temperature profile in the sediment. Only when the temperature of the heat exchanger was further increased were more hydrates dissociated. Cessation of heat resulted in hydrate formation within minutes and over several hours the vessel overpressure decreased to values lower than those observed prior to heating, indicating enhanced hydrate accumulation.

These results suggested that significant heating of the sediment must occur before gas hydrates begin releasing methane into the atmosphere. Hybrid production methods that simultaneously increase temperature and decrease pressure are likely needed to effectively exploit gas hydrate energy reserves. Results also suggested that heating only influences hydrate close to the heat source and to dissociate hydrate far from the heat exchanger likely requires large amounts of heat energy scaling at best with the square of the distance. Further analysis of distributed sensing data will likely yield insight to hydrate formation/dissociation pathways and better characterize the steady state system.

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