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Investigating a clay landslide site using 3D P-wave reflection seismics in Lilla Edet, Sweden

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Landslides are one of the most commonly occurring natural disasters. Global damages range in the billions of dollars and cost hundreds of lives each year; Sweden is not an exception. The main objectives of this geohazard-related project are (1) to improve the understanding of the geometrical shape and structure of clay areas, (2) to develop tools for monitoring changes in their geometry and physical properties as critical factors for landslide triggering, and (3) to provide robust analytical methods for assessing risks associated with clay landslides both in short and long terms. The project is sponsored by the Geoscientists Without Borders (GWB) Program of the Society of Exploration Geophysicists and is multidisciplinary, involving several geophysical methods such as ground gravity and magnetics, geoelectrics, controlled source/radio magnetotellurics, as well as reflection/refraction seismic methods (both P- and S-wave source and receivers).

The test site is located on the shoreline of the Göta river that runs from lake Vänern to Göteborg on the southwest coast. The Göta river is the largest river in Sweden and follows the Götaälv Zone, which is an approximately 4 km wide fault zone dipping towards the west. The 3D seismic survey covers a large landslide scar that occurred about 30-40 years ago. The main objective of the 3D seismic is to image the bedrock topography in detail and possibly define layering in the sediments above.

The 3D seismic data were acquired in September 2011 using a weight-drop source, 4 m geophone spacing and 20 m line spacing with the source activated at most geophone positions. Ten lines with 60 geophones on each line were shot in two overlapping patches. The preliminary results are encouraging and depict the bedrock topography at 100–150 ms or about 70-100 m. The central line in the 3D seismic survey is overlapped by a longer 2D reflection seismic profile, acquired using a dynamite source. The 2D reflection stack, as well as a travel-time tomography image from the 2D line, can, therefore, be correlated with the central part of the 3D image.

Reflections from within the bedrock unit have also been detected in shot-gathers and may be related to fracture zones. Defining local fracture zones in the bedrock can be an important secondary target for the 3D reflection seismic survey.