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Uncovering the surface: surficial geology mapping in Alberta

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Introduction

Mapping the distribution and characteristics of unconsolidated materials overlying bedrock is a key component of natural resource management, infrastructure planning and environmental protection. Since 2002, the Alberta Geological Survey has implemented a multi-year surficial mapping program to complete previously unmapped 1:100 000 NTS sheets across large areas of northern Alberta, in part to meet the growing need for geological information from the resources sector across this region (Fig. 1).

Much of this region occupies the boreal forest, where a high degree of uncertainty exists when mapping the distribution of surficial materials using traditional interpretive techniques due to the dense vegetation cover. LiDAR bare earth models, which give a view of the earth surface without vegetation cover, provide an invaluable dataset for accurately interpreting surficial materials. Primarily AGS mappers perform ‘heads-up’ digitization of polygons based on visual interpretation of the LiDAR hill-shaded DEMs (using multiple sun angles), complemented with LiDAR slope models and other DEM-derived terrain analyses. Satellite imagery is also used for peatland classification, which in some areas accounts for more than 50% of the map sheet. To show how these multiple data sources are applied to surficial mapping, a case study of the glacial retreat from northwest Alberta is presented.

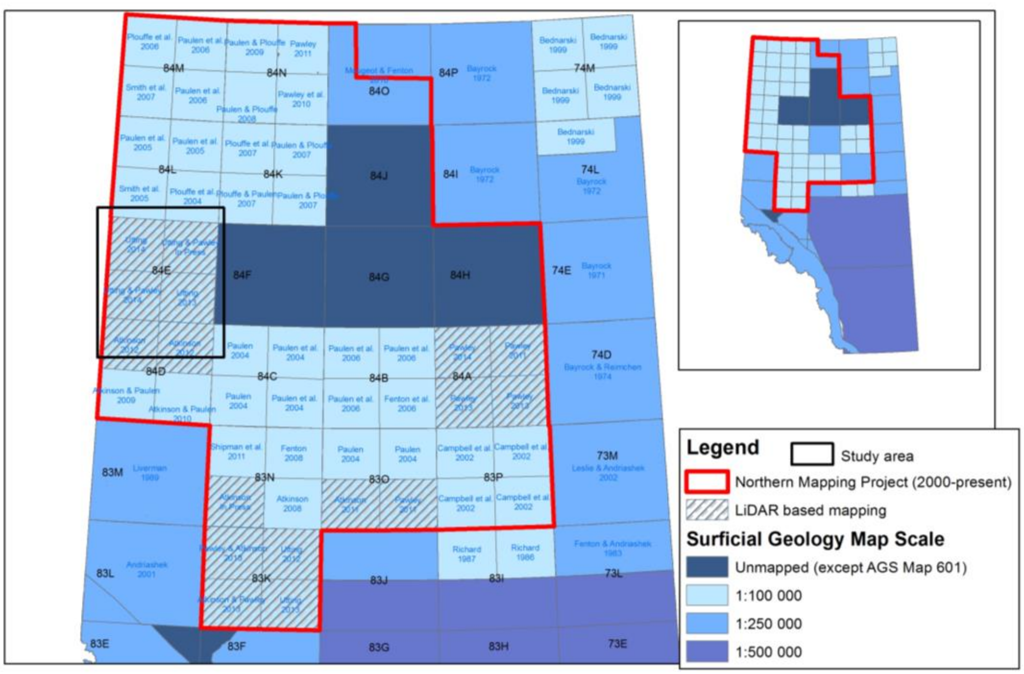

Figure 1: Northern Alberta surficial mapping project area, showing areas with surficial geology maps available, and area of case study.

Cenozoic Geology

The distribution and genesis of surficial materials across the study area is typical to that encountered in much of northern Alberta (Fig. 1). The upland terrain in part reflects a fluvial landscape eroded by Paleogene to Neogene river systems, which flowed across a broad peneplain prior to the first Laurentide glacial advance into the region. River systems continued to incise this peneplain, leaving the uplands as gravel-capped remnants separated by broad valleys. Reworked pre-glacial gravels occur either as colluvial or fluvial deposits at lower elevations within these valleys.

There were likely multiple Pleistocene glaciations across the area, further eroding and remobilizing sediment (Andriashek et al. 2014). Nevertheless, most of the glacial sediments mapped in this area are inferred to relate to the last glaciation. As ice advanced from the east, it blocked regional drainage, damming ice-marginal lakes. At full glacial conditions, ice flow crossed topographic highs, forming streamlined bedforms on the upland surfaces (Fig. 2). During deglaciation, glacial ice on the uplands became disconnected from ice flowing in the valleys, resulting in stagnant ice features such as crevasse fill ridges being deposited over the streamlined bedforms (Fig. 2). In the valleys, ice dammed lakes formed at the margin of retreating Laurentide Ice Sheet; these drained through a succession of outlet channels (Fig. 3). Fluctuating deglacial margins caused overprinting of glacial bedforms. "Smudged" landforms record the progressive retreat of the ice margin, despite limited ice marginal landforms (Greenwood and Clark 2009).

