Geophysical Research Abstracts
Vol. 18, EGU2016-6664, 2016
EGU General Assembly 2016
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# Composite model to reproduce the mechanical behaviour of methane hydrate bearing soils

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Title: COMPOSITE MODEL TO REPRODUCE THE MECHANICAL RESPONSE OF METHANE HYDRATE BEARING SOILS

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Methane hydrate bearing sediments (MHBS) are naturally-occurring materials containing different components in the pores that may suffer phase changes under relative small temperature and pressure variations for conditions typically prevailing a few hundreds of meters below sea level. Their modelling needs to account for heat and mass balance equations of the different components, and several strategies already exist to combine them (e.g., Rutqvist & Moridis, 2009; Sánchez et al. 2014). These equations have to be completed by restrictions and constitutive laws reproducing the phenomenology of heat and fluid flows, phase change conditions and mechanical response. While the formulation of the non-mechanical laws generally includes explicitly the mass fraction of methane in each phase, which allows for a natural update of parameters during phase changes, mechanical laws are, in most cases, stated for the whole solid skeleton (Uchida et al., 2012; Soga et al. 2006).
In this paper, a mechanical model is proposed to cope with the response of MHBS. It is based on a composite approach that allows defining the thermo-hydro-mechanical response of mineral skeleton and solid hydrates independently. The global stress-strain-temperature response of the solid phase (grains + hydrate) is then obtained by combining both responses according to energy principle following the work by Pinyol et al. (2007). In this way, dissociation of MH can be assessed on the basis of the stress state and temperature prevailing locally within the hydrate component. Besides, its structuring effect is naturally accounted for by the model according to patterns of MH inclusions within soil pores.
This paper describes the fundamental hypothesis behind the model and its formulation. Its performance is assessed by comparison with laboratory data presented in the literature. An analysis of MHBS response to several stress-temperature paths representing potential field cases is finally presented.

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