Detection of surface deformation due to volcanic activity using satellite remote ...

Science, Geology

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Satellite remote sensing has brought significant change in the field of volcanology. In earlier times monitoring and investigating volcanos required intensive fieldwork. During volcanic eruptions and unrest, frequent observation of the volcano is required to monitor the change in activity, in order to update hazard assessments and protect local populations. Thus up to date observations of the surface is crucial for current hazard level.

Observations of the volcano can be made using a variety of techniques and sensors, but most of the methods have limitations. Visual observations cannot be used during the night and poor weather conditions such as low lying clouds, which is especially the problem for volcanoes with high relief. Passive sensors like thermal IR cameras that can make observations in low light still requires clear weather conditions. Ground-based sensors such as seismometers can make continuous observations regardless of weather conditions, however, these observations are limited to single location and they are often placed at a distance from the active vents. Active radar sensors provide their own illumination and hence can work at day and night and even in presence of cloud. SAR observations thus complement other monitoring techniques. Satellite-based SAR can capture ten to hundred kilometers of wide areas repeatedly from days to weeks and are therefore most suited for volcanic systems.

In this project, the data provided by Sentinel-1 radar for three main volcanoes “ Erta Ale” at Ethiopia, “ Kilauea” at Hawaii and Piton de la Fournaise” at Ile de La Réunion are taken into account for detecting surface deformations caused due to the injection of magma in the superficial parts of the earth’s crust. These SAR data are complex-valued images that comprise of the amplitude(or intensity) and the phase component. The phase of a single SAR image is of no practical use. Thus, a technique called interferometric synthetic aperture radar(InSAR) is used to produces interferograms. InSAR uses two SAR images taken at a different time of the same region to generate maps of surface deformation using the phase difference of the waves returning to the satellite. In areas where the land changes drastically, for example, due to vegetation growth the phase difference between neighboring pixels observed by InSAR appears random (incoherent), and therefore no meaningful information can be retrieved. To filter out these incoherent regions the associated coherence maps of the interferograms are taken into account. In an interferogram, coherence is the measure of correlation. It serves as a measure of the quality of an interferogram and tells about the surface type such as vegetation or rock. It ranges from 0. 0 to 1. 0, where 0. 0 means there is no useful information in the interferogram and 1. 0 means there is no noise in the interferogram.