Geophysical Research Abstracts
Vol. 13, EGU2011-12013, 2011
EGU General Assembly 2011

The changing shape of dykes during propagation explains the pattern of induced seismicity

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Recent high-quality seismological and geodetic observations from volcanic areas and rift zones evidence some recurring patterns. One example is the pattern of the epicenter locations of earthquakes induced by dyke propagation, where the seismicity forefront appears to follow an exponential trend and where a backfront is also sometimes detectable and seems to have a complicated, but non-random, functional behavior; moreover mismatches between volumes gained by the dykes and lost by the feeding sources are becoming the rule more than the exception. All this can only be partially explained in terms of current models. In this work, we combine two published studies: Dahm et al (2010), explaining the pattern of induced seismicity with Rivalta (2010), modelling the coupling dyke-magma chamber through mass conservation. We first solve the problem for a zero 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. Then we solve semi-analytically the case for a non-vanishing tectonic gradient. Preliminary results show how backfronts of seismicity induced by Afar dykes can be explained by the change of dyke shape with time. The different velocity of dykes traveling in opposite rift directions can also be explained by this model, assuming different tectonic gradients in the two directions. This formulation of the problem can help constraining various parameters of host rock, magma chamber and dyke.