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Can we see the distal dyke communicate with the caldera? Examples of temporal correlation analysis using seismicity from the Bárðarbunga volcano

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The Bárðarbunga volcano is composed of a large oval caldera (7x11 km) and fissures extending tens of kilometers away from the caldera along the rift zone, which marks the divergent plate boundary across Iceland. On August 16th, 2014 an intense seismic swarm started below the Bárðarbunga caldera and in the two weeks that followed a dyke migrated some 47 km laterally in the uppermost 6-10 km of the crust along the rift. The dyke propagation terminated in lava fields just north of Vatnajökull glacier, where a major (1.5 km3) six months long eruption took place. Intense earthquake activity in the caldera started in the period August 21-24 with over 70 M5 earthquakes accompanying slow caldera collapse, as verified by various geodetic measurements. The subsidence is likely due to magma withdrawal from a reservoir at depth beneath the caldera. During a five months period, October-February, the seismic activity was separated by over 30 km in two clusters; one along the caldera rims (due to piecewise caldera subsidence) and the other at the far end of the dyke (as a result of small shear movements). Here we present statistical analysis comparing the temporal behaviour of seismicity recorded in the two clusters. By comparing the earthquake rate in the dyke in temporal bins before and after caldera subsidence earthquakes to the rate away from these bins (background rate), we show posing a statistical p-value test, that the number of dyke earthquakes was significantly higher ($p < 0.05$) in the period 0-3 hours before a large earthquake (>M4.6) in the caldera. Increased dyke seismicity was also observed 0-3 hours following a large caldera earthquake. Elevated seismicity in the dyke before a large caldera earthquake may occur when a constriction in the dyke was reduced, followed by pressure drop in the chamber. Assuming that the large caldera earthquakes occurred when chamber pressure was lowest, the subsiding caldera piston may have caused temporary higher pressure in the dyke and thereby increased the likelihood of an earthquake. Our results thus suggests mechanical coupling over long distances between the distal end of the dyke and the magma chamber and support a simple plumbing system.