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The source of volcanic tremor investigated during the Eyjafjallajokull eruption 2010

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Volcanic tremor is one of the most distinctive signals accompanying volcanic eruptions and is often interpreted as being related to sub-surface fluid movement. Here we investigate volcanic tremor from recent eruptions in Iceland, using data recorded by the SIL seismic network in Iceland as well as from a temporally installed infrasound array which recorded during the top crater Eyjafjallajokull eruption in spring 2010.
Our analysis of the onset of tremor suggests that it can be co-located with the erupting vent but more interestingly the tremor is not pronounced until the vent opens and seems to be synchronous with that opening, i.e. tremor does not seem to be associated with magma transport before the onset of the eruption. This important observation constrains our models of tremor triggering.

A joint analysis of the infrasound and the seismic tremor data shows that these are strongly correlated and distinctive infrasound pulses can be related to low frequency tremor events which exhibit the typical volcanic tremor features, i.e. the wave train is mainly composed of surface waves with frequency content limited at around 1 Hz. The seismic tremor as well as the infrasound can be collocated at the top crater. The time difference between the infrasound and the seismic data suggests that the infrasound and the seismic events occur more or less simultaneously. A single station three component analysis which looks for ellipticity for all back azimuths confirms that the tremor (continuous or as discrete 1hz events) is mainly composed of Rayleigh wave energy.
A thorough correlation analysis shows that the correlation between one hour of infrasound data and the same hour data of the four closest seismic stations gives a coefficient of 0.6. Moreover the amplitude of 25 infrasound events and that of the corresponding low frequency tremor events show a very good correlation (0.8) where higher amplitude infrasound pulses are seen to be associated with higher amplitude volcanic tremor events.

In order to explain our observations we speculate that the tremor pulses are caused by acoustic to seismic coupling at the crater as big gas bubbles explode just below the vent. The explosions cause shockwaves as the speed of the explosion exceeds the speed of sound. Shockwaves (caused by meteorites) have recently been shown to be able to generate reverberations (surface waves) in the top layers as they hit the ground. We propose that the gas explosions causing the volcanic shockwaves (note, these were visually observed during the eruption, video available on youtube.com) generated surface waves as they hit the area around the erupting vent. Because of the nature of such low frequency waves trapped in the surface and having very low attenuation, we observe them at distances of up to tens of km away from the volcano.