Slope Stability

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Together with a few of my colleagues at the geological survey, I am interested in slope stability and landslides. The map that Jan Aylesworth has prepared of the Mackenzie Valley from the arctic coast down to 60 degrees latitude has highlighted

- Areas of failures in the cretaceous shales along the Peel River
- Areas of bedrock slides in the Mackenzie Mountains; and
- Failures in glacial lake sediments that were deposited at the end of the last glacial period, more or less coincident with the Mackenzie River. These are deposits up to 30 or 40 meters thick of sands and silts, often quite ice rich. There are hundreds if not thousands of landslides- far more than are shown on the map.

The major kinds of landslides:

- Deep-seated rotational failures, found commonly in the glacial lake sediments along the Mackenzie River. There has been quite a bit of speculation on the impact of climate warming in situations where there are ice rich materials that are susceptible to thaw. Strength will decrease as the ice melts. However, there are other triggering mechanisms such as river erosion at the toe of the slide, as we have here. Climate warming may affect the frequency of sliding, but there is still the need for the independent trigger.
- Forest fires can result in slides where the surface insulation effect of the vegetation cover is reduced or removed, increasing the depth of the active layer. This can result in thin sheet flows.
- Even several years after a forest fire, surface failures can occur simply because the active layer is extending more deeply.
- These can develop into a retrogressive thaw flow slide, which will continue to develop until it runs out of slope or of ice-rich material in the ground.

These are all cases where climate change may or may not be a factor. To get a clearer idea about this, in the long term what we would like to have is a chronology of slides. One way of going about that is to look for buried organic material such as tree roots. This is really only possible as opportunities arise: setting out to look for this kind of evidence is difficult, or may not yield a lot of information.

Last summer, along with Carolyn Duchenes, we spent a couple of months on the Mackenzie River with a number of objectives in mind, one of which was the climate story. We collected samples for dendrochronology, for possible use as a monitoring method.

One site we have looked at is on a reach of the Mackenzie River in the Old Fort Point area, about 40 km upstream of Fort Norman (Tulita). The bank is about 60 m high; the

entire bank has failed at one time or another, so the slides have different ages. One point of interest from a geotechnical point of view is to find enough information about a particular slide (establishing where the failure surface is, determining the strength of some of the components of the ground) to be able to back-calculate from soil mechanics the failure strength of the ground. One factor that might influence that is the rate at which these slopes are loaded. We can get an idea of that by knowing the erosion rate at the toe of the slope, and the repeat frequency of slides.

Where we have trees re-colonizing the slide slope, we can simply look for the oldest trees on the slope to give us a minimum age for the slide. We need to consider how long before the trees begin colonizing.

Another approach is the use of reaction wood in the tree trunks. When the trees are disturbed, the tree reacts by growing wood preferentially on the underside of the tree. With the tree rings, it's possible to find out when that happened to the nearest year, or even to the season in some cases.

For locations that are not under the direct influence of river erosion or fires, the tree rings show that there are a whole series of reaction events. By sampling trees over an area and correlating in time, we hope to be able to get some idea of areas of individual slide events. Ultimately, we hope to be able to associate this with climate events through some independent measure of climate from the trees.

To summarize, this is a climate monitoring exercise not using instrumentation, but looking at trees that have been growing in these locations for 100 or more years.