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Simulating the gas hydrate production test at Mallik using the pilot scale pressure reservoir LARS

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LARS, the LArge Reservoir Simulator, allows for one of the few pilot scale simulations of gas hydrate formation and dissociation under controlled conditions with a high resolution sensor network to enable the detection of spatial variations. It was designed and built within the German project SUGAR (submarine gas hydrate reservoirs) for sediment samples with a diameter of 0.45 m and a length of 1.3 m. During the project, LARS already served for a number of experiments simulating the production of gas from hydrate-bearing sediments using thermal stimulation and/or depressurization.
The latest test simulated the methane production test from gas hydrate-bearing sediments at the Mallik test site, Canada, in 2008 (Uddin et al., 2011). Thus, the starting conditions of 11.5 MPa and 11°C and environmental parameters were set to fit the Mallik test site. The experimental gas hydrate saturation of 90% of the total pore volume (70 l) was slightly higher than volumes found in gas hydrate-bearing formations in the field (70 – 80%). However, the resulting permeability of a few millidarcy was comparable. The depressurization driven gas production at Mallik was conducted in three steps at 7.0 MPa – 5.0 MPa – 4.2 MPa all of which were used in the laboratory experiments. In the lab the pressure was controlled using a back pressure regulator while the confining pressure was stable. All but one of the 12 temperature sensors showed a rapid decrease in temperature throughout the sediment sample, which accompanied the pressure changes as a result of gas hydrate dissociation. During step 1 and 2 they continued up to the point where gas hydrate stability was regained.
The pressure decreases and gas hydrate dissociation led to highly variable two phase fluid flow throughout the duration of the simulated production test. The flow rates were measured continuously (gas) and discontinuously (liquid), respectively. Next to being discussed here, both rates were used to verify a model of gas hydrate dissociation applying the foamy oil approach, a method earlier adopted to model the Mallik production test (see abstract Abendroth et al., this volume). Combined with a dense set of data from a cylindrical electrical resistance tomography (ERT) array (see abstract Priegnitz et al., this volume), very valuable information were gained on the spatial as well as temporal formation and dissociation of gas hydrates as well as changes in permeability and resulting pathways for the fluid flow.
Here we present the set-up and execution of the experiment and discuss the results from temperature and flow measurements with respect to the gas hydrate dissociation and characteristics of resulting fluid flow.

Uddin, M., Wright, F., and Coombe, D. 2011. Numerical Study of Gas Evolution and Transport Behaviours in Natural Gas-Hydrate Reservoirs. Journal of Canadian Petroleum Technology 50, 70-89.