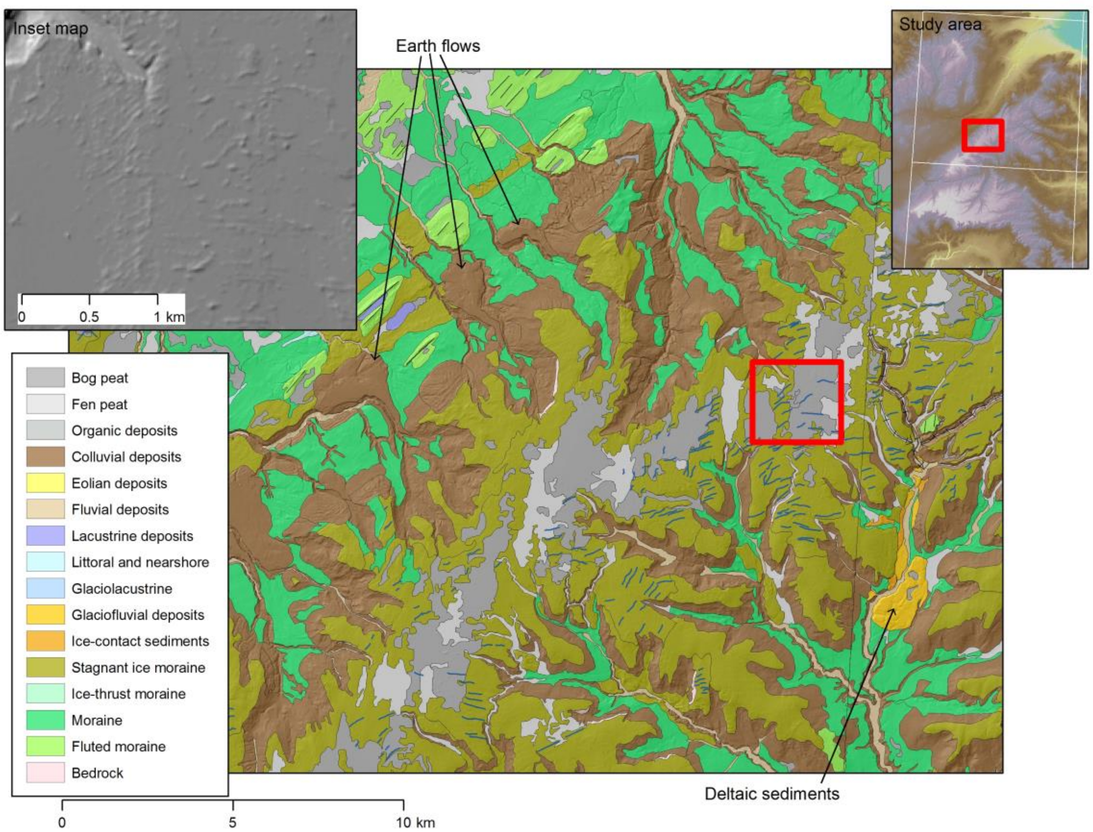

Figure 2: Portion of the surficial geology map of the area (Utting 2014; Utting and Pawley 2013). Uplands are typical of the study area, with subtle fluting related to earlier glacial flow patterns, overlain by stagnant ice features such as crevasse fill ridges. Along the southeast flank of the upland is a glaciofluvial delta, formed at the mouth of a meltwater channel, where it entered an ice marginal lake in that valley. Along the northeast flank of the ridge is a series of earth flows. Inset map is LiDAR image of north-south oriented bedforms, overlain by crevasse fill ridges, which are overlain in places by organic deposits.

