



## **Causes and triggering factors for large scale displacements in the Almenningar landslide area, in central North Iceland**

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For over 40 years the Icelandic road authority has monitored displacements on and along the “whole year road” between the Skagafjörður fjord and the town of Siglufjörður, in the outermost part of the Tröllaskagi peninsula, in central North Iceland. The road crosses a 6 km wide landslide area, named the Almenningar area, and since the road was constructed, almost 50 years ago, landslide movements have repeatedly caused extensive damages to the road, often caused hazardous conditions. The road authority started to monitor the movements in 1977 and today measurements are performed in late autumn every year. These measurements have created a 40 years of data which in combination with other reports gives us unique opportunity to correlate the displacements to meteorological data, and thus determine the causes and triggering factors for the movements.

The road crosses three large landslides, the Hraun landslide in the south, the Þúfnavellir landslide in the middle part of the area and the Tjarnardalir landslide in the north. The front of all these landslides reaches the present coast forming up to 60 m high coastal cliffs, which show clear indications of extensive coastal erosion. Geomorphological indications and the measurements show that the landslide masses have westward movement towards the sea, with a maximum mean rate up to 70 cm/year in the Tjarnardalir landslide. The landslide debris and the underlying sediments were studied in several sections along the present shoreline. The stratigraphical record confirms that glaciomarine fine grained sediments, which rest on a till, underlie the landslide debris, at least in the coastal areas. The fine grained sediments have much lower permeability and thus the groundwater, which penetrates through the coarse grained landslide material, stops on the fine grained material. It is assumed that the main part of the sliding movement takes place on this boundary. There is a clear correlation between the landslide movements and weather conditions. The main sliding movement occurs during the snowmelt period and during the autumn rain period. It is suspected that extensive coastal erosion also plays a role in the sliding movement. Electrical resistivity measurements performed on the debris mass indicate that the moisture content in the debris is very high, which indicates extensive ground water flow within the debris mass.

The prospect for the whole year road to the Siglufjörður fjord, crossing the landslide area is not bright. The constant damages occurring on the road can lead to severe situation and cause hazardous conditions for the traffic. The situation on the northern side of the Tjarnardalir landslide is thought to be more hazardous than in other areas. There, the undercutting of the sediments, due to coastal erosion and sliding activity in the debris mass have destabilized the sediments underneath the road. New crevasses are opening and it seems that the crevasse zone is slowly merging further upwards into the debris mass above the road. If this continues, large parts of the road will fall or slide down, possibly tenths of meters.