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

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Long period volcanic tremors (LPTs), typically termed as VLP in the volcanology community, have been widely observed in many volcanic systems around the world. In many instances, LPTs in different volcanic settings are repetitive, but time-invariant in their location, suggesting a non-destructive source. While the excitation mechanism of LPTs is commonly related to the resonance of volcanic conduit due to fluid-rock interaction, the triggering mechanism of LPTs receives much less consensus and remains enigmatic. If surface degassing or eruption triggers LPTs, does the decompression inside the volcanic conduit trigger deformation in the magma chamber? Is there any detectable deformation associated with the magma chamber that may be indicative of a source of triggering?

In the southwest Japan, LPTs in Aso volcano have been observed since the pioneering work by Sassa (1935) and more recently by Kawakatsu et al. (2000). It is generally thought 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 (Yamamoto et al., 1999). Previously, we constructed LPT catalog between 2011 and 2016 and further identified diverse LPTs with opposite waveform polarities (Niu and Song, 2017, EGU). Through waveform stacking of broadband displacement and horizontal tilt recordings, we find that many LPT stacks are accompanied by a very weak (e.g., vertical displacement of 1 μm and horizontal tilt of < 1 nrad), but detectable ultra-long period wave of 100-200 sec period and longer.

The displacement ratio and tilt ratio among different station or/and different channel do not show appreciate 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 put the source of ultra-long period waves close to previously identified magma chamber, a few kilometers southwest of the first crater and LPT source. We compute the volume change associated with the source of the ultra-long period signal and it is on the order of 100-1000 m^3 per event, whereas the net accumulated volume change over the 6-year period rests at about 100,000-1,000,000 m^3, or 0.0001-0.001 km^3. We will discuss temporal correlation between the inferred volume change (inflation or deflation), LPT diversities and 6-year volcanic activities in Aso volcano, particularly the period prior to and during the 2014 strombolian eruption, as well as possible precursory events before the 2016 phreatomagmatic eruption.