# Frequency domain inversion of synthetic long period volcanic events

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## Motivation

Source inversion for long period (LP) events in volcanic areas is an ongoing research topic. The high interest of volcanologists to understand the physical phenomena which govern these characteristic events is related to the fact that they may be directly generated by fluid transfers and some of them could be candidates for volcanic activity parameters, or precursors of volcanic eruptions. The signal class of LP-type events generally includes different volcanic transients with dominant frequencies in the range between 0.5 and 5 Hz. Although some source models have been proposed to explain their generation (vibration of fluid-filled cavities, etc.), the large variety of LP signal forms and the existence of alternative models to explain some of the observations, make it interesting to develop new inversion schemes. Our main goal is to propose an inversion methodology to determine LP source mechanisms and study these events through an exhaustive source inversion by using synthetic data.

## Method

The LP source inversion method is based on the general assumption that volcanic event sources can be expressed as the sum of a full moment tensor (MT, generalized source dipoles) and a single force (SF) of arbitrary orientation. This model can represent different physical phenomena, such as a slip on a rupture plane, an opening crack, an explosion or a mass movement. Our model also assumes time dependent source parameters. The proposed algorithm, named *VOLPIS* (**VO**lcanic **L**ong **P**eriod **I**nversion for the **S**ource), uses a set of 27 theoretical Green's functions and is thus sufficient to include volcano topography or anisotropy at a later time. The inversion method solves the discretized equations in frequency domain, fitting both amplitude and phase spectrum. This approach has the main advantage to split the expensive numerical inversion of a large complex matrix into a set of inversions dealing with smaller-sized matrices, one for each sampled frequency, reducing the computational requirements.

## Objective

The algorithm has been applied to different sets of synthetic data, currently generated by using the reflectivity method. Synthetic data are calculated for different layered crustal models, which have been proposed for volcanic areas, considering realistic station distribution. A range of different source depths and source mechanisms are used to generate the data set. Inversion tests are established to check the stability of the method and the possibility of retrieving all source components and separate force dipoles from single forces. Stability tests are realized to verify method response for mismodelling of crustal structure,

selection of erroneous source depth and assumption of different constraints for the source mechanism. Inversion is also tested for the cases of a reduced azimuthal coverage of the epicenter or for the inclusion of artificial seismic noise. Finally, a test is realised to check the possibility of retrieving deviatoric components of the seismic source, such as is the case of minor single forces added to large explosions or crack openings. Application to data from Kilauea and Stromboli volcanoes are planned.