# COUPLING POLARIMETRIC L-BAND INSAR AND AIRPORTED LIDAR TO CHARACTERIZE THE GEOMORPHOLOGICAL DEFORMATIONS IN THE FOURNAISE VOLCANO

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The Fournaise volcano has reached an anomalic activity level in the past two years with a major eruption occurring in April 2007, forming terrains with several multiple eruptive periods that make it particularly difficult to quantitatively monitor surface deformation because of the ambiguities associated with remote mapping of the extension of the lava flows, exploring the locations of buried source vents, and assessing the temporal and geographical variability of their textural characteristics. The burial of flows is a result of the deposition of younger pyroclastics or flows associated with more recent eruptive events. Burial of older flows by younger eruptive events often leads to complex surface geomorphology and subsurface stratigraphy, which in turn leads to substantial ambiguities associated with Interferometric Synthetic Aperture Radar (inSAR) monitoring of volcanic activities, limitations in the development of lava flow models that results in a poor understanding of the eruptive history, and hence a failure to address the magma budget in the magma chamber. In order to address those issues, in 2006 we began an intensive SAR polarimetric mapping campaign of the Fournaise volcano mainly with the Advanced Land Observing Satellite (ALOS) L-Band images with parallel and cross polarizations to avoid the clutter caused by vegetation and utilize the full polarimetric modes, which allow a better identification of deformations that occur in the vegetated areas inside and surrounding the volcano. A sample of our interferometric results is shown in Fig. 1 that summarize the measured InSAR displacements observed using the ALOS dataset between June and October 2007. This analysis enabled us to visualize and monitor the evolution of the deformations preceding, during, and after the eruption.

On September 2007 (4 months after the end of the eruption), we performed a heliported radar sounding (using a high power 40 MHz antenna that allows penetration of 50–80 m) of several sections of the Fournaise volcano for which we have observed decimetric topographic deformations in the inSAR maps. The aim of this investigation was to correlate the topographic deformations to the variations of the structural rigidity of the subsurface. We observed that the deformed zones are correlated with the occurrence of subsurface fractures, suggesting occurrence of collapsing zones at the caldera. In September 2008, we complemented our analysis with airported Lidar scan of the west and North sections of the Fournaise in order to perform high resolution 3D topographic model of the most active sections of the volcano. In particular, we surveyed the Dolomieux crater (Fig. 2), which shows substantial correlation between the inSAR observed anomalies and the collapsing zones, suggesting additional enlargement of the crater in the upcoming eruptions. Four locations in the great slopes area east of the caldera also showed similar significant fracturing and will have to be monitored closely as potential eruption locations. Combining both inSAR, radar sounding and LIDAR allow us to monitor closely weak-structured zones that are candidates for future collapses. The LIDAR high resolution of few tenths of centimeters combined with the installation of three L-Band corner reflectors (CR) would allow us to increase the accuracy on measuring sub-centimetric inSAR displacements that may precede major eruption as observed in the L-Band. Results from coupling inSAR and Lidar are currently under processing and will be shown at the time of the conference.

Reference: *Wada, Heggy et al., 2009, ALOS L-BAND INTERFEROMETRIC OBSERVATIONS OF THE FOURNAISE VOLCANO: MONITORING AND MODELLING THE DISPLACEMENTS OF THE 2007 MAJOR ERUPTION, Submitted, JGR-Earth Surface, 2009JF001396, 2009-06-12.*

