8th International Symposium
on Andean Geodynamics
(ISAG)

Seismo-acoustics of paroxysmal eruptions of Tungurahua volcano

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Explosive sustained eruptions, usually lasting several hours, eject mixtures of gases and pyroclasts causing significant seismic and acoustic phenomena. Their records show strong correlations between them in a wide spectral range, which are consequence of interactions on the volcanic surface of the waves travelling within the volcanic edifice and those traveling in the air due to the entrainment in atmosphere of the volcanic products. A better understanding of such interactions helps the volcanic monitoring specially in those cases when the volcano is cloudy. From Tungurahua paroxysms we have learned the difference between those strong and long-lasting seismic tremors, without eruption, and those related to explosive sustained eruptions, which pose the major hazards. Here it is presented seismo-acoustic results of the ten largest eruptions of Tungurahua volcano of the period 2006-2016.

In order to explore the seismic and acoustic records from paroxysms we use two main analyses. First, it is well known that seismic waves are affected by existent geological heterogeneities beneath each station. The site effect caused by those structures are particularly important in volcanic environments. In case of Tungurahua, it is a stratovolcano formed by sequences of pyroclastic flows, lava flows and ash fallouts. We can only observe the final effect of this complexity in the records of each station. However, we use an approach that normalize the seismic noise as an approximation that represents the transfer functions of these site effects, which allow us to correct the seismic signals that finally provide us better source locations and intensities. Second, we explore the coherence between the acoustic records with each seismic component. Coupled acoustic waves in the ground change the seismic signals, becoming much more difficult discriminate seismic from acoustic records along the eruptions. However, we have found a frequency band, roughly between 1 and 2 Hz, common at all stations, where non coupled acoustic waves are evident, and belonging to a range where site-corrected seismic waves are strong. After these two analyses we define the seismic and acoustic intensities to compare the ten largest eruptions of Tungurahua.

Ultimately, what our study shows is the importance and necessity of including infrasound sensors in volcanic stations, providing better tools to improve both hazard monitoring and the understanding of the volcanic processes.