Ground surface deformation patterns evidenced by interferometric synthetic aperture radar techniques DInSAR and SBAS and implications on magma storage at Sabancaya volcano, 2013-2017 period

Katherine Gonzales*†[1], Edu Taipe[1], Juan Casas[1], Hugo Zárate[1], and Domingo Ramos[1]

[1]Instituto Geológico Minero y Metalúrgico – Av. Canadá 1470, San Borja., Peru

Abstract

Sabancaya volcano is the youngest of the Sabancaya–Ampato (north to south) volcanic complex (ASVC), located in southern Peru, which borders to the north with the older and eroded Hualca Hualca volcano. Its last volcanic activity started in February 2013 when an intense fumarolic (water vapor 3.5 km height) activity was followed by the occurrence of 4 big earthquakes (4.5 – 5.2 ML) located _˜10 km to the E-SE of the present day crater of Sabancaya volcano. Later, the 16th July 2013, occurred a big earthquake (5.9 ML) located 15 km to the west of Hualca Hualca summit, caused by the activity of a, not previously cartographed normal fault. Intermittent ash and fumarolic emissions and the occurrence of volcanic-tectonic seismicity has been registered since then at present. Explosive events started in 6th November 2016.
We used interferometric synthetic aperture radar techniques, such as D-InSAR (Differential Interferometry) and SBAS (Small BAseline Subset) in order to evaluate the deformation field associated to its last and current activity. Terrasar-X and Sentinel-1 temporal series of SAR images spanning 14/01/2012-25/09/2016 and 08/10/2014-06/07/2017 respectively, were used.

D-InSAR Terrasar-X results showed a deformation area of _˜28x26 km produced by the 5.9 ML earthquake affecting most of the Hualca Hualca volcano edifice. A differential interferogram series obtained by D-InSAR shows the re accommodating process of the volcano edifice after the occurrence of the 5.9 ML earthquake in a period of 3 years, however a residual deformation showing the normal fault feature (of about 1/3 of a fringe cycle) is still preserved at the end of 10/2016.

SBAS Sentinel-1 results, show concentric patterns of deformation (inflation rate, 5 cm per year) around the Hualca Hualca and afecting also ASVC but centered in Hualca-Hualca volcano where the maximum amplitude of displacement, 14 cm LOS, has been derived by SBAS data. The source of this inflation has been modeled (Taipe et al., 2018) by mean of dMODELS software (Battaglia, 2009) and a spherical deformation source of around 4 km radius and 12 km depth beneath the summit results as the best fit model. This inflation might be related to the presence of a big magma storage located beneath Hualca Hualca.
Furthermore, the SBAS deformation profiles near and around Hualca Hualca volcano show

*Speaker
†Corresponding author: kgonzales@ingemmet.gob.pe

linear inflation behavior, where GPS measurements support this observation, however deformation profiles near and around Sabancaya (< _˜3km) are affected by undulating behavior, where the risings are nearly related with periods of increasing occurrence of VT seismic events. This would suggest: a) A shallow and smaller magma storage beneath Sabancaya volcano might be fed through dipping conduits connecting the previously mentioned big and deeper source, b) Sabancaya active vent might be fed by dipping conduits connecting the deeper source. A large distance (7 km) and partial feeding from magma chamber between deformation source near Hualca Hualca and Sabancaya eruptive center has been previously referred for the 1990 eruption (Pritchard and Simons, 2002).