Submarine slides caused by gas hydrates – Sediments stress history as a key factor

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Submarine mega slides can be easily triggered by dissociating gas hydrates and therefore gas hydrates have been considered as a major geohazard causing tsunamis. Quality, plausibility, and transferability of numerical stability calculations of slopes are highly depending on the significance of the constitutive laws describing the sediments mechanical behavior. However, the mechanics of gas hydrate bearing sediments is poorly understood. But still more serious is the fact that no information is available concerning the basic controlling mechanism of the mechanical soil behavior, i.e. the stress history and the pore pressure regime of marine sediments which follow gas hydrate formation and decay.

To address this fundamental engineering geological circumstance, approaches have to keep strict mechanical boundary conditions as well as marine deep sea conditions. For experimental research a soil mechanical testing device GTS (Gas Hydrate Test System) was set up. GTS enables the generation and decomposition of gas hydrates under real marine conditions and simultaneously allows to measure the oedometric stress-strain-gas/water-pressure behaviour of the sediment. Experimental investigations, however, are rather time expensive. To broaden the insight into the mechanical interaction of gas hydrate and sediment, a numerically based virtual laboratory was created in parallel using the Distinct Element Method as a computation tool.

First real and virtual experiments were focussed on the stress history of sediment affected by growing of interstitial hydrates. The results show that the mechanical sediment reaction depends decisively on the surface energy of the gas hydrate - water surface and the time of the first formation of hydrate in the course of mechanical diagenesis. Furthermore the creep and yielding resistance of gas hydrate bearing sediment are considerably higher than the sediments resistance in the frozen state. Hence, the well known stress-strain behaviour of frozen soils cannot be transferred to gas hydrate bearing sediments.