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Gas hydrates and hydraulic overpressure: numerical modelling results from the Cascadia Margin

Feng Ding* (1), **Vikram Unnithan** (2), Volkhard Spieß (1)

(1)Universität Bremen, Germany (dingfeng@uni-bremen.de), (2)International University Bremen, Germany

Quite a few seismic, bathymetric and coring surveys in the Cascadia Margin have confirmed the presence of gas hydrates in the shallow subsurface (Shipboard Scientific Party, 1994; Tryon et al., 1999, 2002). Seismic data indicates the presence of free gas beneath the hydrate stability zone (Yuan et al., 1994), while pockmarks and active vent sites confirm the expulsion of free gas from the seabed (Zühlsdorff et al., 2004). This poster reports on the results obtained from numerical simulations and modelling of the generation of overpressure beneath and fracturing of a hydrate layer.

The modelling of hydraulic overpressure was carried out using the commercial basin modelling software PetroMod (IES GmbH). The models are 2D and their geometries were obtained from a 2D multichannel seismic profile (10 km across, 1.5 km thick), shot across a pockmark in the vicinity of ODP site 889/890. Thermal and hydrological data from this ODP drill were used to calibrate the models.

The modelling work assumes gas hydrate formation decreases permeability of the host sediments. This in turn can produce hydraulic overpressure inside or below the hydrate zone, and thus mechanically weaken the sediments by reducing their effective stress. Such process should be one of the candidate mechanisms for gas hydrate layer fracture and periodical gas discharge.

The results show that with sedimentation rate of 41.5 cm/kyr, sediment permeability of 0 log mD and gas hydrated sediment permeability of -1 log mD is assumed, the hydraulic overpressure in the sediment column is very small, far below the fracture threshold. A range of sedimentation rates, sediment permeability and hydrated sediment permeability values were used for model sensitivity testing. The results from these simulations show that even with rather rapid sedimentation rate (340 cm/kyr)

the influence of hydraulic overpressure is still rather limited. On the other hand, significant overpressure occurs when the permeability of the hydrated sediment is lower than a fixed value (-3.5 log mD). Regardless of the sediment permeability (tested -2.5 to 1 log mD), when the permeability of the hydrated sediment is set to be -3.5 log mD the hydraulic pressure reaches lithostatic (in spite of the fact that the hydrated sediment is fractured). If the hydrated sediment permeability is -3 log mD, hydraulic pressure is nearly hydrostatic. This result suggests that for this area, the hydration of sediment cannot reduce the sediment permeability over a fixed lower limit.

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