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Numerical simulation of gas hydrate exploitation from subsea reservoirs

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Natural gas hydrates are considered to be a potential energy resource in the future. They occur in permafrost areas as well as in subsea sediments and are stable at high pressure and low temperature conditions. According to estimations the amount of carbon bonded in natural gas hydrates worldwide is two times larger than in all known conventional fossil fuels. 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 injection of carbon dioxide) is numerically studied in the frame of the German research project »SUGAR«. The basic mechanisms of gas hydrate formation/dissociation and heat and mass transport in porous media are considered and implemented into a numerical model. The physics of the process leads to strong non-linear couplings between hydraulic fluid flow, hydrate dissociation and formation, hydraulic properties of the sediment, partial pressures and seawater solution of components and the thermal budget of the system described by the heat equation.

This paper is intended to provide an overview of the recent development regarding the production of natural gas from subsea gas hydrate reservoirs. It aims at giving a broad insight into natural gas hydrates and covering relevant aspects of the exploitation process. It is focused on the thermodynamic principles and technological approaches for the exploitation.

Both the occurrence of natural gas hydrates and the production efficiency strongly depend on the geological setting of subsea sediments. The mechanisms occurring during natural gas production within hydrate filled sediment layers are identified and discussed by means of numerical simulation results. In a case study data from a site in the Black Sea has been used. The behaviour of relevant process parameters such as pressure, temperature and phase saturations will be shown. Based on the simulation results it can be shown that the hydrate decomposition and thus the gas production mainly depend on the mass and heat transport within the reservoir. In particular, the permeability and the available heat, which is required to decompose the hydrate, play an important role.