Application of Airborne Lidar (Light Detection and Ranging) Imagery for Surficial Geology Mapping in Densely Vegetated (Boreal Zone) Terrain, Lesser Slave Lake, Northern Alberta

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Summary

The boreal zone covers 60% or 5.5 million km^2 of the Canadian landmass and is problematic in regards to surficial geology mapping because the dense vegetation cover obscures the morphology of underlying landforms. In boreal areas of northern Alberta, surficial geology maps have typically been based on air photo interpretation supplemented by ground-based observations and digital elevation models (DEM's). However, LiDAR-based mapping offers several advantages over air photos because: (1) it can penetrate the forest canopy to reveal the bare-earth surface; (2) the direction of simulated solar illumination can be varied; (3) the magnitude of vertical exaggeration can be varied; and (4) it can be used in combination with orthophotos to analyse both vegetation patterns and small-scale relief.

Here we present results of surficial geology mapping from map area NTS 83O/S, which borders the south and east shore of Lesser Slave Lake, and contrast our LiDAR-based interpretations with those based on traditional mapping techniques. The LiDAR digital surface model (DSM) used for mapping has a 1 m horizontal grid spacing and a 0.3 m vertical accuracy. This model was used to generate hill shaded images from several illumination directions along with slope angle maps, which were then superimposed with the colour-coded elevation data for analysis.

We find that the surface morphology exposed by the LiDAR imagery is significantly greater than that revealed on air photos or on traditional 30 m horizontal resolution DEM's. In particular, many small-scale landforms can be identified, including fluting, hummocky moraine, doughnut moraine, raised shorelines, and sand and gravel deposits. Such landforms were found to be difficult to distinguish in areas of dense vegetation without the use of LiDAR. The extent and location of mass-movement deposits was underestimated when based on air photo interpretation alone.

The implications of our work are that LiDAR is useful for the detailed mapping of low relief landforms in northern Alberta, which enhances our understanding of Quaternary landscape evolution. In the Lesser Slave Lake area, LiDAR has revealed a number of surficial landforms that have aggregate potential. Moreover, this application has helped to identify colluvium deposits situated on steep slopes, which represent potential geohazard areas. Accurately mapping their distribution is therefore important for the development of infrastructure within the region.