Waveform inversion of oscillatory signatures in long-period events beneath volcanoes

Hiroyuki Kumagai[1], Bernard Chouet[2], Masaru Nakano[3]

[1] NIED, [2] USGS, [3] Architecture., Nagoya Univ

The source mechanism of long-period (LP) events is examined using synthetic waveforms generated by the acoustic resonance of a fluid-filled crack. We perform a series of numerical tests in which the oscillatory signatures of synthetic LP waveforms are used to determine the source-time functions of the six moment tensor components from waveform inversions assuming a point source. We follow the inversion method developed by Ohminato et al. [JGR, 103, 23839-23869, 1998]. The results indicate that the moment tensor representation is valid for the odd modes of crack resonance with wavelengths 2L/n,2W/n, n=3,5,7,,,, where L and W are the crack length and width, respectively. For the even modes with wavelengths 2L/n, 2W/n, n=2,4,6,,,, a generalized source representation using higher order tensors [Takei and Kumazawa, GJI, 121, 641-662, 1995] is required. In light of the small excitation efficiency of seismic waves in the even modes [Takei and Kumazawa, 1995], the moment tensor inversion may be generally applicable to LP events. Our numerical tests also suggest that more than four, and ideally ten to fifteen, three-component stations surrounding an LP source are required for an accurate description of the moment tensor. We apply the moment tensor inversion to the oscillatory signatures of an LP event observed at Kusatsu-Shirane Volcano, central Japan. Our results point to the resonance of a sub-horizontal crack located a few hundred meters beneath the summit crater lakes. This source mechanism is consistent with previous source mechanisms determined for LP events at Kusatsu-Shirane. The present approach is relatively convenient to quantify the source location, geometry, and force system of LP events, and opens the way for moment tensor inversions of tremor.