Submarine Deposit Instabilities in Fine Tailings Pit Lakes

Background

One of the closure alternatives for the oil sands tailings ponds includes development of a lake to support an aquatic ecosystem. In this option, fine tailings are first treated with coagulants and/or flocculants before deposition into the bottom of a completed mine pit. Overtime, the water released from the deposit combined with runoff, precipitation and seepage water create a lake above treated tailings. Concurrently, the treated fine tailings in the bottom of the pit consolidate overtime and create the lake bottom. In some cases, the final lake could consist of ~30-40 m sediment solids and ~20-30 m of water. Given such dimensions, physical phenomena observed in natural lakes could also be potentially observed in tailings pit lakes. Submarine land instabilities such as mass movement of deltas created by runoff sediments and slope failures of the perimeter walls are some examples of such physical phenomena (see for example [1], [2]). Such instabilities are of two general types as shown schematically in Figure 1. In one case, the submarine surrounding perimeter of the lake could fail under rotational or translational deformation modes leading to the detachment of coherent blocks of soil [3]. Alternatively, avalanche-like movement of deltas created by the runoff sediments in the lakes could occur. When rates of sedimentation outpace the rate of consolidation, these deltas fail under their own weight or as a result of externals stimulus. In contrast to terrestrial slope instabilities that often occur at slopes greater than 10°, submarine slope failures can potentially be developed anywhere on the lake floor at slopes as low as 1° [4]. As a result of such deposit motions, subsurface as well as on surface waves could be generated in the lake potentially leading to resuspension of fines and other constituents of concern in the water. Therefore, understanding the formation and behavior of submarine instabilities and their potential impacts on the quality of the water is of great importance for developing viable aquatic ecosystems in the oil sands industries.

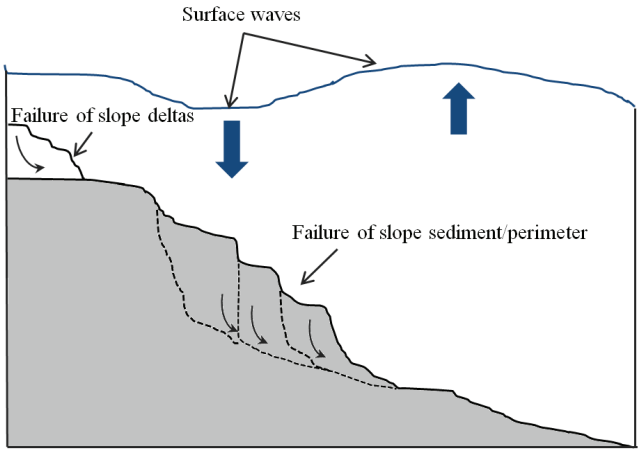

Figure-1: Typical submarine deposit instabilities in lakes and seas

Statement of Research Opportunity

Funding opportunities are available to conduct research studies focused on developing a better understanding of the conditions required for initiation of submarine instabilities in pit lakes. Additionally, research focused on developing tools to predict the onset of such instabilities, predict their potential impacts on the dynamics of pit lakes, and methods to mitigate such disturbances are also of interest.

Desired Results

Future research activities focused on this topic are expected to provide the following knowledge:

a) Whether submarine instabilities observed in natural water bodies could occur in pit lakes,

b) To understand the conditions at which such instabilities may occur in pit lakes and to develop tools to predict them,

c) To predict the extent by which such instabilities may impact the dynamics of the lakes, and

d) To develop plans for mitigating risks associated with submarine instabilities in tailings aquatic closure systems.

Works Cited

[1] Kramer, "Triggering of liquefaction flow slides in coastal soil deposits," Engineering Geology, vol. 26, no. 1, pp. 17-31, 1988.

[2] L. Edgers and K. Karlsrud, "Soil flows generated by submarine slides: Case studies and consequences," Nordic Geotechnical Institute Bulletin, vol. 143, pp. 1-11, 1982.

[3] D. Petley, M. Bulmer and W. Murphy, "Patterns of movements in rotational and translational landslides," Geology, vol. 30, pp. 719-722, 2002.

[4] J. P. Syvitski, D. C. Burrell and J. M. Skei, Subaqueous slope failure, New York: Springer, 1987, pp. 175-209.