Laboratoire
Génie Civil
et géo-Environnement
Lille Nord de France

Titre de la thèse : **The numerical approach of the multi-phase flow in methane hydrate-bearing sediment**	
Ecole Doctorale : X ED 72 SPI ☐ ED585 STS ☐ ED104 SMRE	
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Résumé:

Methane hydrates are solid compounds, found frequently in the marine sediment and the permafrost, formed by methane molecule trapped in water molecule cage. The stability of such formation depends on the pressure and temperature, and other parameters, such as the salinity in the marine environment. A shift from the stability conditions triggers hydrate dissociation and the release of methane in gaseous state, such as the decrease in pressure or the increase in temperature, which are the two classic methods used for the methane production. As one the most important potential energies in the future, the commercial recover technologies, however, yet need more scientific supports. The hydrate-bearing sediments play an essential role in the viable and reliable commercial production of methane gaseous. In fact, the hydrate dissociation, which transfers the stable solid structure to methane in gaseous state and water in liquid state, induce stress redistribution in the geoformation (i.e., marine sediments or permafrost) and thus trigger larger deformation in the sediments. As consequence, the large scale of landslide or subsidence, so as the tsunami are potential risks, which will induce the uncontrolled release of methane, the famous greenhouse gas, and will aggravate the global warming.

The production process concerns mainly the release the methane gas from the methane hydrates in the reservoir. The idea process keeps the stable water-molecule cage by replace the methane with other gas, such as the CO_2, with less perturbation on the geoformation. This method, however, is far away from maturation and expensive. The traditional methods, with the decrease of pressure or increase in temperature, are more efficient and cost-effective. With application of these methods, it is a strong thermo-hydro-mechanical coupling process in the reservoir geoformation, and the hydrate-bearing geomaterial could be regard as porous medias.

The proposed research focuses on the numerical approach on the multi-phase flow in the porous material under the fully thermo-hydro-mechanical coupling process, in the scenario of commercial gas production. The first part of the thesis consists of the state of arts of the numerical approaches on the porous media, with the accent on the phase change. Then, in the framework of porous media, the full coupled process in the marine sediment during the gas production will be analyzed and discussed, the essential parameters are then be identified. The third part is concentrated on the numerical approach on the multi-flow in the porous media with the methane hydrate. And the validation of the numerical approach with the laboratory tests should be followed. Finally, the numerical approach should be applicated in the scenario of the production site, for well understanding and parameter optimization, etc.

The candidate will conduct this research at Laboratory of Civil Engineering and geo-Environment (LGCgE) at Polytech-Lille, Lille University. And the candidate should have solid base in mechanics and numerical calculation (numerical method, program capacity). Of cause, a solid English language base is also necessary.