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Mechanism of intrusions: a comparison of models with application to the earthquake swarm region in NW Bohemia

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Earthquake swarms are often assumed to be caused by magmatic or fluid intrusions, where the stress changes in the vicinity of the intrusion control the position, strength and rate of seismicity. Fracture mechanical models of natural or injection-induced intrusions pose constraints on orientation, magnitude, shape and growing rate of intrusions, and thus on possible stress changes in the vicinity of the intrusions. Although the idea of intrusion-induced seismicity is widely accepted, specific comparisons of seismicity patterns with fracture models of stress changes are rarely done.

In this presentation we compile cases of intrusion models and discuss the predicted pattern of stress and stress changes. Due to the lack of specific information on the geometry of natural intrusion, we include hydraulic fracturing experiments in the discussion and present new hydraulic fracture models. We explain the causes of bilateral, asymmetric fracture growth during the injection phase, as well as a unilateral propagating ceasing front of seismicity short time after the injection stops.

The comparison of different models with swarm earthquakes in the Northwest Bohemia region shows that buoyancy effects are small if earthquakes are caused by fluid intrusions. This questions whether dense magma is injected rather than CO2, as suggested by other studies.