

## Seismic and tilt observation of vulcanian explosions at Lokon-Empung volcano, Northern Sulawesi, Indonesia

Taishi Yamada<sup>1</sup>, Hiroshi Aoyama<sup>1</sup>, Takeshi Nishimura<sup>2</sup>, Hiroshi Yakiwara<sup>3</sup>, Haruhisa Nakamichi<sup>4</sup>, Jun Oikawa<sup>5</sup>, Masato Iguchi<sup>6</sup>, Muhamad Hendrasto<sup>7</sup>, Yasa Suparman<sup>7</sup>

<sup>1</sup>Hokkaido University, Japan, <sup>2</sup>Tohoku University, Japan, <sup>3</sup>Kagoshima University, Japan, <sup>4</sup>Nagoya University, Japan, <sup>5</sup>the University of Tokyo, Japan, <sup>6</sup>Kyoto University, Japan, <sup>7</sup>Center for Volcanology and Geological Hazard Mitigation, Indonesia

E-mail: taishi@mail.sci.hokudai.ac.jp

Lokon-Empung located in the northern Sulawesi is one of the most active volcanoes in Indonesia. Vulcanian eruption activity is considerably high, so we began temporal seismic and tilt observation around the volcano since September 2012, to understand the mechanism of vulcanian eruptions at Lokon-Empung.

Four broadband seismometers, Trillium 40, are deployed around the volcano in the distance range of 1.6 - 6.8 km from active Tompaluan crater. At the closest station WAILAN, a tilt meter (Pinnacle Denali) is also installed. Each seismometer is connected to a data logger (HKS-9550) to record seismic data in a CF card with an A/D resolution of 24 bit and a sampling rate 100 Hz with GPS time stamps. Tilt data digitized every 1 second within the tilt meter are transmitted to a laptop PC at Kakaskasen Volcano Observatory (KKVO) through wireless LAN. Seismic data of WAILAN is sent to Japan through the wireless network and global internet on a trial basis.

Explosion earthquakes on October 5 and November 11 have obvious onset with compressional P phase. Ground velocity of the event on October 5 is in the order of 0.001 m/s at the station WAILAN. Visual report on the height of ash column was about 1500 m above the crater. Before the eruption, small inflation phase (-80 nanoradian) around crater can be seen in tilt record. Duration of the inflation phase is about 40 minutes, which is almost same order to those found in Semeru volcano (3 - 30 minutes). The height of ash column of the explosion on November 11 is about 600 m. The velocity amplitude of the event on November 11 is about half of that on October 5. Although the seismograms of these two explosions seem different in non-filtered traces, we can find very similar waveforms in the lower frequency band below around 1 Hz. This similarity indicates that explosion mechanism of these two events have common physical process. In the low-pass filtered seismograms, large dilatational phase is identified after the compressional P wave and then clear retrograde motion representing Rayleigh wave appears. These waveform characteristics are similar to the explosion earthquakes at Sakurajima, Suwanosejima which often explode with Vulcanian styles. While small deflation phases appearing about a few seconds before the initial compressional phase that are reported for the explosion of Suwanosejima and Semeru volcanoes are not well recognized.

Although we have analyzed only a few events, several remarkable features have found in the obtained data, comparable to the other vulcanian eruptions. To analyze more events and compare them to the other eruptions are effective ways to understand also the mechanism of vulcanian eruption itself, not only at Lokon-Empung.