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Comment on: Dynamics of the Askja caldera July 2014 landslide, Iceland, from seismic signal analysis: precursor, motion and aftermath

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Anne Schöpa et al. (2018) report on an analysis of seismic signals released by the Askja July 2014 rockslide, Central Iceland, and conclude from their analysis that the volume of material displaced by the slide was 35–80 million m³ and that the centre of mass was displaced horizontally by 1260±250 m and vertically by 430±300 m. Referring to Gylfadóttir et al. (2017) as source, they state that the volume of the slide was 12–50 million m³ according to geodetic surveys. We note that the volume of the rockslide according to Gylfadóttir et al. (2017) was actually reported as 20 million m³ based on field measurements that include multi-beam surveys of the bottom of Lake Askja, measurements of the lake level, and photogrammetric DEMs of the rockslide area on land, from before and after the slide. Larger, preliminary estimates for the volume of the rockslide (30–50 million m³, Helgason et al., 2014; >12 million m³ for the tongue that entered Lake Askja, Höskuldsson et al., 2015; 20–50 million m³, Sæmundsson et al., 2015; and 15–30 million m³, Gylfadóttir et al., 2016) were given in a memo with preliminary results and in conference presentations. They were based on initial estimates of the rise of the water level in the lake due to the slide and inaccurate estimates of the rockslide volume on land. These were revised after the processing of multi-beam and lake level data and photogrammetric DEMs was completed (Grímsdóttir et al., 2016), and the revised results were used in the tsunami modelling of Gylfadóttir et al. (2017). Some of these earlier reports and conference presentations are also referenced by Schöpa et al.

Our estimate for the volume of material mobilized by the rockslide is based on a reconstruction of the geometry of the sliding plane from the available field evidence and it is hard to exclude the possibility that some rotational movement took place at a deeper level, leaving little evidence in the surface geometry of the rockslide after the event. The volume of the debris tongue in the lake, approximately 10 million m³, is rather well determined and the average horizontal displacement of this mass on the bottom of the lake is ~2000 m. If the horizontal displacement of the centre of mass of the mobilized mass was as great as estimated by Schöpa et al., most of the debris mass that terminated on land must have moved from the starting area down to the run-out zone near the shore of the lake, which has an area of ~330 thousand m² (counting here the part of the run-out area farther than 600 m from the highest part of the source area of the rockslide since material that travelled a shorter distance does not contribute much to the horizontal displacement of the centre of mass). The volume and centre-of-mass displacement estimated by Schöpa et al. correspond to average debris thickness of 75–210 m in this part of the run-out zone of rockslide on land. This thickness is difficult to reconcile with the available field measurements, in particular the thickness values near the higher end of this range. The field measurements indicate more than an order of magnitude less thickness of the debris tongue in most of this area.

Schöpa et al. (2018) also report an averaged maximum sliding velocity for the rockslide of 7±0.7 m/s from their seismic analysis, which is much lower than the impact velocity U_0 = 31 m/s used in the tsunami simulations of Gylfadóttir et al. (2017). Gylfadóttir et al. estimated their impact velocity by calibrating the tsunami model against measurements of the run-up of the tsunami wave around the lake. The velocity corresponding to the potential energy released in the collapse from the release area down to the run-out zone is on the order of 50 m/s. A velocity of several tens of m/s must be expected for moving debris under the conditions of the Askja slide. A maximum velocity of only 7 m/s (corresponding to the potential energy of an object raised vertically by 2–3 m) seems unreasonably low since this would imply a delicate local balance between frictional forces and the potential energy released at each instance during the fall, which does not seem likely. It is also difficult, if not impossible, to account for the observed run-up of tsunami waves in the lake with a slide velocity as low as deduced by Schöpa et al. from their seismic analysis.

There are few direct measurements of the velocity of large rockslides, and volumes are often uncertain because of difficulty locating the sliding surface. Interpretation of seismic data to estimate volumes and velocities of landslides is, therefore, interesting and could be useful in the context of hazard management,

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and, of course, for general understanding of rockslides as a geophysical phenomenon. The disagreement between the results of Schöpa et al. and available field measurements for the Askja 2014 rockslide indicates that further development is needed to obtain quantitative information about rockslide dynamics from the seismic signal analysis that they employ.

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