Geophysical Research Abstracts
Vol. 20, EGU2018-16450-1, 2018
EGU General Assembly 2018

Inter-event times of volcanic earthquakes in comparison with gas emission events of Villarrica (Chile)

Johanna Lehr (1), Stefan Bredemeyer (2), Wolfgang Rabbel (1), and Martin Thorwart (1)

(1) Institute of Geosciences, Kiel University, Kiel, Germany (johanna.lehr@ifg.uni-kiel.de), (2) GEOMAR Helmholtz Centre for Ocean Research Kiel

Frequency distributions of inter-event times (iets) – the time between two consecutive earthquakes – allow for a statistical analysis of earthquake occurrences without the need of identifying fore-, main-, or aftershocks. The distribution of iets implies an underlying stochastic process which, in turn, may be explained by a physical process. Moreover, when scaled with the mean occurrence rate, the frequency distributions of quakes occurring on different time scales, regions, etc. can easily be compared. This makes iets an ideal observable for comparing the different types of seismicity encountered at volcanoes.

We analyzed volcano-tectonic (VT) and low-frequency (LF) seismicity at Villarrica Volcano during nine days of early March 2012. VT-events were identified using an STA/LTA trigger. LF-events, recorded near the active vent, were triggered when the envelope of the signal exceeded the low-pass filtered envelope. By the same means, we identified 'gas emission events', i.e. a short-term elevation of sulfur dioxide fluxes, which were measured in the downwind portion of the volcanic gas plume (at ∼6km distance from the vent) by three scan-DOAS stations between January and April 2012. Iets of VT-events are well represented by the right skewed universal Gamma distribution for tectonic earthquakes, as proposed by Corrall et al. (2004). In contrast, iets of LF-events, although asymmetric, show a clearly unimodal distribution which can be fitted e.g. by another Gamma distribution with significantly different shape parameters. Our result for the LF-seismicity is in good agreement with similar analyses at Stromboli and Etna, where LF-activity originates from outgassing magma.

In order to verify such a relationship for Villarrica, we applied the iet analysis to the 'gas emission events'. Despite the significant differences between the two data sets, both iets collapse into almost identical frequency distributions after rescaling. This requires at least a similar stochastic process of event occurrence, but strongly suggests a common physical process as well.

We suggest interpreting the sulfur dioxide variations in the gas plume as a low-pass filtered response of a discrete degassing process: assuming that LF-events are eventually caused by frequent escapes of relatively small amounts of gas, the material accumulates in the plume resulting in a slower fluctuation of the gas flux, but involving larger quantities. The scale-invariance of the Gamma distribution in case of proportional rate parameters would then allow for our observation. The atmospheric mixing processes in the equilibrating plume which cause a homogenization of gas distribution inside the plume act as the filter.

We have no means to verify the emission of discrete gas parcels at the vent opening for our observation period. However, Villarrica is well-known for its infrasonic signals, which accompany coinciding seismic LF- and outgassing events during small strombolian eruptions – a mechanism that was 1) most likely active during our campaign and 2) supports the idea of a degassing process by frequent discharge of small amounts of gas.