EUROVOLC

European Network of
Observatories and Research Infrastructure for Volcanology

Deliverable Report

D23.1 Report on the WP23 VA service during the project

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Work Package leader:	*Chris Bean*	
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Contents

Summary

WP23 concerns the provision of access to the seismic full wavefield modelling tool VolcSeisSimu, as part of the Virtual Access (VA) activities within the EUROVOLC project.
The VolcSeisSimu infrastructure comprises a software tool, Elastic Lattice Method (ELM) for the numerical modelling of seismic wave propagation in highly heterogeneous media (including media with fractures. ELM is a discrete particle numerical method for simulating seismic wave propagation through complex media in the presence of topography.

Description of the tool

The infrastructure comprises a software tool (ELM) for the numerical modelling of seismic wave propagation in highly heterogeneous media (including media with fractures). The tool kit also comprises starter heterogeneous volcano models. Whilst full wavefield simulators are becoming more common, a unique aspect of this tool is its ability to handle media with discrete fractures of arbitrary scale, in addition to intrinsic geological heterogeneity.

The Elastic Lattice Method (ELM) is a discrete particle numerical method for simulating seismic wave propagation through complex media in the presence of topography [1]. The model structure consists of particles arranged on a cubic lattice which interact through a central force term and bond-bending force. Particle disturbances are propagated through space by numerically solving their equations of motion. A description of the code, examples, and benchmarking against finite difference codes can be found in references [1-6]. The ELM code has both 2D and 3D implementations.

Potential application in volcano observatories

One of the aims of volcano monitoring is to understand physical processes within a volcano and ultimately help in forecasting potential hazards. One of the primary interests in volcano-seismology is determining volcanic seismic sources, but the generation and propagation of seismic waves throughout volcanic regions is a complex and nonlinear phenomenon controlled by the interaction of many processes. Because volcanoes are highly mechanically heterogeneous they significantly distort seismic wave propagation and hence the source 'fingerprint' in seismograms is often hidden by 'path effects' created when the wave propagates from the source to the seismic receiver. Using the VolcSeisSimu tool researchers or monitoring scientists can determine these propagation path effects for arbitrarily heterogeneous models and 'deconvolve' them from observed seismograms to better understand and constrain volcano source models. Source inversion is a highly specialized and time-consuming research area, but is critical to an improved understanding of volcano seismograms in terms of source processes. This scheme offers an alternative 3D method for modelling wave propagation in the presence of strong topography and subsurface heterogeneity, and the flexibility of the method allows for a wide range of possible source mechanisms with no restriction on source geometric shape or on the distribution and degree of elastic heterogeneity.

Provision of access

Following completion of internal testing, access to the software was made available in late March 2019.

The ELM code is available via the DIAS gitlab page: https://git.dias.ie/graphiit/DIASGEO/wikis/home

This page contains documentation and instructions on how to download and run the software, as well as example input files and models and references of relevant publications utilising the method.

A detailed description and link to the above page was also added to the EUROVOLC wiki page: https://eurovolc.cp.dias.ie/index.php/Open_software

Access statistics

Basic web usage statistics collected show that the ELM tool was downloaded 49 times in 2019, 183 times in 2020 and 9 times in 2021.

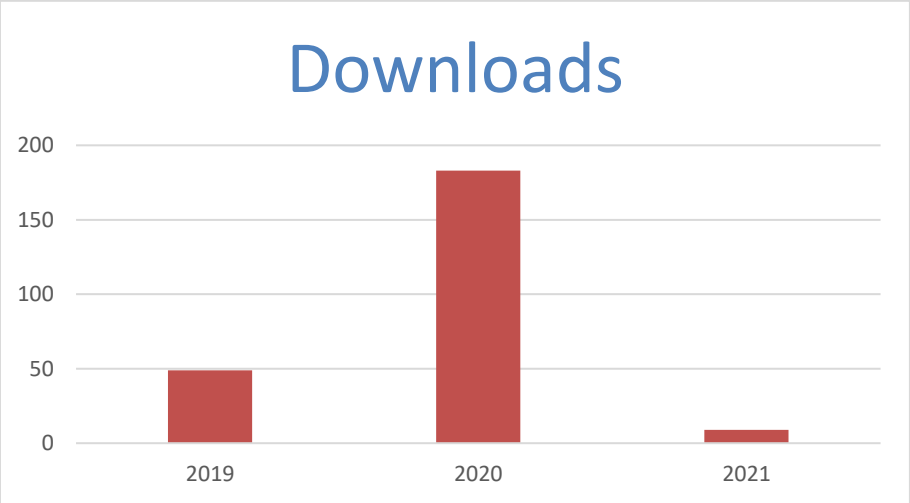

Figure 1: Statistics of ELM tool downloads between 2019, 2020 and 2021.

References

O'Brien, Gareth S., Bean, Christopher J. (2004), A 3D discrete numerical elastic lattice method for seismic wave propagation in heterogeneous media with topography, Geophys. Res. Lett., Vol. 31, No. 14, L14608 10.1029/2004GL020069.