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Effect of complex topography on the wavefield recorded by DAS and buried fiber optic cable at Azuma volcano, Northeast Japan

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First DAS observation at Mt. Azuma, Japan was conducted in July 2019 using buried fiber optic cable along the road access to the volcano. Mt. Azuma is an active volcano located in the Tohoku region. Different from non-volcanic regions, wavefields in the volcano is more complex due to its topography and the strong heterogeneities beneath the volcanic edifice. The strength of the scattering of seismic waves due to small-scale velocity heterogeneities in the volcano is reported to be more than one order higher than that in the non-volcanic region. To estimate small-scale heterogeneities, a dense observation network is necessary. The high spatial resolution is one of the advantages of the DAS observation. Therefore, DAS observation in the volcano might be a good chance for the estimation of the small-scale heterogeneity.

We used 14km length of the fiber optic cable buried along to the access road to the observatory near the summit installed by the Ministry of Land, Infrastructure, Transport and Tourism to monitor the volcanic activities. The spatial and temporal samplings were 10m and 1000Hz, respectively. The observation period was for 3 weeks. In addition to regional and teleseismic earthquakes, volcanic earthquakes were also observed. A teleseismic P-wave was analyzed to investigate the effect of small-scale heterogeneities. Because the incident angle of the teleseismic P-wave is almost vertical to the portion of the fiber optic cable used for the DAS observation, a simple model can be used. We calculate the cross-correlation coefficient (CCC) of waveforms between channels and analyze its dependence on the distances between channel pairs. The recorded wavefield was fluctuated by scattering due to the small-scale heterogeneities and different waveforms were recorded even though the propagation distances are the same. Therefore, the spatial variation of the waveforms of teleseismic P-wave recorded at surface stations would be related to the small-scale heterogeneities beneath of the array.

The CCC decreases with increasing separation distance and converges to a constant value. This shape can be modeled by the Gaussian function and we defined the spatial scale of CCC by fitting the Gaussian function. The scale decreases with increasing frequency. The finite difference

simulation of the wave propagation was performed by changing the velocity structure and compare the synthetic and observed CCCs. We found that the effect of the topography is most significant on the CCC. Because analyzed waveforms mainly consist of the converted surface wave from the teleseismic P-wave, the effect of subsurface small-scale heterogeneities is not significant. Our result shows that it is necessary to consider the effect of the topography in analyses of DAS data recorded in volcanoes.