Regional Slope Stability Assessment: Challenges in Spatial and Stratigraphic Geologic and Geotechnical Data Integration

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Sediment instability and risk of submarine mass failure is one of the most significant geohazard on continental slopes. Site-specific assessments typically involve slope stability analysis to predict static and dynamic critical slope failure conditions. Vertical measurements of sediment geotechnical properties used in these analyses can be reasonably extrapolated on local scales for site assessment purposes. Regional slope stability assessments, however, have the challenge of integrating geological and geotechnical conditions that vary spatially and stratigraphically. In addition, regional assessments generally consider long time periods and therefore must consider temporal variability. Finally, the sample database for regional studies is typically sparse and geophysical coverage may be limited. In this paper, we present a case study of the eastern Canadian continental slope where available geotechnical, geological and geophysical data were used to provide a regional slope stability assessment in aid of industry exploration.

Along the Scotian margin, seismic reflection and multibeam bathymetric data are available, as is a significant geotechnical properties database. These data show that submarine mass movement deposits comprise some 30-40% of the Cenozoic sedimentary section. In this case, the seabed was modeled by total stress analysis for slope stability using the infinite slope method of analysis. A deterministic model using the conventional factor of safety approach estimated several areas with factors of safety less than unity and about 10% of the area with a factor of safety less than 1.5. A probabilistic model was employed as well, using an appropriate averaging interval based on spatial correlation. This probabilistic model estimated a stable region based on expected values with a minimum factor of safety of two. Areas of lowest factors of safety are thick modern sediment accumulations lying on a slope, yet for the Scotian Slope, excess pore pressures are required to initiate submarine instability. It is surmised that ground accelerations due to earthquakes are the principal causes of excess pore pressure development and landsliding. In a distributive model of earthquake activity, the areas of greatest potential for submarine instability are regions of thick modern sediment accumulations on the uppermost continental slope where greatest contiguous slope angles are found.