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The 2014-2015 slow collapse of the Bárðarbunga caldera, Iceland

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The Bárðarbunga caldera is located in central Iceland, under in NW corner of Vatnajökull ice cap. The caldera is about 65 km2 in area, with 500-600 m high topographic rims and is fully covered with up to 800 m thick ice. On 16 August 2014 an intense earthquake swarm started in Bárðarbunga, the beginning of a major volcano-tectonic rifting event forming a 45 km long dyke extending from the caldera to Holuhraun lava field outside the northern margin of Vatnajökull (Sigmundsson et al., 2014). A large basaltic, effusive fissure eruption began in Holuhraun on 31 August that by January had formed a lava field of volume in excess of one cubic kilometre. The collapse of the caldera is expected to have begun a few days after the onset of the earthquake swarm, probably coinciding with the first M5 earthquake. This slow caldera collapse has been monitored through repeated mapping of the gradually increasing subsidence bowl (∼80 km2 in December) with airborne profiling of the ice surface, satellite mapping, an online GPS station set up in September on the glacier surface in the centre of the caldera with a strong motion sensor added in November, and indirectly through recording of seismic activity. Satellite interferograms constrain both ice movements and the rate of collapse. The rate of collapse was greatest in the first two weeks or 0.5-1 m/day in the centre, but has since gradually declined with time. The daily rate was 0.1-0.2 m/day in January, when the maximum lowering had reached about 60 m. A gradual widening of the subsidence bowl has been observed since early September. It is asymmetric, deepest in the NE part of the caldera. Downwards displacement extends outside the pre-existing topographic caldera rims, particularly on the south side where the rims have subsided by over 10 meters. Ice-flow modelling indicates that the ice is mostly passively subsiding with the caldera floor. Thus, horizontal ice flow has had little effect on the shape of the subsidence bowl, at least in the first few months. No indication of large scale basal melting of ice has been detected within the caldera. However, the heat output of pre-existing minor subglacial geothermal areas at the caldera rims has increased considerably, with fast deepening of ice cauldrons observed since early October. The seismic swarm associated with the subsidence had produced over 85 earthquakes of magnitude M5-5.7 and in total over 15,000 earthquakes had been detected by the beginning of January. Distribution of earthquakes correlates with the margins of the collapse structure, with activity being most intense on faults along the northern margin. This event has no parallels since instrumental recording of earthquakes began in Iceland almost a century ago and it throws new light on the mechanics of basaltic calderas.

Reference:

Sigmundsson and 36 others. 2014. Segmented lateral dyke growth in a rifting event at Bárðarbunga volcanic system, Iceland. Nature. doi:10.1038/nature14111.