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Coda wave interferometry and correlation study using multiplets in the Katla volcano, 2011 and 2012

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The Katla volcano, a glacier overlain hyaloclastite massive in S-Iceland, is one of the most active and hazardous volcanoes in Iceland. Its ice filled oval caldera, 9x14 km in diameter, forms a glacier plateau surrounded by higher rims. The glacier surface is marked with about a dozen circular depressions or cauldrons, manifestations of shallow geothermal activity. Katla eruptions are usually accompanied by intense tephra fall and hazardous glacial floods, jökulhlaups. Since year 1179, there are 17 documented eruptions, on average every decennia ($\pm$40 years), the last one being in 1918. Thus, the Katla volcano is being closely watched.

The SIL seismic catalogue for 2011 and 2012 includes over 4000 events within the Katla volcano. By far the most events occur in the steep western part of the glacier and have been shown to be caused by shallow glacial processes. These events are easily recognized in the data due to their low frequency content (0.5-2 hz) and long surface wave coda. The second most common events are found around the glacial cauldrons and seem to be caused by very shallow processes probably involving glacial deformation and changes in the geothermal activity. Tectonic events within the massive are not as common. In fact, the low rate of tectonic events recorded in Katla during the past two years, as well as their small size (<M3) might suggest that the deformation rate within the volcano is low.

However, considering the volcano's repose interval and the impending threat we focus on the latest data and methods that are capable of finding even the smallest changes within the volcano. One such method is the coda wave interferometry technique. The method is based on the fact that changes in stress in the edifice lead to changes in seismic velocities. Hence continuous monitoring of these changes is desirable in the pre-eruptive phase. Coda waves are multiply scattered in the medium and are very sensitive to small changes. For repeating or multiplet earthquake source (same source, same path) small time shifts in the arrival times of wavelets in the coda can be used to track temporal variations in velocity through coda wave interferometry analysis.

The glacial seismicity in the western part offers a set of multiplets with magnitudes M0.5-2.5. Although these events have a strong seasonal tendency, they do occur throughout the year. We present a coda wave interferometry study using the glacial multiplets. Their seismic rays, originating in the western flank of the volcano, penetrate down to around 5 km depth beneath the volcano when recorded at a roughly 30 km distance at several stations east of the volcano and even (at a closer distance, and with shallower penetration) south and north of the volcano.