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From hydrofracture to gaseofracture in porous rocks: influence of the nature of the injection fluid on the process

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We present experimental systems where we inject a fluid at high pressure in a poorly cohesive porous material saturated with the same fluid.
This fluid is either a highly compressible gas (air), or an almost incompressible and viscous fluid (oil), in an otherwise identical porous matrix. We compare both situations.
These porous materials are designed as analogs to real rocks in terms of processes, but their cohesion and geometry are tuned so that the hydrofracture process can be followed optically in the lab, in addition to the ability to follow the imposed pressure and fluxes.
Namely, we work with lowly cohesive granular materials, confined in thin elongated Hele-Shaw cell, and follow it with high speed cameras.
The fluid is injected on the side of the material, and the injection overpressure is maintained constant after the start. At sufficiently high overpressures, the mobilization of grains is observed, and the formation of hydrofracture fingering patterns is followed and analyzed quantitatively.

The two situations where air is injected and where oil is injected are compared together. Many striking similarities are observed between both situations about the shape selections and dynamics, when time is rescaled according to the viscosity of the interstitial fluid. Some differences survive in the speed of the traveling hydrofracture, and their physical origin is discussed.

In practice, this problem is relevant for important aspects in the
formation and sustenance of increased permeability macroporous networks as
demonstrated in nature and industry in many situations. E.g., in active hydrofracture in boreholes, piping/internal erosion in soils and dams, sand production in oil or water wells, and wormholes in oil sands.
It is also important to understand the formation of macroporous channels, and the behavior of confined gouges when overpressured fluids are mobilized in seismic sources. Indeed, the formation of preferential paths in this situation can severely affect the fluid and heat transport properties in this situations, and thus affect the pore pressurization effects.