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Inferring a shallow degassing model for Villarrica Volcano from seismic explosion signals and SO_2 flux

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Villarrica is a basaltic volcano with an active lava lake in South Central Chile. The lava lake displays a variety of degassing styles from gentle seething to more violent Strombolian explosions. This activity is accompanied by sequences of transient seismic waveforms suggesting the presence of discrete gas bubbles in the upper magma column. Gas bubbles flow through liquid-filled pipes according to distinct patterns depending on viscosity of the liquid and volumetric gas flow rate. Laboratory experiments indicate that these regimes are characterized by distinct frequency distributions of bubble sizes and spacings. By assuming that these parameters are reflected by the magnitude of the transients and the time between them, we compared their statistical distributions to infer a flow regime for the shallow conduit of Villarrica. The approximately log-normal distributions indicate a sustained slug flow regime in which the gas ascends in trains of conduit-wide gas slugs. The event catalog for our analysis contained about 20,000 events and was generated from 12 days of seismic data from March 2012 acquired by a dense local network. A well-known problem in earthquake statistics is the incompleteness of event catalogs towards low magnitudes due to decreasing detectability in the ambient noise. We estimated the actual distribution of magnitudes by using a Monte Carlo simulation of the event detection based on the statistical properties of the observed seismic noise. The unknown source depth and mechanism introduce further ambiguity regarding the distributions. Nevertheless, we hope to refine the degassing model by taking into account degassing rates, magma properties and more detailed analysis of the nature of the seismic events.