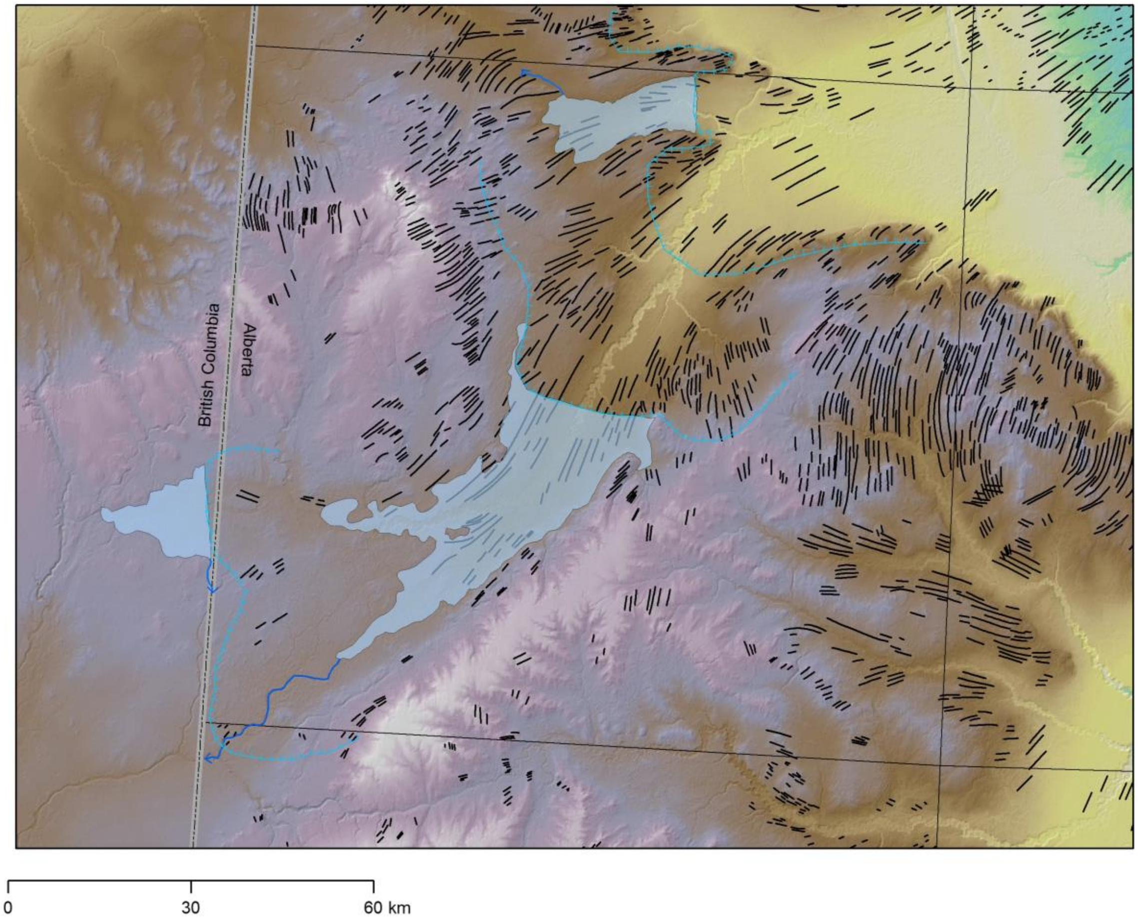

Figure 3: Study area with streamlined bedforms from Atkinson et al. (2014), with three interpreted ice margin positions, and associated proglacial lake configurations. Retreat pattern is to the northeast.

Following glaciation, ongoing fluvial incision has continued to deepen these valleys. Earthflows, as well as colluvium, are present along the flanks of the uplands. The poorly drained landscape of till and glaciolacustrine sediment was conducive to the development of bogs and fens, resulting in accumulation of organic sediments of variable thickness mantling the glacial sediments. Many of the bogs in the lowlands have developed palsas, represented by mounds within the bogs containing ice lenses (permafrost) beneath a blanket of peat.

To show the vertical relationship of these deposits, we present a schematic stratigraphy (Fig. 4). This shows the position of Paleogene gravels, overlain by fluted till, meltout deposits and in places variable thicknesses of organics. It also shows the buried re-worked gravel deposits flanking the uplands, and relatively thin glacial sediments in the valley floor.

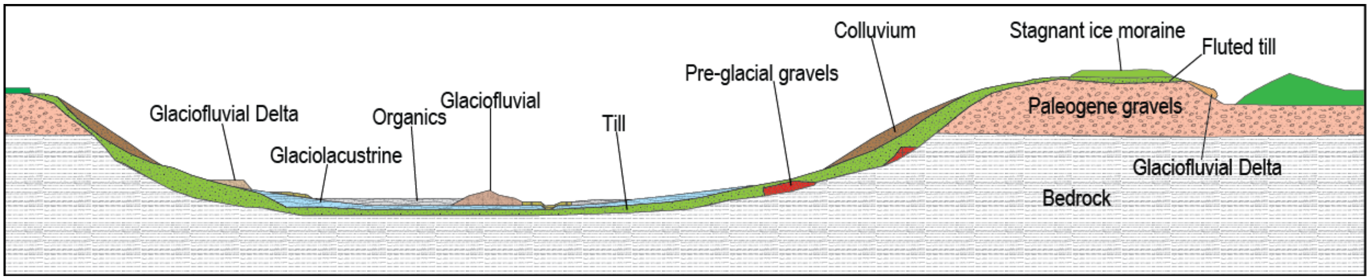

Figure 4: Schematic stratigraphy of the Chinchaga area.

Summary

To date, fourteen 1:250 000 NTS map areas have been completed (Fig. 1). When the project is finished, the province will have a complete coverage of a published surficial map for every NTS map sheet area. The maps from the northern Alberta surficial mapping project are published at 1:100 000 scale, and contain more information than many of the older maps, including delineation of landslides, permafrost, peatlands and alluvium. The increased resolution and data layers are valuable to stakeholders for natural resource management, infrastructure planning and environmental protection.

References

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