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Simulation of subsea gas hydrate exploitation

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The recovery of methane from gas hydrate layers that have been detected in several subsea sediments and permafrost regions around the world is a promising perspective to overcome future shortages in natural gas supply. Being aware that conventional natural gas resources are limited, research is going on to develop technologies for the production of natural gas from such new sources. Thus various research programs have started since the early 1990s in Japan, USA, Canada, India, and Germany to investigate hydrate deposits and develop required technologies.
In recent years, intensive research has focussed on the capture and storage of CO_2 from combustion processes to reduce climate impact. While different natural or man-made reservoirs like deep aquifers, exhausted oil and gas deposits or other geological formations are considered to store gaseous or liquid CO_2, the storage of CO_2 as hydrate in former methane hydrate fields is another promising alternative. Due to beneficial stability conditions, methane recovery may be well combined with CO_2 storage in the form of hydrates. Regarding technological implementation many problems have to be overcome. Especially mixing, heat and mass transfer in the reservoir are limiting factors causing very long process times.
Within the scope of the German research project »SUGAR« different technological approaches for the optimized exploitation of gas hydrate deposits are evaluated and compared by means of dynamic system simulations and analysis. Detailed mathematical models for the most relevant chemical and physical processes are developed. The basic mechanisms of gas hydrate formation/dissociation and heat and mass transport in porous media are considered and implemented into simulation programs.
Simulations based on geological field data have been carried out. The studies focus on the potential of gas production from turbidites and their fitness for CO_2 storage. The effects occurring during gas production and CO_2 storage within a hydrate deposit are identified and described for various scenarios. The behavior of relevant process parameters such as pressure, temperature and phase saturations is discussed and compared for different strategies: simple depressurization, simultaneous and subsequent methane production together with CO_2 injection.