Geophysical Research Abstracts
Vol. 16, EGU2014-6817, 2014
EGU General Assembly 2014

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

Luigi Passarelli (1), Eleonora Rivalta (1), Cesca Simone (1,2), and Yosuke Aoki (3)

(1) GFZ Sec 2.1 Physics of Earthquakes and Volcanoes,Potsdam, Germany (luigi.passarelli@gfz-potsdam.de), (2) University of Potsdam, Germany, (3) Earthquake Research Institute, University of Tokyo, Japan

The emplacement of magma-filled dikes often induce abundant seismicity in the surrounding host rocks. Most of the earthquakes are thought to occur close to the propagating tip (or edges, in 3D) of the dike, where stresses are concentrated. The resulting seismicity often appears as a swarm, controlled mainly by dike-induced stresses and stressing rate and by other factors, such as the background stressing rate, tectonic setting, regional stresses and tectonic history. The spatial distribution and focal mechanisms of the seismicity bear information on the interaction of the dike stress field and the tectonic setting of the area. The seismicity accompanying the intrusion of a dike is usually characterized by weak events, for which it is difficult to calculate the focal mechanisms. Therefore, only for a few well-recorded dike intrusions a catalog of focal mechanisms, allowing to perform a robust statistical analysis, is available. The 2000 dike intrusion at Miyakejima is in this sense an outstanding case, as about 18000 seismic events were recorded in a time span of three months. This seismic swarm was one of the most energetic ever recorded with five M>6 earthquakes. For this swarm a catalog of 1500 focal mechanisms is avalable (NIED, Japan). We perform a clustering analysis of the focal mechanism solutions, in order to infer the most frequent focal mechanism features prior to the intrusion (pre-diking period) and during the co-diking period. As previously suggested, we find that the dike stress field modified substantially the pre-existing seismicity pattern, by shadowing some non-optimally oriented strike-slip structures and increasing seismic rate on optimally oriented strike-slip tectonic structures. Alongside, during the co-diking period a large number of normal and oblique-normal faulting were observed. These events cannot be explained within the tectonics of the intrusion area. We suggest they are directly generated by the intense stress field induced at the dike edges. We further investigate the distribution of the two main clusters we identify, i.e. strike-slip and oblique-normal mechanisms. We find that the strike-slip family obeys a Gutenberg-Richter law with a b-value close to one. The oblique-normal family of events deviates from the Gutenberg-Richter distribution and is slightly bimodal, with a marked roll-off on its right-hand tail suggesting a lack of large magnitude events (M>5.5). This set of events seems to collect earthquakes rupturing above the dike, similar to graben faulting events widely observed in volcanic areas during diking. A possible explanation of the anomalous frequency-magnitude distribution is that these earthquakes may be limited in size by the thickness of the layer where they nucleate, being spatially constrained between the dike upper edge and the Earth's surface.