EGU21-16028
https://doi.org/10.5194/egusphere-egu21-16028
EGU General Assembly 2021

Synthetic seismic modeling and inversion for the Oldoinyo Lengai volcanic complex.

Abolfazl komeazi[1], **Yi Zhang**[2], Luca de Siena[2], Georg rümpker[1], Boris Kaus[2], Miriam Reiss[1], César Castro[1], Arne Spang[2], Philip Hering[1], Andreas Junge[1], and Tobias Baumann[2]

[1]Goethe university, Geosciences, Geophysics, Frankfurt, Germany (komeazi@geophysik.uni-frankfurt.de)

[2]Johannes Gutenberg University Mainz, Institute of Geosciences, Mainz, Germany

What is the effect of crustal melt accumulation on the seismic wavefield? Can we reproduce the dispersion, scattering and associated stress-anisotropy with modeling tools? By performing numerical experiments of seismic wave propagation in a synthetic and geodynamically-consistent volcanic system we can test our ability to model the seismic wavefield and to reconstruct the target “magma chamber”.

We built a synthetic volcano based on recent seismic observations at the Oldoinyo Lengai volcanic complex. The velocity model is based on a geodynamic model that provides shear modulus, Poisson's ratio, and density. The isotropic P- and S-wave velocities can be computed directly from these parameters. To test a more realistic depth dependence, we introduced a reference 1D velocity model for Northern Tanzania and expanded this to 3D. Then, we inserted variations in the rock parameters mimicking a magma chamber and resolved it using the Fast Marching Travel Time tomography code.

To further our understanding, we also added 3D anisotropy and random velocity fluctuations to the system, acting both as synthetic input for future applications and testing of seismic techniques (e.g., shear wave splitting analysis) and as noise for the travel time tomography. For the waveform modeling we used the velocity-deviatoric stress-isotropic pressure equations together with perfectly matched layers. Also, we encoded the boundary condition between solid and air in this formulation. The 25 receivers with their real geographic locations were placed for inversion sensitivity analysis. In particular, the ability to reconstruct the magma chamber and the effect of anisotropy and velocity fluctuations at frequencies up to 5 Hz are evaluated. The results are compared with a parallel forward modeling and inversion of synthetic MT data. To confirm our results and as an additional test, we also employ adjoint tomography based on spectral element method to implement a forward waveform modeling and inversion using the tools provided in the SPECFEM3D_Cartesian package.

The results present a better idea of how to construct a realistic synthetic volcano in the future. By combining multiple seismic forward models and inversion approaches, this study yields insights into the sensitivity of the seismic wavefield to geodynamically-consistent volcanic structures.