Geophysical indicators of slope stability: towards improved early warning of landslide hazards

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Project description

Most current methodologies for assessing landslide hazard are heavily dependent on surface observations (e.g. remote sensing or walk-over surveys). These approaches generally neglect the influences of subsurface structure and hydrogeological processes on landslide triggering and activation; instead they typically only quantify the surface expressions of slope failure events once they have been initiated. Consequently, there is a growing interest in the development geophysical approaches for investigating slope stability (e.g. Perrone et al., 2014). Geophysical techniques have the potential to deliver volumetric subsurface information revealing the internal structure and hydraulic process within the slope or landslide body – thereby providing an indication of subsurface precursors to slope failure (e.g. elevated moisture distributions) and possibly early warning of failure events.

Here we seek to develop two very promising, and complementary, geophysical approaches for slope characterisation – geoelectrical and seismic methods. Geoelectrical imaging is sensitive to lithological variability, and crucially with recent advances in monitoring instrumentation, changing moisture conditions in the subsurface. Seismic methods, such as P and S wave tomography, can provide information on the engineering properties of the subsurface in terms of strength, stiffness and compressibility. Emerging developments in the area of geophysical inverse theory now enable joint inversion of geoelectrical and seismic data – thereby improving image resolution and enhancing the information content of the resulting interpretations. ***Our hypothesis is that the combined use of geoelectrical and seismic monitoring will provide the means to investigate subsurface processes at unprecedented levels of spatial and temporal resolution – thereby providing an enhanced diagnostic and predictive capability for early warning of failure events within vulnerable slopes.***

The student will have access to a number of geophysical observatories on natural and engineered slopes, all of which are instrumented with geophysical monitoring systems and environmental / geotechnical sensor networks (e.g. weather stations, pore pressure, tilt, and moisture content). A key site is the Hollin Hill Observatory in North Yorkshire (Merritt et al., 2014), which BGS has been operating since 2008 on an active landslide in Lias Clays. This observatory has a permanently installed resistivity monitoring system, seismic survey data, and a broad band seismometer. The primary purpose of the seismometer is to monitoring fracking activities in the

Vale of Pickering – but will also be capable of monitoring shallow landslide movements at the site. This combination of sensors, instrumentation and surveys provides the potential to investigate both moisture-driven and seismically induced landslide events.

References

Merritt, AJ, Chambers, JE, Murphy, W, Wilkinson, PB, West, LJ, Gun, DA, Meldrum, PI, Kirkham, M, and Dixon, N, 2014. 3D ground model development for an active landslide in Lias mudrocks using geophysical, remote sensing and geotechnical methods. Landslides, 11, 537-550.

Perrone, A., Lapenna, V. & Piscitelli, S. 2014. Electrical resistivity tomography technique for landslide investigation: A review. Earth-Science Reviews, 135, 65-82.

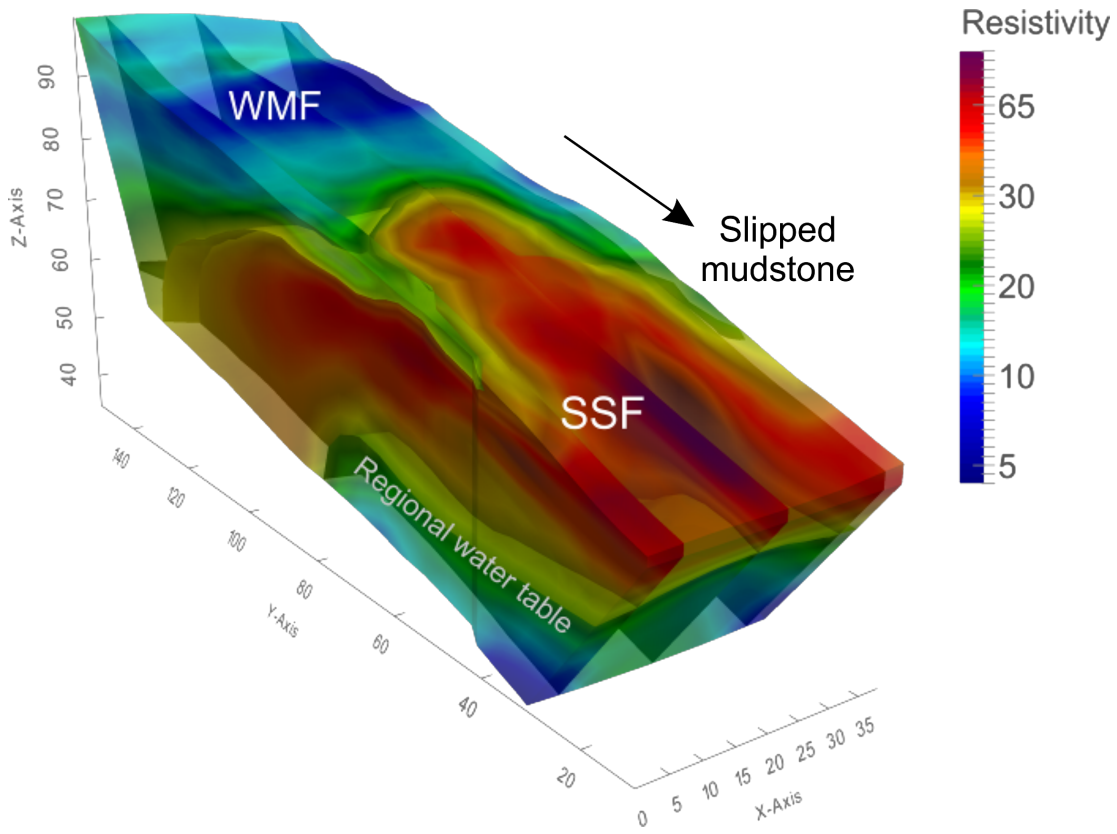

Figure. 3D geoelectrical image of the Hollin Hill landslide, North Yorkshire, showing the Lias clays of the Whitby Mudstone Formation (WMF) slipping over the Staithes Sandstone Formation (SSF).