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Dynamics of hydrofracturing and microseismic signals in porous versus tight rocks

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There are still many unanswered questions regarding the dynamics of solid and fluid interaction in the geological systems during the hydrofracturing. Monitoring fluid movement and fracturing is one of the key research aspects in the modern unconventional industry. Microseismicity observation is currently the best available monitoring tool for such operations. Each fracturing in its essence is a small earthquake which can be picked up by seismometers and then inverted to track it back to its origin location.

We are using and improving in house build ELLE simulation software. At its original stage this package was designed to model solid-fluid interaction in the 2D space composed using hybrid approach of combining triangular lattice discrete element model (DEM) and square grid fluid continuum. Our purpose is to improve this model by adding seismic analytic aspect to it. The ultimate goal is to be able to simulate the microseismic signal produced by fracture opening.

We are interested at viewing the dynamics behind the fracture opening. It is known that there are two dominating fracture opening modes: tensile mode (Mode I) and shear mode (Mode II). However, these two are the end members of the scale and the actual mode of fracture opening is the combination of both. We were interested in seeing how properties of the rock as well as properties of the fracturing mechanics might affect the seismic response and the opening mode. We tried changing several parameters and it was concluded that changes in the Young's modulus had the most drastic impact upon the parameters. It was discovered that there are two dominating regimes in which fractures tend to open during hydrofracturing with the turning point between the two regimes at around 10GPa which is a typical value of the shale.