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Seismic velocity changes in response to different direction of tidal strain

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Seismic velocity changes caused by large earthquakes or volcanic activities have been studied to understand the mechanical properties of the shallow structure. One of the mechanism of velocity changes is closing/opening of cracks by strain (stress) changes (Walsh, 1965). In order to evaluate the in-situ strain effect on the velocity changes, seismic velocity changes in response to the Earth tide have been investigated by active sources (e.g. Yamamura et al., 2003) and noise correlation method (e.g. Takano et al., 2014). Here, we further investigate the seismic velocity changes in response to the tidal strain systematically paying attention to the crack alignment and the direction of tidal strain.

We analyzed ambient noises recorded by seismic stations of Japan Meteorological Agency from 2012 to 2015 at 11 active volcanoes in Japan where more than two seismic stations are deployed. The interstation distances are within about 3 - 10 km, which is suitable to investigate the velocity changes at the shallow part of the structure by the cross correlation functions at the frequency band of 1 - 2 Hz. We calculate seismic velocity changes in response to the Earth tide by stacking the cross correlation functions of ambient noise in different tidal strain amplitude at each seismic network station. We estimate the strain sensitivity of velocity changes in different directions of tidal strain by the GOTIC2 software (Matsumoto et al., 2001).

The observed strain sensitivities of the velocity changes which are ranging from 10^3 to 10^4 /strain show azimuthal dependence for the tidal strain at 7 volcanoes. Aligned cracks may be deformed differently for the tidal strain that changes the direction of principal strain axis. Consequently, the polarity of strain sensitivity of velocity changes may change in different direction of tidal strain.