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Combining CO_2 sequestration and CH_4 production by means of guest exchange in a gas hydrate reservoir: two pilot scale experiments

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Methane (CH_4) hydrates are considered as a player in the field of energy supply and – if applied as such – as a possible sink for the greenhouse gas carbon dioxide (CO_2). Next to the more conventional production methods depressurization and thermal stimulation, an extraction of CH_4 by means of CO_2 injection is investigated. The method is based on the chemical potential gradient between the CH_4 hydrate phase and the injected CO_2 phase. Results from small-scale laboratory experiments on the replacement method indicate recovery ratios of up to 66% CH_4 but also encounter major discrepancies in conversion rates. So far it has not been demonstrated with certainty that the process rates are sufficient for an energy and cost effective production of CH_4 with a concurrent sequestration of CO_2.

In a co-operation of GFZ and GEOMAR we used LARS (Large Scale Reservoir Simulator) to investigate the CO_2-CH_4-replacement method combined with thermal stimulation. LARS accommodates a sample volume of 210 l and allows for the simulation of in situ conditions typically found in gas hydrate reservoirs. Based on the sample size, diverse transport mechanisms could be simulated, which are assumed to significantly alter process yields. Temperature and pressure data complemented by a high resolution electrical resistivity tomography (ERT), gas chromatography, and flow measurements serve to interpret the experiments.

In two experiments 50 kg heated CO_2 was injected into sediments with CH_4 hydrate saturations of 50%. While in the first experiment the CO_2 was injected discontinuously in a so called “huff’n puff” manner, the second experiment saw a continuous injection. Conditions within LARS were set to 13 MPa and 8°C, which allow for stability of pure CO_2 and CH_4 hydrates as well as mixed hydrates. The CO_2 was heated and entered the sediment sample with temperatures of approximately 30° C. In this presentation we will discuss the results from the large-scale experiments and compare them with data from small-scale experiments.