Tracking magma migration in near-real time, the FUTUREVOLC supersite approach

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Our ability to predict the onset and evolution of eruptions depends, in part, on our ability to image the movement of magma beneath the surface, and model the associated changes in stress. To date, this has been achieved primarily using GPS and seismic data gathered in situ, with satellite-borne radar data being used, in the main, to analyse eruptions retrospectively. With the more frequent revisit times of the current generation of radar satellites, and the upcoming launch of the Sentinel-1 mission, we are now in the position where radar imaging can also be used to monitor volcanoes. One of the aims of FUTUREVOLC, a collaborative project encompassing 26 partners in 10 countries, is to develop a system that will automatically ingest synthetic aperture radar (SAR) images and output deformation maps in near-real time. FUTUREVOLC is a supersite project, where Iceland has been selected as the target area. The main objectives of FUTUREVOLC are to establish an integrated volcanological monitoring procedure through European collaboration, develop new methods to evaluate volcanic crises, increase scientific understanding of magmatic processes and improve delivery of relevant information to civil protection and authorities.

In order to achieve the goal of analysing SAR images in near-real time, a new approach is needed. We have developed a system that uses pre-analysis of the SAR archive to identify pixels that have similar noise characteristics, but not necessarily the same deformation history. This information can be used to very quickly identify coherent pixels for interferograms formed using a new image acquired in a time of crisis. We have also developed new methods for 'unwrapping' the phase of these new interferograms, which utilise the redundancy of the interferogram network to automatically and robustly detect unwrapping errors. We use data acquired prior to, and during, the 2010 Eyjafjallajökull eruptions to test our algorithms. A subsequent aim of FUTUREVOLC will be to take the output from this SAR processing chain, together with other in situ data, and produce models of magma migration and stress evolution, also in near-real time.