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Layered seismic anisotropy at Icelandic volcanoes: implications for crustal growth and consequences for shear wave splitting monitoring.

Jessica Johnson (1), Robert White (2), Diana Roman (3), and Tim Greenfield (2)

(1) School of Environmental Science, University of East Anglia, Norwich, United Kingdom (jessica.johnson@uea.ac.uk), (2) Bullard Laboratories, University of Cambridge, Cambridge, UK, (3) Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC, USA

The measurement of seismic anisotropy using the method of shear wave splitting (SWS) has potential as a stress monitoring tool and is increasingly being used by researchers. Even though anisotropy, caused by preferentially aligned microcracks, can be a valid proxy for determining the stress regime in the subsurface, there are many other reasons that SWS may be observed. Anisotropy in the crust may be due to aligned macroscopic fractures, layering, or aligned minerals. Temporal changes in SWS may be an artefact of migrating sources passing through a heterogeneous anisotropic field.

We have analysed shear wave splitting at four volcanic areas in Iceland using unbiased, automated methods. At Upptyppingar, we observe a strong dependence of shear wave splitting parameters with source earthquake depth. At Hekla, we observe incoming polarisations radial to the volcano, while the fast wavelets are consistent with tectonic stress. Both of these observations suggest a vertical variation of seismic anisotropy. With this in mind, investigation of previously published data sets showed that this effect is apparent at the majority of volcanic areas in Iceland, if not the whole island.

The layering of shear wave splitting can be interpreted in multiple ways but we favour the model of a stress discontinuity at depth, which has profound consequences for the migration of melt and formation of the crust under Iceland. This result should also be considered when using shear wave splitting as a monitoring tool as it shows that it is not only lateral variations that can create apparent temporal changes, but also varying depth of earthquake sources.