

The assessment of different production methods for hydrate bearing sediments – results from small and large scale experiments

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Natural gas hydrates occur at all active and passive continental margins, in permafrost regions, and deep lakes. Since they are supposed to contain enormous amounts of methane, gas hydrates are discussed as an energy resource. For the production of gas from hydrate bearing sediments, three different production methods were tested during the last decade: depressurization, thermal and chemical stimulation as well as combinations of these methods.

In the framework of the SUGAR project we developed a Large Scale Reservoir Simulator (LARS) with a total volume of 425L to test these three methods in a pilot plant scale. For this purpose we formed hydrate from methane saturated brine in sediments under conditions close to natural gas hydrate deposits. The obtained hydrate saturations varied between 40-90%. Hydrate saturation and distribution were determined using electrical resistivity tomography (ERT). The volumes of the produced gas and water were determined and the gas phase was analyzed via gas chromatography. Multi-step depressurization, thermal stimulation applying in-situ combustion as well as chemical stimulation via the injection of CO₂ and a CO₂-N₂-mixture were tested. Depressurization and thermal stimulation appear to be less complicated compared to the chemical stimulation.

For the understanding of the macroscopically observed processes on a molecular level, we also performed experiments on a smaller scale using microscopic observation, Raman spectroscopy and X-ray diffraction. The results of these experiments are of particular importance for the understanding of the processes occurring during the CO₂-CH₄ swapping. Under the chosen experimental conditions the observations indicate a (partial) decomposition and reformation of the hydrate structure rather than a diffusion-controlled exchange of the molecules.