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The simplest visco- or elasto-plastic rheology allowing to spontaneous earthquake nucleation

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Understanding the physical processes governing earthquake nucleation has been a hot topic since the last decade. A lot of research has been done trying to explain the physics of seismic triggering events. However, the exact physics behind seismic events nucleation is still poorly understood. The outcome of our recent research is the new theory of earthquake nucleation (Alkhimenkov et. al., 2021). The simplest visco-plastic or elasto-plastic rheology allows us to model spontaneous earthquake nucleation. We consider pure shear boundary conditions and slowly increase stress in the model reflecting the stress increase e.g., due to tectonic forces in real rocks. Once the stress field reaches the yield surface, the strain localization occurs, resulting in slowly developing fractal shear bands. As time evolves, shear bands grow spontaneously, and stress drops take place in the medium. Such stress drops are caused by the instantaneous development of new shear bands, their intersections, and intersections with the boundaries of the numerical domain. A stress drop corresponds to a particular new strain localization pattern. The new strain localizations act as seismic sources and trigger seismic wave propagation (Minakov and Yarushina, 2021). We suggest that the (seismic) radiation pattern of the focal mechanism might be similar to a particular moment tensor source, typical for realistic earthquakes (Alvizuri et al., 2018). This new modeling approach is based on conservation laws without any experimentally derived constitutive relations.

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