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Seismic precursors of vulcanian explosions at Ubinas volcano (Peru) : Statistical analysis and source locations

J.-P. Métaxian (1), O. Macedo (2), O. Lengline (3), V. Monteiller (4), and E. Taipe (5)

(1) IRD, LGIT-Universite de Savoie, Le Bourget du Lac, 73376, France (metaxian@univ-savoie.fr), (2) Instituto Geofisico del Peru, Cayma, Arequipa, Peru (omacedo@geo.igp.gob.pe), (3) Laboratoire de Géophysique Interne et Tectonophysique, Université de Savoie, Le Bourget du Lac, 73376, France (Olivier.lengline@univ-savoie.fr), (4) Dynamique Terrestre et Planétaire, CNRS UMR 5562, Observatoire Midi Pyrénées, 31400 Toulouse, France(vadim.monteiller@dtp.obs-mip.fr), (5) Instituto Geofisico del Peru, Cayma, Arequipa, Peru (edu.aqp@gmail.com)

Ubinas stratovolcano (5672 m), located 60 km east from Arequipa city is historically the most active volcano in Peru. The present eruption began on March 25th 2006. A lava plug has been observed at the bottom of the pit crater situated in the south part of the caldeira. The eruptive activity involves very brought closer exhalations rising a few hundred meters above the crater rim to larger plumes produced by explosions that may reach up to 3 kilometers. The seismic activity is characterized by high rates of long-period (LP) event production accompanying eruptive activity and very long period (VLP) events observed at the same time as vulcanian explosions. The LP and VLP events have a spectral content respectively dominated by frequencies between 2-5 Hz and 0.3-0.9 Hz. The vulcanian explosive activity is characterized by the occurrence of LP swarm preceding most of the VLPs by about 2 hours. In some occasions, the LP swarm merges into tremor about half an hour before the explosion. LPs belonging to the same swarm have similar waveform suggesting a unique source area, which could be the conduit and/or the lava plug surface. The monitoring system includes 4 seismic stations, among which one is equipped with a broadband sensor and 2 tiltmeters.

In this work we analyzed a catalogue of data including more than 40000 LP events and 130 VLP events recorded between May 2006 and December 2008.
The evolution of the average number of LP events preceding explosions was computed. The variation of the LP rate is clearly diverging from the background rate ~ 0.1 days before explosions. In particular, the most energetic explosions are correlated with the biggest increases of seismicity. However this general behavior is not observed for every single explosion. A direct test is now under study in order to check if the earthquake rate can be used as an alert tool for future explosions.
To locate the source of LP events belonging to the swarms, we used a method based on the measurement of the delays among arrivals of LP events to each of the network receivers. The observed differences of delays between events obtained for each pair of receivers were therefore compared to theoretical values deduced from the computation of travel times between grid nodes positioned in the structure and each receiver.