Magma chamber and volcanic conduit interaction: A tale from diverse long-period tremors in Aso volcano, Japan

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In the southwest Japan, long-period tremors (LPTs), in Aso volcano have been observed since the pioneering work by Sassa (1935). LPTs typically have a resonant period of ~15 seconds and they are repetitive and appear time-invariant in their location and mechanism. It is considered that LPTs represent the resonance of a crack-like volcanic conduit located in the proximity close to the active first crater, with a source depth close to the sea level. While surface degassing/eruption and magmatic heating (or hot gas) are often invoked to trigger LPTs, the response of deep conduit or magma chamber during LPT excitation is not known. In this study, we aim to clarify possible response/feedback between shallow conduit of the LPT source and the magma chamber.

Previously, we constructed LPT catalog between 2011 and 2016 and identified diverse LPTs with opposite waveform polarities (Niu and Song, 2018, this meeting). Through waveform stacking of broadband displacement and horizontal tilt borehole recordings, we find that LPT stacked waveforms are accompanied by a very weak (e.g,. vertical displacement of ~ 1 μm and horizontal tilt of < 1 nrad), but detectable static offset, with a rise time on the order of ~100 seconds. When stacked waveform quality is not sufficient to provide a stable observation of the static offset, we use ultra-long period waves of 100-200 sec period as a proxy, termed filtered static offset (FSO), since their amplitude decay in the near field is practically identical to the static offset.

The displacement ratio and tilt ratio of FSO among different station or/and different channel do not show appreciable change over the 6-year period, and they are distinct from those measured against LPT, suggesting a repetitive, but non-destructive source located away from the LPT source. Joint inversion of tilt and displacement data of FSO put the source close to previously inferred magma chamber of ~ 5 km, a few kilometres southwest of the first crater and the LPT source. This observation demonstrates that the LPT source and FSO source occur almost concurrently beneath Aso volcano, indicating a causal interaction between the shallow conduit and the magma chamber.

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