EGU2020-7111
https://doi.org/10.5194/egusphere-egu2020-7111
EGU General Assembly 2020

Towards more realistic values of elastic moduli for volcano modelling

Michael Heap[1], Marlène Villeneuve[2], Fabien Albino[3], Jamie Farquharson[4], Elodie Brothelande[5], Falk Amelung[4], Jean-Luc Got[6], and Patrick Baud[1]

[1]Université de Strasbourg, CNRS, IPGS UMR 7516, F-67000 Strasbourg (heap@unistra.fr)
[2]Department of Geological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand
[3]School of Earth Sciences, University of Bristol, Bristol, UK
[4]Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, USA
[5]Carnegie Institute for Science, Washington, USA
[6]IS Terre, Université de Savoie, Chambéry, France

The accuracy of elastic analytical solutions and numerical models, widely used in volcanology to interpret surface ground deformation, depends heavily on the Young's modulus chosen to represent the medium. The paucity of laboratory studies that provide Young's moduli for volcanic rocks, and studies that tackle the topic of upscaling these values to the relevant lengthscale, has left volcano modellers ill-equipped to select appropriate Young's moduli for their models. Here we present a wealth of laboratory data and suggest tools, widely used in geotechnics but adapted here to better suit volcanic rocks, to upscale these values to the scale of a volcanic rock mass. We provide the means to estimate upscaled values of Young's modulus, Poisson's ratio, shear modulus, and bulk modulus for a volcanic rock mass that can be improved with laboratory measurements and/or structural assessments of the studied area, but do not rely on them. In the absence of information, we estimate upscaled values of Young's modulus, Poisson's ratio, shear modulus, and bulk modulus for volcanic rock with an average porosity and an average fracture density/quality to be 5.4 GPa, 0.3, 2.1 GPa, and 4.5 GPa, respectively. The proposed Young's modulus for a typical volcanic rock mass of 5.4 GPa is much lower than the values typically used in volcano modelling. We also offer two methods to estimate depth-dependent rock mass Young's moduli, and provide two examples, using published data from boreholes within Kīlauea volcano (USA) and Mt. Unzen (Japan), to demonstrate how to apply our approach to real datasets. It is our hope that our data and analysis will assist in the selection of elastic moduli for volcano modelling. To this end, our new publication (Heap et al., 2019), which outlines our approach in detail, also provides a Microsoft Excel© spreadsheet containing the data and necessary equations to calculate rock mass elastic moduli that can be updated when new data become available. The selection of the most appropriate elastic moduli will provide the most accurate model predictions and therefore the most reliable information regarding the unrest of a particular volcano or volcanic terrain.

Heap, M.J., Villeneuve, M., Albino, F., Farquharson, J.I., Brothelande, E., Amelung, F., Got, J.L. and

Baud, P., 2019. Towards more realistic values of elastic moduli for volcano modelling. Journal of Volcanology and Geothermal Research, https://doi.org/10.1016/j.jvolgeores.2019.106684.