Wave-equation modelling of elastic wavefields in volcanic samples.

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Seismic imaging through heterogeneous structures is highly affected by incoherent scattering and attenuation, which, at the field scale, manifest themselves as seismic coda waves, the tail part of direct- and surface-wave seismograms. M3ODEL has recently funded the PhD project "*Radiative transfer and Bayesian inversion: application to modelling and imaging using stochastic seismic wavefields"*, with Yi Zhang as PhD candidate. The project focuses on forward modelling the scattered and attenuation wavefield in seismic recording, then developing an advanced inversion strategy to be applied to seismic imaging of the heterogeneous Earth. This internship will strengthen the forward modelling part of the research topic, as it will use wave-equation based techniques modelling the propagation of seismic wavefields in samples. It will expand its application to sample scale, contemporaneously giving the applicant the necessary tool to develop research skills in computational Science.

The project is based available extensive petrological and mineralogical characterizations of heterogeneous samples and established experimental links between attenuation and scattering parameters and seismic observation at laboratory scale. These data will be included in a finite-difference forward modelling scheme for the propagation of seismic waves in anisotropic viscoelastic media. The final aim is to establish a second modelled-based link, complementary to the laboratory one, between seismic observations intrinsic properties of the host rocks (petrophysical/mineralogical). By the interaction with Zhang and lay down the use of these parameters to develop new imaging techniques of heterogeneous sequences, based on the inversion of field data.

Duration: 4 months

Task	Activity	Time frame
1	Example implementation of the FD code for modelling anisotropic waveforms in rock samples on a laboratory scale, based on the previous modelling of Acoustic Emissions.	1 week
2	Building a more realistic model of the volcanoclastic samples through an SH simulation using a 2D FD scheme at a very fine scale (smaller grid/nodes). Including boundary conditions and adjusting the source wavelet.	3 weeks
3	Implementation of available experimental measurements from the laboratory experiments into the simulation, informed by literature. Parametric study of sensitivity and uncertainty.	3 weeks

4	Implementation of Specfem2D, build-up of meshes based on geometries obtained in previous rock physics analyses. Parametric study of sensitivity and uncertainty.	5 weeks
5	Comparison of results of FD, Specfem2D, and existing radiative transfer codes. Discrimination of best theory to model waveforms at different frequencies and source-sensor distances. Final joint sensitivity analysis of scattering and attenuation parameters to rock physics experimental measurements.	4 weeks