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Eruptive activity of Ibu volcano, Indonesia, revealed by using a small aperture seismic array and infrasound sensor

Jean Philippe Metaxian (1,2), François Beauducel (1,2), Martanto Martanto (3), Devy Syahbana (3), Jatmika Teja Sukmana (1), Nia Haerani (3), Kuswarno Kuswarno (3), Philippe Lesage (1), Jacques Grangeon (1), Nurul Husaeni (3), Etwin Purawouw (3), and Ridwan Jalil (3)

(1) ISTerre, IRD, CNRS, Université Savoie Mont Blanc, F-73376 Le Bourget du Lac, France (Jean-Philippe.Metaxian@ird.fr), (2) Institut de Physique du Globe de Paris, Université Sorbonne-Paris-Cité, CNRS, France, (3) Badan Geologi, Jalan Diponegoro No. 57, 40122 Bandung, Indonesia

The double subduction located in northeastern Indonesia is at the origin of a very high tectonic seismicity and two extremely active volcanic belts located in Sulawesi in the west and on the archipelago of the Moluccas in the east. Located on Halmahera Island, North Moluccas, Ibu volcano has a permanent eruptive activity since 1998. The formation of dacitic domes gradually fills a circular crater of about 1km diameter. The continuous growth of domes could produce in a near future pyroclastic flows through the depression open to the north of the crater and threaten populations whose closest are within 5 km from the summit. The eruptive activity is characterized by tens to hundreds of vulcanian explosions a day. Presently the volcano is monitored by a network of 4 seismic stations and a tiltmeter. A small aperture seismic array and an infrasound sensor were set up in November 2016 for a temporary experiment to 1) identify the different types of eruptive seismic events; 2) estimate the source positions, in particular the depth; 3) analyse the temporal evolution of the activity over a period of several months.
The array was positioned on the west flank of Ibu volcano at approximately 3 km from the crater. Its aperture is 338m and the shortest distance between sensors is 38m. This antenna allows analysing low frequency signals, below 1 Hz and up to 5 Hz. It is composed of 5 3-components broadband sensors (Guralp 6-TD), 3 short-period vertical sensors (Sercel L4C) and an infrasound sensor build at Université Savoie-Mont Blanc.
The array analysis consists of estimating the slowness vector and therefore the back-azimuth and the apparent velocity for successive time windows moving along the seismograms. The back-azimuth indicates whether the activity is originating from the crater and the apparent velocity is a proxy of the source depth.
Seismic activity characterized by back-azimuth values pointing to the crater shows several types of events: 1) Explosion quakes identified by an acoustic pressure onset, high coherency, apparent velocity values around 1200m/sec, 2) LP events or low energy explosions which have no acoustic phase, but similar apparent velocity values as explosion quakes. For these two types of events, we observe a variation of the apparent velocity preceding the onset of the signals from $\sim$3000 to 1200m/sec, which could characterize a migration of the seismicity in the conduit. Other types of signals such as low frequency tremors ($\sim$1 Hz) and portions of coherent noise with a source apparently deeper compared to explosion quakes will also be presented.