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Isotope fractionation during natural gas hydrate formation

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In the task of pursuing the origin of hydrate-bound gas, isotope analysis is a well established tool of prediction. The carbon isotope values of methane, ethane, propane and i-butane will strongly indicate the source to either be microbial, thermogenic or of mixed origin. This is due to kinetic fractionation during microbial activity. In microbial CO_2 reduction, the microbes tend to reduce δ^{12}C molecules preferentially to δ^{13}C. This leads to light methane and ethane in the gas from microbial activity compared to methane and ethane of thermogenic origin.

Recently, isotopically light methane and ethane from hydrate-bond gas from the pockmark field of Nyegga (Norwegian Sea) has been reported. The gas has migrated from a free gas system beneath the base of gas hydrate stability and reached the seafloor through a chimney structured migration feature. The free gas layer is thought to be supported by deeper sources, and polygonal faulting that is known to lay on top of petroleum reservoirs supports speculations that the free gas layer contains thermogenic gas. The isotopic evidence classifies the hydrate gas as fractionated by microbial activity, while the composition and geological setting tell tales of a thermogenic source. This conundrum has led to the speculation upon a fractionation of carbon isotope through hydrate formation.

With an experimental setup consisting of a cooling incubator and a pressure cell with controlled torque stirring, hydrates can form under controlled pressure and temperature conditions. The gas hydrates are formed with excess of gas making it possible to sample both the excess gas and hydrate gas. The gas is 99.5 % methane, $<$200 ppm C_{2+} and $<$200 ppm N_2. Gas samples are taken from gas hydrate when; 1) the formation is continuous at the face boundary, and; 2) well inside the hydrate envelope in the pressure temperature phase diagram.

This setup can either constrain the possible fractionation scenarios and lead to more distinctive interpretation of some specific migration settings, or give new insights to the carbon isotope fractionation as a proxy of light hydrocarbon origin delimiter. Isotope analyses are in progress and will be presented in EGU displaying the fractionation of carbon isotopes in hydrate formation.