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2014 年御嶽山噴火に伴う地震活動の時空間発展
Spatial temporal evolution of seismicity before and after the 2014 phreatic eruption of Mount Ontake

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On 27 September, 2014, Mount Ontake caused a phreatic explosion, spraying ash, gas and debris on the surrounding areas. The height of the ash column reached around 7000 m. Earthquake catalog constructed routinely shows that a micro-seismicity (Magnitude <1.0) beneath the summit sharply increased around two weeks before the eruption. However, the preparation stage of the phreatic eruption is not well constrained. In order to understand the physical process associated with the phreatic eruption, we relocated earthquakes including two low-frequency earthquakes beneath the summit using double differential travel times extracted from waveform cross-correlation method, and revealed a spatial and temporal evolution of seismicity applying the matched filter technique to continuous waveform data from 23 August to 30 September, 2014.

The relocated hypocenters aligned along a vertically dipping plane, oriented to NWN-SES. The size of the vertical plane was approximately 0.5 km length and 1 km width. The distribution of hypocenters well matched with alignments of volcanic vents identified by remote sensing images (GSI). Earthquakes before the eruption were tightly clustered and located at relatively deep depths. In contrast, earthquakes after the eruption occurred at depths shallower than the preceding seismicity by around 0.5 km. The vertical alignment of hypocenters implies an intrusion of vapor/gas into volcanic vents near the summit.

Using these relocated hypocenters as template events, we searched similar waveforms to the template events from continuous waveform data. The total number of the newly detected events was greater than 2600. The newly detected seismicity initiated from the end of August and gradually increased to the middle of September, 2014. Following this phase, the seismicity had a peak on the middle of September, and kept the relatively high rate, while slightly decaying. The number of low-frequency earthquakes increased, having a delay of about 5 days from the peak of regular earthquakes. About ten minutes prior to the eruption, the hypocenters migrated to shallower depths and expanded to both NWN and to SES directions, accompanying with typical volcanic tremors. The amplitudes of volcanic tremors increased at an accelerated rate before the eruption. These observations suggest that pressurized vapor/gas rapidly intruded into shallow conduits during final ten minutes, resulting in the 2014 phreatic eruption.