Abstract

The prospects for gas production from methane hydrates have greatly improved since hydrate deposits were found to exist in sandy sediments. It encouraged numerous studies into gas hydrate resources with a view towards future production. A cost-effective method for investigating the geohazards and gas production quantities, is numerical simulation of gas hydrate production.

Heterogeneity is a very important feature of natural hydrate-bearing sediments. Both hydrate heterogeneity and turbidite formation, observed at Eastern Nankai Trough, influence not only gas productivity but also geomechanical behaviours. In previous research into simulating the large-scale geomechanical behaviour of hydrate-bearing sediments during gas production, the heterogeneity inside each numerical model element was homogenized by a simple averaging process (Rutqvist et al., 2009a; Uchida, 2012). Thus, the simulated results such as gas and water production, effective stresses, and displacement may not be sufficiently accurate to adequately represent the behaviour of heterogeneous hydrate-bearing sediments. Therefore, a more sophisticated numerical homogenization method for describing geomechanical behaviour was developed in this study.

This research contributed to four major advances in the geomechanical study of hydrate-bearing sediments with turbidite formation and hydrate heterogeneity : (1) homogenization methods of hydrate saturation, permeability profiles, and mechanical responses of the hydrate-bearing sediments were developed; (2) AMHCS-TH model was developed, which is capable of simulating the anisotropic mechanical behaviours of the hydrate-bearing sediments; (3) the developed homogenization method was used in the history matching simulations and demonstrated that the homogenization method can improve the accuracy of the numerical simulation results of the coarse mesh model; (4) numerical simulations of the randomly generated site formation were carried out to present the capability of the homogenization method for a randomly generated site formation and to demonstrate that even with information from only one existing site, many different site formations can be numerically simulated.