Global propagation of seismic waves generated by the explosive eruptions of Hunga Tonga-Hunga Ha’apoi: Preliminary analyses

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An explosive eruption of the Hunga Tonga-Hunga Ha’apoi occurred on January 15, 2022. This eruption generated not only seismic and infrasound waves but also meteotsunamis, which arrived earlier than the expected arrivals of tsunamis. Although this eruption attracted the attention of many researchers on the generation of meteotsunamis, clear seismic signals have also been recorded by broad-band seismometers in the world. Here we summarize the characteristics of long-period seismic waves (10 - 200 s) observed in the Global Seismograph Network (GSN) and preliminary back-projection analysis using the first arrivals of teleseismic P-waves to unravel the seismological characteristics of the eruption sequence.

The first arrivals of P waves have been observed in farther epicentral distances for which P waves are radiated nearly downward from the source. The corresponding PP arrivals can also be seen clearly in the distance greater than 7000 km. These characteristics are consistent with the seismic waves generated by the vertical single-force at the source location, reflecting the eruption mechanisms.

Multiple sequences of the explosive eruptions can be identified from the multiple P and PP wave arrivals until they are masked by the energetic Rayleigh waves from the first explosive event. Long-period surface waves indicate significant variations of frequency contents in each explosive event, some of which have generated multi-orbit Rayleigh waves (up to R3) in the longer-period range (100 s ~). The infrasound waves propagating at 0.3 km/s have also been observed clearly in broad-band seismometers of GSN in the world.

We have used the long-period P-waves (10 –100 s) for the back-projection analysis. The preliminary back-projection images located the source of long-period P-waves northwest of Hunga Tonga-Hunga Ha’apoi. Further analysis of the multiple arrivals of P and PP waves would enable us to clarify the eruption sequence.

Keywords: Hunga Tonga-Hunga Ha’apoi, Teleseismic body waves, Seismic surface waves, Infrasound waves, Explosive eruption, Single force

