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Simulation of natural gas production from submarine gas hydrate deposits combined with carbon dioxide storage

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The recovery of methane from gas hydrate layers that have been detected in several submarine sediments and permafrost regions around the world so far is considered to be a promising measure to overcome future shortages in natural gas as fuel or raw material for chemical syntheses. Being aware that natural gas resources that can be exploited with conventional technologies are limited, research is going on to open up new sources and develop technologies to produce methane and other energy carriers. Thus various research programs have started since the early 1990s in Japan, USA, Canada, South Korea, India, China and Germany to investigate hydrate deposits and develop technologies to destabilize the hydrates and obtain the pure gas.
In recent years, intensive research has focussed on the capture and storage of carbon dioxide from combustion processes to reduce climate change. While different natural or manmade reservoirs like deep aquifers, exhausted oil and gas deposits or other geological formations are considered to store gaseous or liquid carbon dioxide, the storage of carbon dioxide 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 form of hydrates. This has been shown in several laboratory tests and simulations - technical field tests are still in preparation.
Within the scope of the German research project »SUGAR«, different technological approaches are evaluated and compared by means of dynamic system simulations and analysis. Detailed mathematical models for the most relevant chemical and physical effects 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 like CMG STARS and COMSOL Multiphysics.
New simulations based on field data have been carried out. The studies focus on the evaluation of the gas production potential from turbidites and their ability for carbon dioxide storage. The effects occurring during gas production and CO_2 storage within a hydrate deposit are identified and described for various scenarios. The behaviour of relevant process parameters such as pressure, temperature and phase saturations is discussed and compared for different production strategies: depressurization, CO_2 injection after depressurization and simultaneous methane production and CO_2 injection.