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On the physical links between the dynamics of the Izu Islands 2000 dike intrusions and the statistics of the induced seismicity

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The frequency-magnitude distribution (FMD) of earthquakes has been widely studied in a variety of settings, from global to laboratory scale. The b-value of the FMD is in general close to one on a global scale; however, on a regional scale it is found to deviate significantly from this behavior. Spatial variations of the b-value have been evidenced around major fault systems, in subducting slabs as well as in volcanic and geothermal areas. Although in tectonics environments, such as fault systems, the b-value varies only spatially, generally in association with different stress levels, in volcanic areas b-value anomalies occur both spatially and temporally and are generally associated to the presence of fluids or large rock heterogeneities within the crust. The physical and mechanical interpretation of such anomalies is still a difficult task, in particular for areas where multiple seismic sources are in play, or for volcanic areas, where multiple physical processes influence earthquake occurrence. In this study we focus on the seismic swarm which accompanied the well-studied 2000 Izu islands (Japan) dike intrusion in order to link the intrusion dynamics to temporal and spatial variations of the b-value of the FMD. We first calculate the b-value anomalies relative to different areas in the different phases of the intrusion and then compare them with the stress levels we infer from the published inversions of time-dependent dike-induced deformation. Then, we study the evolution of the maximum expected magnitude in this area that experienced in a few weeks more than five earthquakes with magnitude greater than 6. Finally, we calculate the effect of the dike-induced stress on the observed seismicity in the region, highlighting the areas that experienced an enhancement in seismicity and the area where the seismicity is inhibited.