Thermal signals in volcano monitoring: combining MODIS-MIROVA data with ground-based measurements at Aso Volcano, Japan

*Corrado CIGOLINI[1], Akihiko Yokoo[2], Diego Coppola[1], Marco Laiolo[1]

1. Department of Earth Sciences, University of Torino, Italy, 2. Aso Volcanological Laboratory, Institute for Geothermal Sciences, Kyoto University, Japan

Active volcanoes bearing crater lakes are rather challenging targets for thermal monitoring since their anomalies are rather small when compared to lava flows and/or domes. Thus, we have combined satellite data with ground-based measurements at Aso Volcano during its recent activity.
The thermal signals of Aso Volcano (Nakadake) during unrest episodes have been analyzed by means of the MODIS-MIROVA data set and high resolution images (LANDSAT 8 OLI and Sentinel 2) cross-checked with ground-based thermal observations. The Volcanic Radiative Power (VRP) detected by nighttime satellite data during the time span considered was mainly below 3 MW. This value is a thermal threshold that marks the transition from high fumarole activity (HFA) to Strombolian eruptions (SE). Periods with the occurrence of sporadic phreatic eruptions (PE, eventually bearing phreatomagmatic episodes), is the dominant phase during unrest episodes, with VRP values around 0.5 MW. However, during sustained Strombolian phases (November-December 2014) the radiative power was higher than 4 MW, reaching peak values up to 15.6 MW (on December 7, 2014, 10 days after the major Strombolian explosion of November 27). Ground-based measurements, recorded by FLIR T440 Thermo-camera on the fumarole field of the South Area, shows that the heat-flux stabilized around 2 MW until February 2015. Apparent temperatures measured on the fumarole field were around 490-575˚C before the major Strombolian explosive event, whereas those recorded at the active vent (Central Pit) reached their maxima around 600 ˚C. In the following days they both exhibited a decreasing trend. However, during the Strombolian phase the crater lake dried out and was then replenished by early July, 2016. Then volcanic activity shifted back to phreatic-phreatomagmatic and the eruptive cycle was completed; in this period ground measurements were fluctuating around 1 MW. Following the major phreatic explosion of October 8, 2016 satellite VRP were moderately above 2 MW and then progressively decreased. During 2018, they were essentially below 1 MW (with a mean of 0.75 Mw and few peaks above 1 MW).
We estimated the total amount of Magma Equivalent Volume (MEV) responsible for satellite thermal anomalies during the Strombolian phase (from the end of November 2014 to May 2015). The cumulative volume involved in this phase reached 4.5 x 10^5 m^3, which is two order of magnitude lower than the total volume of magma undergoing degassing (estimated by means of the petrologic models based on SO_2 degassing). This indicates that thermal anomalies during the Strombolian phases detect the magma that is reaching the surface and through a feeder dike, or conduit, connected at depth with a major reservoir.

Keywords: Aso Volcano, unrest episodes, thermal anomalies, Strombolian activity, major explosions

