Geophysical Research Abstracts
Vol. 12, EGU2010-8642, 2010
EGU General Assembly 2010

Acoustic emissions during experimental fragmentation of volcanic rocks

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Forecasting volcanic eruptions is a fundamental objective of volcanology. Given the complexity of magma ascent dynamics and that direct observations are impossible, laboratory experiments provide a promising approach to better understand the processes that lead to and feed explosive eruptions.

Fragmentation of porous natural samples in a shock tube apparatus gives insights into the behavior of volcanic rocks during rapid decompression.

In this preliminary study, we use acoustic emissions (AE) to monitor the generation of cracks and describe the signal that accompanies the fragmentation of natural volcanic rocks.

Rapid decompression experiments were carried out in a fragmentation bomb at room temperature. We used sample sets from Merapi volcano (Indonesia) and Montserrat volcano (West Indies, UK) with open porosities ranging between 20% to 67%. Cylindrical samples were pressurized with Argon gas in an autoclave. To overcome the fragmentation threshold of the specific rocks, applied pressures varied from 5-20 MPa. Subsequent rapid decompression of the samples caused fragmentation.

During fragmentation, acoustic emissions were monitored by a two 2- channel- AE system that allows sampling rates of 1-5 MHz/channel. Two piezzoelectric sensors (100-1000 kHz) were attached to the autoclave and simultaneously recorded the micro-seismic events.

An enhanced setup with a waveguide connecting the sample to the AE sensors allowed a better quality of the recorded signals. Furthermore, to find the optimum sensor position, various settings were tried during decompression experiments.

The recorded AE were analyzed with respect to their distribution, frequency, amplitude, and the energy released during fragmentation. The AE energy parameter takes into account both the number of hits and their sizes. Moreover, changes in size and characteristics of these acoustic emissions with explosion energy, magma state and energy partitioning will be discussed.

The results of this study may contribute to better understand volcanic processes, and improve our ability to correctly evaluate the seismic nature of explosive eruptions, necessary to implement forecasting methods.