Geophysical Research Abstracts
Vol. 13, EGU2011-12095, 2011
EGU General Assembly 2011

Infrasound Generated by Strombolian Eruptions – Insights from Laboratory Experiments

Amy Dabrowa (1), Jeremy Phillips (1), Alison Rust (1), and David Green (2)

(1) University of Bristol, Earth Sciences, United Kingdom (amy.dabrowa@bristol.ac.uk), (2) AWE Blacknest, Reading, United Kingdom

The exact mechanism which produces infrasound (sound with frequencies below 20 Hz) during Strombolian eruptions is currently uncertain. Suggested mechanisms include an “explosive point source” at depth within the conduit [1], the oscillation prior to bursting of a gas slug at the surface of a fluid filled conduit [2], or the actual bursting of this gas slug [3]. Such mechanisms at the vent need to be understood if infrasound recorded in the field is to be used to infer conditions in the volcanic system.

In this work a very simple model is used as a starting point to help us understand the mechanisms that might be at work during a Strombolian eruption, and what physical parameters could be important in the system. Bubbles are injected at the base of a tank containing a viscous Newtonian fluid (Golden syrup) and rise to burst at the surface. Here they are recorded by two microphones and a high speed camera. Various physical parameters expected to control the form of the acoustic wave produced are investigated, such as fluid viscosity, bubble volume and bubble rupture speed. Although the experimental set-up is simple and idealized, importantly it allows accurate control of physical properties and measurement of the processes observed.

Initial results show that the onset of the main low frequency part of the recorded acoustic waveform occurs concurrently with the onset of bubble rupture, whilst subsequent high frequency parts of the waveform are caused by contact between syrup surfaces. Amplitude and phase of the recorded acoustic waveform vary strongly according to the relative locations of the recording microphone, and the starting point of bubble rupture. This indicates the sound produced is not purely monopole. The speed of bubble rupture shows a strong negative correlation with viscosity, and seems to influence both the amplitude and the frequency of the recorded acoustic waveform. As fluid viscosity decreases, the amplitude and frequency of the recorded acoustic waveform increase.

It seems plausible that the rupture speed and the pressure difference between bubble interior and surrounding atmosphere control the rate of volume outflow from the pressurised bubble, which in turn controls both the amplitude and frequency of the waveform. Results are compared to simple models guided by the experimental observations. Firstly, a numerical model of the monopole acoustic waveform produced by the equilibrating flow of mass from a pressurised bubble through a growing aperture. This model showed a poor fit to experimental results and prompted further investigation. Subsequently, high speed video footage of a bursting and collapsing bubble is analysed to measure the volume outflow from the bubble, which is then used to create a synthetic monopole waveform. Lastly a scenario where the bubble membrane is not “seen” by the acoustic wave is investigated. Here the process can be thought of as the movement of a parcel of air rather than an outflow of volume, which implies a dipole source for the sound produced rather than a monopole.

This study shows that even here where the simplest system has been investigated as a guide to more complex situations, results are still not as simple as might be expected. Importantly, fluid viscosity is found to be a key parameter and the sound produced is not purely monopole.

[1] Buckingham M. & Garces M. (1996). Canonical model of volcano acoustics. JGR. 101(B4). 8129-8151.
[2] Vergniolle S. et al. (2004). Acoustic measurements of the 1999 basaltic eruption of Shishaldin volcano, Alaska 1. Origin of Strombolian activity. JVGR. 137. 109– 134.
[3] Johnson J. et al. (2008). Acoustic source characterization of impulsive Strombolian eruptions from the Mount Erebus lava lake. JVGR. 177. 673–686.