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Predicting Spatial and Stratigraphic Quick-clay Distribution in SW Sweden

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Abstract

Clay sediments are associated with a wide variety of engineering problems, of which landslides, together with settlement, are the most investigated due to the large associated costs. Quick-clay deposits, which if disturbed can transform into a liquid, pose a serious threat to society in southwestern Sweden and have been involved in several large landslides, sometimes with fatal consequences. Even though the theories that explain quick-clay formation are well advanced, no modeling that combine geologic information and reasoning with hard geotechnical data to predict its distribution has previously been done.

The stepwise multi-criteria evaluation technique suggested here involves identification of quick-clay preconditions from the literature. Then to derive criteria priorities, an expert group consisting mostly of geologists and geotechnical engineers carried out pairwise comparisons using matrices from which weights were calculated. The same group also participated in the development of the utility functions used to standardize the criteria to allow direct criteria comparisons. To populate the model, all criteria were quantified using empirical geotechnical data, existing geological documentation and/or environmental proxy data. The model results were later cross-checked at selected sites with geophysical methods. Finally, a rather large geotechnical data set was divided and used to add a depth dimension to the model results and to test the predictive powers of 2D and 3D models.

Quick-clay type settings were separately defined to facilitate clear communication of quick-clay predictions to non-specialists and to provide a structure for comparisons to the depositionary and post-depositionary conditions in well-studied east-Canadian and Norwegian quick-clay areas. These settings were derived from trends observed in geotechnical, geologic, geophysical and modeling records.

Results of the predictive modeling were subsequently applied to landslide hazard zonation in SW Sweden. However, the framework could, with slight regional adaptation, also be applied in other areas (e.g. eastern Canada and coastal mid-Norway) or even to other issues, wherever groundwater fluxes and ground conditions are of interest (e.g. in contaminant transport, geological process studies and groundwater resource exploration).

Keywords: Quick clay, SW Sweden, Stratigraphic modeling, Leaching