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Analysis of particle motions of volcanic earthquakes at White Island, New Zealand, using multicomponent complex trace analysis method

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To investigate particle motions of volcanos seismic waves, we applied multicomponent complex trace analysis to the non-harmonic tremor detected on August 19 and very long period (VLP) and long period (LP) events recorded on October 3, 2013 at seismic stations WIZ and WSRZ on White Island volcano in New Zealand. Seismic data of 1,000 s duration from continuous records were digitized at a 100-Hz sample rate. Since spectral ranges for the tremor and LP events were overlapped to each other, a low-pass filter with a corner frequency of 0.5 Hz was applied to the VLP event only. To generate the quadrature traces, we applied the Hilbert transform to seismic data and then we calculated instantaneous polarization attributes. To minimize the effects of rapid temporal changes, 10-s moving averages were applied to the instantaneous polarization attributes. The volcanic tremor was mainly composed of horizontally polarized waves with retrograde elliptic motions for which the phase difference between vertical and horizontal components and the reciprocal ellipticity was 9 deg and 0.2 to 0.3, respectively. The rise angle less than 4 deg indicated that the sources were located at shallow depths. The VLP event was linearly polarized with phase difference nearly constant at 0 deg, reciprocal ellipticity close to 0.1, and rise angle of 58 and 52 deg at the two seismic stations. The positive values of rise angle indicate that the VLP event was composed of the compressional waves. Using the values of rise angle, elevations, and surface locations of two seismic stations, we computed the source depth of the VLP event. The depth was estimated to be 0.9 km. The LP events had values for phase difference of 11 and 3 deg, reciprocal ellipticity of 0.2 to 0.3 and rise angle less than 5 deg. The polarization attributes and particle motions of the LP events were similar to those of the volcanic tremor.