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## Pulsating localised fluid expulsions

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A wide variety of fluid-rich natural systems exhibit a distinct pulsating signature on geophysical measurements. Identifying the processes leading to these observed pulses are key to further understand important multi-scale and multi-physics valve-like dynamics in natural environments such as gas flow in volcanic systems, magma transport in the crust, tremors and slip or subsurface flow migration. These natural two-phase systems share common features as they can be described as viscously deforming saturated porous media. They exhibit a time-dependant deformation of their porous matrix, buoyant pore-fluid, an effective pressure dependant bulk viscosity and a nonlinear porosity-permeability relation.

We here investigate the role of coupled hydro-mechanical processes to trigger pulsating localised fluid expulsions. We show that the pulsating regime may be a natural outcome of the interactions between a viscously deforming porous matrix and a nonlinear pore-fluid flow. We rely on high-resolution direct numerical two-phase flow calculations in three dimensions to explore what parameters control the main characteristics of the pulsating signal. We are particularly interested in how amplitudes, wave lengths and frequencies of the signal relate to the input model parameters.

We show that repeated fluid pulses are a natural outcome of the coupled Stokes and Darcy equations within the nonlinear viscous two-phase flow regime. We discuss the relevance of our findings in light of the valve-like behaviour in a variety of natural fluid-rich environments. We propose to use the characteristic of the pulsating signal to gain further insight in the dynamics of complex natural systems.