How to create, and understand, surficial geology maps
Manitoba Geological Survey, 2014
Surficial maps describe the distribution and characteristics of sediments at the surface. This can include unconsolidated sediment and consolidated rock.
Each map has a legend, with common classes that may have been modified to provide information for a specific area.
The production of a surficial geology map involves a combination of air photo interpretation and field work.
Pre-fieldwork

- Mappers start by gathering pre-existing data:
  - Surficial, terrain, soil or aggregate maps,
  - mineral deposits, and/or
  - historical data.
Pre-fieldwork

• Mappers also gather topographic data:
  • Shuttle Radar Topography Mission (SRTM; http://dds.cr.usgs.gov/srtm),
  • Canadian Digital Elevation Model (CDED, www.geobase.ca).
Pre-fieldwork

• Mappers then order aerial photographs.

• In general, air photos should be at a scale slightly larger than that of the finished map. Air photos with a smaller scale than the finished map should not be used unless photos of a suitable scale are not available.

https://www.gov.mb.ca/conservation/canadamapsales/
Fieldwork

- Fieldwork involves identifying and characterizing different surficial materials and landforms.

- Geologists go into the ‘field’ (the outdoors), set up a camp, and get ready to explore and document what they find.
Fieldwork

At each site, the geologist writes down:

- **Location**: Latitude and longitude, or UTM coordinates.
- **Elevation, vegetation, drainage**
- **Surface expression/landform**: flat, undulating, hummocky, sloping (gentle, moderate, steep), depression, drumlin, terrace, etc.
- **Sediment/Rock**: matrix grain-size, sorting, stratification.
- **Clasts**: concentration, shape, rounding, type.
- **Ice-flow measurement**: orientation, type, relative age, position.

And if a sample is taken:

- **Sample**: name, material, depth (top and bottom), soil horizon, position on landform.
Fieldwork

• In order to characterize the sediment, mappers need to see at least 1 m down into the substrate.
As geologists collects more data, their understanding of the region evolves. This allows them to make a more informed/detailed interpretation at subsequent sites – and informs the interpolation process that happens during air photo mapping of areas that haven’t been field-checked.

Example
The white top of this drumlin tells the mapper that the area is well-drained. This could be because either:
1. The whole area is till but this area is higher, or
2. The drumlin is made mostly of sand and gravel, which is more permeable than till.

The geologist will make sure to dig a hole at this site, so they know the answer.
Fieldwork

- Field sites are chosen according to what questions need answers; and to cover 1) enough different types of material, and 2) aerial coverage appropriate for the scale of mapping.

1:250 000 scale mapping

1:50 000 scale mapping
Fieldwork

• Guidelines and Standards to Terrain Mapping in British Columbia (1996)* suggests the following rules:

<table>
<thead>
<tr>
<th>TERRAIN SURVEY INTENSITY LEVELS</th>
<th>SCALE</th>
<th>% OF POLYGONS FIELD CHECKED*</th>
<th>FIELD CHECKS ** PER 100 ha (1 km²)</th>
<th>METHOD OF FIELD CHECKING</th>
<th>TYPICAL OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&gt; 1:20,000</td>
<td>75 - 100</td>
<td>&gt; 1.5</td>
<td>foot traverses</td>
<td>slope stability in sensitive areas: residential land planning; hazard zonation</td>
</tr>
<tr>
<td>B</td>
<td>1:10,000 to 1:50,000</td>
<td>50 - 75</td>
<td>1.0 to 3</td>
<td>foot and vehicle traverses</td>
<td>slope stability assessment;</td>
</tr>
<tr>
<td>C</td>
<td>1:20,000 to 1:100,000</td>
<td>25 - 50</td>
<td>0.5 to &gt; 1.0</td>
<td>foot, vehicle, some flying</td>
<td>inventory mapping; biophysical mapping</td>
</tr>
<tr>
<td>D</td>
<td>1:20,000 to 1:250,000</td>
<td>0 - 25</td>
<td>0 to 0.1</td>
<td>vehicle and flying</td>
<td>regional planning; preliminary mapping</td>
</tr>
<tr>
<td>E</td>
<td>any scale</td>
<td>0</td>
<td>none</td>
<td>no field work (air photo interp. only)</td>
<td>general reconnaissance</td>
</tr>
</tbody>
</table>

* See Section 7.5 for field checking methods.
** Data in column 4 are based on the following estimates of mean polygon size: 1:10,000 - 25 ha (estimated); 1:20,000 - 50 ha; 1:50,000 - 250 ha; 1:100,000 - 400 ha; 1:250,000 - 2500 ha. (see Table 4):

Fieldwork

• Ice-flow orientation information is collected from bedrock outcrops.
Fieldwork

• Till samples are collected throughout the area.
Post-fieldwork

- Till samples are sent for characterization of grain size, carbonate concentration, major and trace-element geochemistry, and till-clast lithology.
Post-fieldwork

Composition data may be added to map legends.

Example

Depending on the carbonate content of the till in this area, the till has been mapped as either $T$, or $T^2$. The former is interpreted as till derived from the Keewatin Sector (to the north), while the latter is interpreted as till derived from the Quebec/Labrador Sector (to the east).

The source area of the till is important information for people who use surficial sediments as part of a mineral exploration program.
Post-fieldwork

• Field data points are added to air photos.
• Mappers use codes for each surficial material type, and for thickness or surface classification.
  • O = organic
  • M = marine
  • T = till
  • v = veneer
  • b = blanket
  • p = plain

Post-fieldwork

• Using the field data points, and an understanding of glacial and post-glacial environments, a mapper interpolates between the field points to create map polygons across the entire area of study.

• Interpolation is easier in some areas than others

Example
In some areas the map legend or explanatory notes may state that “the occurrence of glaciolacustrine (GL) sediments is highly variable and unpredictable”.

This is because within glacial (and modern) lakes, deposition is not always constant. As lakes regress, wave-action may wash sediments from some areas into other areas, in an unpredictable way.

This means that a person using the map should expect to find GL sediment in some areas that aren’t mapped as such, and it could be missing from other areas that are mapped as GL.
Post-fieldwork

A mapper does not simply draw lines between one data point and the next (“connect the dots”). Instead, the mapper creates a geologic model for the evolution of the landscape, and then uses and/or modifies this model continually during field work and air photo interpretation.

Mappers must take into consideration:
- Vegetation types, including growing and drainage preferences;
- fire history;
- geological and geomorphic history.

Post-fieldwork

• The size of a polygon is dependant on the scale of mapping, so small polygons may be ‘lumped’ into larger polygons. The smaller the scale of map (1:250 000 vs. 1:50 000), the more lumping has occurred.

A user of a small-scale map may think this area is all bedrock, but larger-scale mapping shows that this area is a mix of thin till, thick till, bedrock and glaciomarine sediment.
Post-fieldwork

• Map polygons are digitized by a cartographer, in a GIS software program.

• Map polygons are then assembled into a map layout, along with a legend and descriptive or explanatory notes.
Post-fieldwork

• Maps are released as PDFs and as shapefiles.

• Remember that maps are most accurate when the number of field sites are high, or the sediment was deposited in non-complex environments.
Using surficial geology maps

- Where available, the user should obtain the appropriate scale of map for their purposes.

- All maps should **not** be considered accurate for property-scale work, unless there are a high number of field sites in that area.