Geophysical Research Abstracts
Vol. 21, EGU2019-481-2, 2019
EGU General Assembly 2019

Development of shear stress in hydrate-bearing sand during direct shear tests

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In recent years gas hydrates have been in the focus not only of scientific but also of economic research as they are considered to be a potential source of energy. Production scenarios are being tested in the field as well as in laboratories. In addition to production efficiency, the possible effect of the presence of gas hydrates in sediments on slope stabilities is of major interest. The geo-mechanical parameters of hydrate-bearing sediments do not only concern gas hydrate production but also the increasing usage of the continental slope sediments in general, since gas hydrates occur in marginal sediments worldwide.
Shear stress is one of the geo-mechanical parameters of interest and there are a number of publications on selected laboratory and natural samples. However, systematic investigations to determine the dependencies of shear strength and hydrate saturation and/or effective stress, all of which influence the shear stress, are rare. This is based on small numbers of natural samples and difficulties in the formation of gas-free, hydrate-bearing sediments with high saturations and pore-filling character. This is due to small numbers of natural samples and difficulties in the formation of gas-free, hydrate-bearing sediments with high saturations and pore-filling character.
In the study presented here hydrate of pore-filling and load-bearing character was produced in water saturated sandy samples and examined for changes in shear stress, peak and residual shear strength using a ring shear test. The available external ring shear test rig (ESTER) was constructed and build at the GFZ to study shear stress, friction angle and cohesion in relation to hydrate saturation. The circular sample even allows for studies on the shear strength of healed hydrate-bearing sediments.
A series of tests were carried out on gas-free sands with hydrate saturations of 40 – 100%, clearly showing a non-linear dependency of the maximum shear strength on the hydrate saturation with a strong increase between 70-80%. Experiments on “healed” hydrate-bearing sediments did not reach comparable maximum shear strengths but reached values slightly above the original residual strength.