RETREAT - a REal-time TREmor Analysis Tool

Patrick Smith and Chris Bean
School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland (psmith@cp.dias.ie)

The EUROVOLC project aims to promote an integrated and harmonised European volcanological community, and one of its main themes focuses on understanding sub-surface processes. Early identification of magma moving towards the surface is very important for the mitigation of risks from volcanic hazards, and joint research activities within the project aim to develop and improve volcano pre-eruptive detection schemes. Volcanic tremor is a sustained seismic signal associated with eruptions and is often linked to movement of magmatic fluids in the subsurface. However, it can occur pre-, syn- and post-eruption, and signals with similar spectral content can also be generated by several other processes (e.g. flooding, rockfalls). Hence one of the best ways of distinguishing between the processes underlying tremor generation is through tracking the evolution of its spatial location. Due to its continuous nature tremor cannot be located using classical seismological methods and so its source must be determined using alternatives such as seismic array analysis.

This work presents RETREAT, a REal-time TREmor Analysis Tool developed under EUROVOLC, that uses seismic array data and array processing techniques to detect, quantify and locate volcanic tremor signals. It is an open-source python-based tool that utilizes existing routines from the open-source obspy framework to carry out analysis of seismic array data in real-time. The tool performs f-k (frequency-wavenumber) analysis using beamforming to calculate the back azimuth and slowness in overlapping time windows, which can be used to detect and track the location of volcanic tremor sources.

A graphical and web-based interface has been developed which allows adjustment of highly configurable input parameters. These include options for setting the data source, pre-processing, timing and update options as well as the parameters for the seismic array analysis which must be carefully selected and tuned for the specified array. Once configured the tool fetches waveform data in real time and updates its output accordingly, returning plots of the array processing results (slowness and back azimuth values) as well as plots of the seismic waveform, envelope and spectrogram. The tool has been tested on real-time data using the obspy FDSN (International Federation of Digital Seismograph Networks) client to fetch data from the IRIS datacenter, using example array data from the small aperture SPITS seismic array in Spitsbergen, Svalbard. A ‘replay’ mode using existing archive (non real-time) data has also been implemented and tested on array data from the 2014 eruption at Holuhraun and Bardarbunga volcano in Iceland, collected as part of the FUTUREVOLC project. The RETREAT tool is now ready for testing and implementation in a volcano monitoring setting at observatories. It will also be made freely available to download as a
EUROVOLC community tool.