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A multidisciplinary geophysical investigation of a prospective post-glacial fault in central Sweden

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Glacially induced, intraplate faults are conspicuous in northern Fennoscandia where they reach trace lengths of up to 150 km with estimated magnitudes of 8 and above (e.g. Lagerbäck and Sundh 2008). Based on a nationwide LiDAR survey (Petersen and Rost 2011), recent studies suggest that glacially induced faults are not, as previously understood, confined to the northernmost parts of Sweden and can also be found in the central parts (Smith et al., 2014). Some of these faults are associated with scarps (and possibly landslides) that strike for more than 5 km giving a recognizable expression on LiDAR data. While LiDAR data provide valuable information, it is important that the presence of the fault is ground truthed, its extent and geometry at depth are unraveled and if possible an estimate on its displacement is given. These together with the surface expression represented by the scarp can then provide some information about their displacement mechanism(s) and earthquake magnitude.

In this study, we focused on a recently inferred (Smith et al., 2014), through LiDAR data, post/end-glacial fault near the city of Bollnäs about 250 km north of Stockholm. The prospective fault has about 6 km long scarp expression that is ca. 5 m higher in the western side of the scarp. A multidisciplinary geophysical investigation was conducted during October 2014 to provide information about the fault geometry with respect to the scarp, and displacement in the bedrock. This included high-resolution three-component refraction and reflection seismics, gravity and magnetic measurements, ground penetrating radar, radio-magnetotellurics and direct current geoelectrics. Preliminary results suggest a zone of low-velocity and conductivity that is associated with a magnetic lineament that is horizontally about 50 m offset from the scarp. Depth to bedrock surface is about 10 m (consistent in all the measurements) in the eastern side of the scarp while it is about 20 m in the western side. This difference is due to different thickness of sediments (and surface topography) and that the bedrock surface is likely more or less at the same topographic elevation. This makes an estimation of the fault throw challenging if not impossible. While speculative at this stage, the prospective fault is likely associated with an old normal fault, within a wide zone (> 150 m) highly fractured and water-bearing, that reactivated at the end of the deglaciation. Alternatively, it is part of an old horst-graben type structure with more sedimentary cover on the western side of the scarp than its eastern side. Different approaches are currently being tested to estimate the fault throw and if thicker sediments on the western side of the scarp can be explained given the fault geometry and its likely reverse mechanism.

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