



## **Continuous thermal infrared monitoring at Campi Flegrei and Vesuvius (Italy) by automated data processing: an effective surveillance tool of active volcanoes**

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The INGV-Osservatorio Vesuviano Thermal Infrared Imagery Monitoring Network (TIIMNet) is made up of IR acquisition stations designed to continuously acquire IR scenes of diffuse degassing areas in the Neapolitan volcanic district.

Every station consists of a RMS (Remote Monitoring Station) which manages the shooting functionalities of the IR camera and the connection to the surveillance Centre of INGV-Osservatorio Vesuviano in Naples. The first developed station was equipped with a NEC Thermo Tracer TS7302 IR camera (with 320x240 pixel FPA uncooled microbolometer); a newer one is equipped with a FLIR SC645 IR camera (with 640x480 pixel FPA uncooled microbolometer) and is supported by an in-house developed hardware which manages a fully real-time control of data acquisition and transfer procedures.

As a whole, TIIMNet is composed of four permanent stations and three transportable ones. The first permanent NEC Station was installed at Vesuvius on July 2004 and dismissed on May 2007. A new permanent FLIR Station was set up on June 2011 and it acquires IR scenes from the inner SW slope of Vesuvius crater.

In the Campi Flegrei caldera (Pozzuoli, Italy) a permanent NEC Station was operative at Solfatara since September 2004 and it acquired scenes of the major fumaroles area located on the SE inner slope at the intersection of two active, SW-NE and NW-SE main faults. A permanent FLIR Station has been installed at Solfatara on June 2013 and takes IR shots of a significant thermal anomaly on the Northern inner slope of the crater.

At Pisciarelli locality, on the Solfatara NE outer slope, a transportable NEC Station was set up on October 2006 and dismissed on September 2013. It was abreast of a permanent FLIR Station on March 2013. Both stations stored IR scenes of the outer eastern flank of the Solfatara tuff-cone characterized by heavy water vapor and CO<sub>2</sub> emissions close to an active NW-SE fault.

IR scenes are acquired every night by the TIIMNet stations and in real time processed by a fully automated in-house developed software which performs the following automated tasks for every station: a) it identifies low quality IR scenes by using a statistical approach and removes them from the analysis; b) it calculates maximum temperature values in a selected area of the IR scenes; c) it corrects the temperature values using a procedure aimed to remove seasonal effects; d) it exports the results into a proper format in order to be plotted and displayed at the Osservatorio Vesuviano Surveillance Room. All the FLIR Stations can also be remotely controlled and can acquire IR scenes if requested for surveillance needs.

Results of thermal IR images analysis give a detailed picture of the evolution of surface temperatures in the monitored areas. The time behaviour of the extracted thermal parameters fully agrees with ground deformation (GPS) and CO<sub>2</sub> flux trends, this confirming continuous thermal infrared image acquisition as a useful tool for volcano monitoring.