

MODELLING OF SEISMO-VOLCANIC SOURCES

by

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The candidate confirms that the work is his own and that appropriate credit has
been given where reference has been made to the work of others.

Abstract

In 1995 Leeds University deployed a 5 station broadband seismic array around the active vents at Stromboli volcano. Cross-checking these data with a video record revealed that eruptions at vents 1 and 3 correspond to characteristic very-long period (VLP) seismic phases (periods 2-20 s) which show that the volcano inflates rapidly immediately prior to each eruption. These VLP phases are the key to unlocking the physical processes that give rise to eruptions at each of the vents. The problem is to relate these seismic signals to the underlying physical processes since no work exists that discusses the seismic signatures of different flow-related processes. The main purpose of this thesis is to start to bridge that gap.

Two modelling methods are derived in order to estimate the pressure change needed to generate the very-long period phases recorded at vent 1. The first method works by extrapolating the displacement and stress at the conduit wall from that recorded at a seismometer, and then by assuming continuity of stress the pressure inside the conduit can be estimated. Separate models are developed for point sources and line sources. The second method is based on solving the wave equation in cylindrical coordinates and applying a set of boundary conditions at the conduit wall and is used to calculate synthetic seismograms for some simple volcanic processes. Line sources and moving sources are represented by the perturbations in pressure and shear stress they produce at the conduit wall. The main example of a moving source used is rising magma. Both of these methods incorporate near field (in addition to far field) effects, which are particularly important for these VLP signals since they are recorded at distances much less than 1 seismic wavelength from the source.

The VLP signals are consistent with a stationary (rather than moving) non-destructive source, which can be modelled as a point source at a depth of 350 m. This source is thought to represent a pressure variation of no more than 0.5 MPa in a magma chamber with a radius of at least 100 m, centred on a depth of 350 m. This corresponds to a volume change of about 600 m³. The Bernoulli effect can be rejected as a source of these VLP phases because the largest seismic signals it could generate are several orders of magnitude too small.

Although these methods were only applied to VLP signals at Stromboli volcano they can be generally applied to isotropic, near-field seismic signals at any volcano.

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Chapter Four: k - ω modelling method for an infinite solid

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