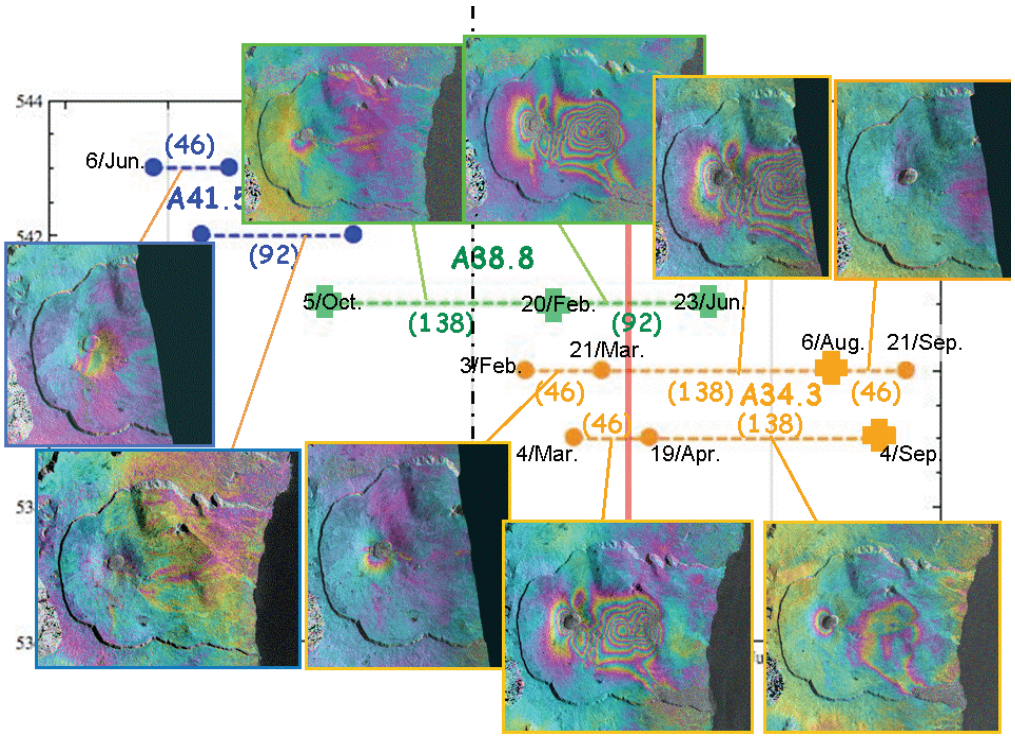


*Fig. 1: ALOS interferograms of the period from 6 June 2006 to 21 September 2007, showing the succession of the deformation that occurred on the Fournaise volcano in the periods preceding, during, and after the eruption. We can clearly note the variability of the patterns and the amplitudes that suggest the complexity of the form of the current magma chamber.*

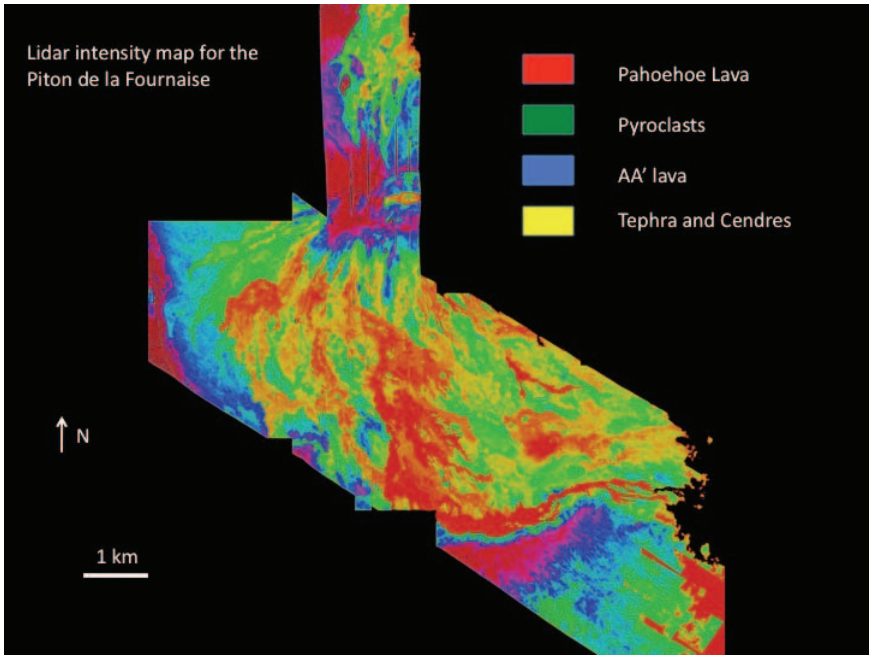


*Fig. 2: Airported Lidar intensity map of the southern part of the Dolomieu crater. The Lidar intensity data indicated the occurrence of several collapsing zone around the Dolomieu crater, suggesting additional enlargement of the crater in the upcoming eruptions.*