
Experimental modeling of fluid migration in sedimentary basins

Camille Porceillon^{*1,2}, Aurélien Gay¹, Alfredo Taboada¹, and Valérie Vidal²

¹Géosciences Montpellier – Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique, Université des Antilles, Université de Montpellier – France

²Laboratoire de Physique de l'ENS Lyon – Ecole Normale Supérieure de Lyon, Centre National de la Recherche Scientifique – France

Résumé

Sedimentary basins are large areas where numerous particles, including organic matter, accumulate. Due to various bio-physical-chemical reactions during burial, these kilometer-thick layers of sediment generate large quantities of gases and liquids, mainly CO₂ and methane. These fluids can then migrate through the sedimentary layers until they reach the seabed, forming fluid escape structures. They can present significant risks for offshore anthropogenic activities, such as the laying of transoceanic telecommunication optical fibers, or contribute to the release of large quantities of climate-altering greenhouse gases.

To model fluid migration through marine sediments, we carried out laboratory experiments involving localized water injection into a submerged granular medium. The originality of this work is to consider the influence of one (or more) coarse/fine grain interface(s) on fluid migration. Experiments are carried out in a Hele-Shaw cell (2- or 4-mm gap), allowing direct visualization of any grain displacement using a light panel and a camera.

Within a certain range of experimental parameters, we observe the development of instabilities at the coarse/fine grain interface, with the appearance of a quasi-periodic fluidization pattern, studied here. This work has a direct application to the prediction and interpretation of the location of fluid expulsions at the seabed. Indeed, geophysical imagery in sedimentary basins only provide a fixed image of such structures at the instant of acquisition. It gives the envelope of a fluid pipe and neither the internal architecture nor the volume of involved fluids (injected and expelled) has been characterized so far. Interpretations are based on the idea that each fluid pipe has a unique source at depth. This work demonstrates that a unique injection point at depth may be the source of multiple fluid pipes and fluid seeps, revolutionizing the way fluid migration structures are interpreted.

Mots-Clés: laboratory experiments, sedimentary basins, pipes, granular materials, fluid injection, fluidization, multiphase flows, instabilities

*Intervenant