PROJECT TITLE: **Linking precursory volcano deformation to eruptive activity using satellite InSAR.**
DTP Research Theme(s): Dynamic Earth
Lead Institution: University of Bristol
Lead Supervisor: Juliet Biggs, University of Bristol, School of Earth Sciences.
Co-Supervisor: Michael Poland, USGS, Cascades Volcano Observatory
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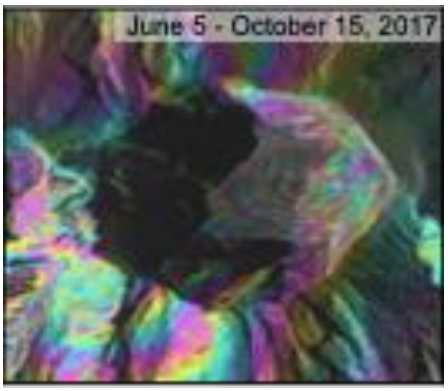
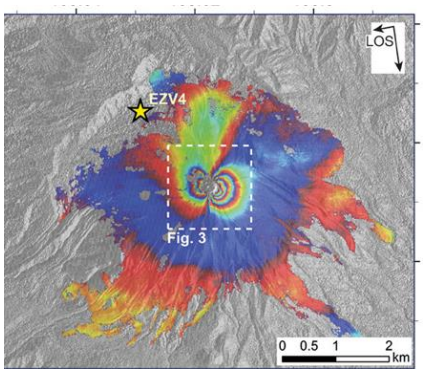
Project keywords: (provide as required)



Deformation observed inside the crater of Agung Volcano, Indonesia using CosmoSkyMed prior to its eruption in 2017 (credit. M. Poland)



Deformation observed inside the crater of Colima Volcano, Mexico using TerraSAR-X prior to an explosion in 2013. From Salzer et al, 2014.

Project Background

Improved volcano monitoring enables mitigation measures to be put in place and reduces the socio-economic impacts of eruptions. However, the ability to observe volcanic and magmatic processes has traditionally been limited by the spatial resolution and coverage of networks of ground-based sensors. Satellite InSAR provides an opportunity to observe volcano deformation at unprecedently high-resolution (<5m) and at every volcano globally. Increasingly, small-scale or localised deformation patterns are being noted, but their origin, characteristics and link to the eruption cycle are poorly understood. The above figures show examples of deformation occurring over only ~1 km at the summits of Colima, Mexico (Salzer et al, 2014) and Agung volcano, Indonesia (Poland, pers. comm), prior to eruptive events.

Project Aims and Methods

The aim of this project is to characterise the spatial and temporal properties of localised volcano deformation patterns and determine their origin and relationship to eruptive activity. Possible mechanisms for this deformation style include conduit processes associated with the final stage of magma ascent, pressurisation of hydrothermal systems prior to phreatic eruptions, instabilities associated with recent deposits, and the localisation of deformation onto creeping structures such as faults. Each of these possibilities has different implications for the volcanic system and potential eruptive activity, and the student will investigate ways in which the signals could be used to improve forecasting. The project will focus on the latest generation of high-resolution satellite radar data, from satellites such as TerraSAR-X, CosmoSkyMed and Paz, using methods such as InSAR, pixel tracking, and developing dynamic corrections for changing topography. The project will focus on targets of interest to the USGS Cascades Volcano Observatory and Volcano Disaster Assistance Program, including Agung, Indonesia (see figure), and Mount St Helens, Kīlauea, and Yellowstone in the USA, and will contribute to the real-time response to any eruptions that may occur.

Candidate Requirements

This project would suit a student with a numerate background in the geosciences and an interest in satellite data, natural hazards, and/or volcanology.

CASE or Collaborative Partner

The CASE Partner is the USGS Cascade Volcano Observatory (CVO), and the co-supervisor is the current scientist-in-charge of the Yellowstone Volcano Observatory, head of the USGS Volcano InSAR project, and co-lead of the CEOS Volcano Demonstrator. The student would spend an extended period of time working at CVO, which is located just outside Portland, Oregon, and is also where the USGS Volcano Disaster Assistance Programme is based. The student will have the opportunity to participate in the scientific response to volcanic crises around the world by contributing to the real-time analysis of satellite data.

Training

The student will receive training in geophysical methods and volcanology, specifically InSAR processing, time series analysis and modelling. The opportunity to spend time at the Cascades Volcano Observatory will provide on-the-job training in the operational use of satellite data to inform the response to volcanic crises.

References / Background reading list

Hamling, I. J., Williams, C. A., & Hreinsdóttir, S. (2016). Depressurization of a hydrothermal system following the August and November 2012 Te Maari eruptions of Tongariro, New Zealand. *Geophysical Research Letters*, *43*(1), 168-175.

Kobayashi, T. (2018). Locally distributed ground deformation in an area of potential phreatic eruption, Midagahara volcano, Japan, detected by single-look-based InSAR time series analysis. *Journal of Volcanology and Geothermal Research*, *357*, 213-223.

Neuberg, J. W., Collinson, A. S., Mothes, P. A., Ruiz, M. C., & Aguaiza, S. (2018). Understanding cyclic seismicity and ground deformation patterns at volcanoes: Intriguing lessons from Tungurahua volcano, Ecuador. *Earth and Planetary Science Letters*, *482*, 193-200.

Salzer, J.T., Thelen, W.A., James, M.R., Walter, T.R., Moran, S. and Denlinger, R., 2016. Volcano dome dynamics at Mount St. Helens: deformation and intermittent subsidence monitored by seismicity and camera imagery pixel offsets. *Journal of Geophysical Research: Solid Earth*, *121*(11), pp.7882-7902.

Salzer, J. T., Nikkhoo, M., Walter, T. R., Sudhaus, H., Reyes-Dávila, G., Bretón, M., & Arámbula, R. (2014). Satellite radar data reveal short-term pre-explosive displacements and a complex conduit system at Volcán de Colima, Mexico. *Frontiers in Earth Science*, *2*, 12.

Stephens, K. J., Ebmeier, S. K., Young, N. K., & Biggs, J. (2017). Transient deformation associated with explosive eruption measured at Masaya volcano (Nicaragua) using Interferometric Synthetic Aperture Radar. *Journal of Volcanology and Geothermal Research*, *344*, 212-223.

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The application deadline is 1600 hours GMT Monday 6 January 2020 and interviews will take place between 10 and 21 February 2020

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