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A physical model for the pattern of seismicity induced by propagating dikes

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The seismicity observed during lateral dyke propagation in rifts shows recurrent patterns: (1) often, a forefront linked to the propagation of the tip emerges, with an approximately exponential space-time dependency, (2) a backfront is also sometimes detectable, likely due to a moving stress shadow; the backfront seems to have a complicated, but non-random, functional behavior, (3) the moment tensor solutions during the stopping phase have sometimes the same fault planes as during propagation, but opposite mechanisms, (4) mismatches between volumes gained by the dykes and lost by the feeding sources are becoming the rule more than the exception. Some of these patterns can be explained in terms of current models: Dahm et al (2010) explain the pattern of induced seismicity, Rivalta (2010), models the coupling dyke-magma chamber through mass conservation explaining the missing volumes; however a conceptual model which explains all the observations aboveis still missing. Here we combine the two quoted studies into one formulation, and apply the rate and state earthquake nucleation theory to model the induced seismicity. We solve the problem for a vanishing tectonic gradient, obtaining a curve for the propagating tip that fits well the observed seismicity forefront, including the stopping stage that was never explained before. Next, we model the time dependent moment tensor that one can expect during fault slip coupled to a propagating dike, obtaining an estimate for the isotropic and CLVD components that should be expected during dike-induced faulting. Work is in progress to add a non-vanishing tectonic gradient to the dynamics.