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Numerical simulation of gas hydrate exploitation from subsea reservoirs in the Black Sea

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Natural gas (methane) is the most environmental friendly source of fossil energy. When coal is replace by natural gas in power production the emission of carbon dioxide is reduced by ∼50 %. The vast amount of methane assumed in gas hydrate deposits can help to overcome a shortage of fossil energy resources in the future. To increase their potential for energy applications new technological approaches are being discussed and developed worldwide. Besides technical challenges that have to be overcome climate and safety issues have to be considered before a commercial exploitation of such unconventional reservoirs.

The potential of producing natural gas from subsea gas hydrate deposits by various means (e. g. depressurization and/or carbon dioxide injection) is numerically studied in the frame of the German research project »SUGAR - Submarine Gas Hydrate Reservoirs«. In order to simulate the exploitation of hydrate-bearing sediments in the subsea, an in-house simulation model HyReS which is implemented in the general-purpose software COMSOL Multiphysics is used. This tool turned out to be especially suited for the flexible implementation of non-standard correlations concerning heat transfer, fluid flow, hydrate kinetics, and other relevant model data. Partially based on the simulation results, the development of a technical concept and its evaluation are the subject of ongoing investigations, whereby geological and ecological criteria are to be considered.

The results illustrate the processes and effects occurring during the gas production from a subsea gas hydrate deposit by depressurization. The simulation results from a case study for a deposit located in the Black Sea reveal that the production of natural gas by simple depressurization is possible but with quite low rates. It can be shown that the hydrate decomposition and thus the gas production strongly depend on the geophysical properties of the reservoir, the mass and heat transport within the reservoir, and the model settings. In particular, the permeability and the available heat, which is required to decompose the hydrate, play an important role. The work is focused on the thermodynamic principles and technological approaches for the exploitation.