Name: ________________________________

GEOGRAPHY 1013
CRANDALL UNIVERSITY

Lab 5: Glacial Geomorphology

Print this lab off. Complete it. And then scan/photo it and send it as ONE PDF document through Canvas. Please do send it as <u>ONE PDF document with the pages in order</u>. Before you send it, make sure it is legible. If you cannot read it, neither can I 😊

Glaciers are not static features! They produce a variety of erosional and depositional features within the landscape. In this lab you will have the opportunity to explore some of these features.

A. Alpine Glaciers

Alpine glaciers are glaciers found in mountainous regions of the world, including the Rocky Mountains of Canada and the United States. The Columbia Icefields, on NTS 83 C/3 are a typical region with many alpine glaciers, flowing from a central icefield (note the difference between and ice field and a glacier in your notes).

1. Using 83 C/3, your notes, and the text (especially 4CE Figures 17.10-17.11, pp.546-547 [3CE Figure 17.11-17.12 pp. 525-526]), provide the correct geomorphic term for the following locations:

   a. 830660-840670 (a bowl-shaped depression): ________________________________

   b. 827657 (a small alpine lake): ________________________________

   c. 954757 (a sharp peak): ________________________________

   d. 870699 (a waterfall from a hanging valley): ________________________________

   e. 840655-890625 (a long, sharp ridge): ________________________________

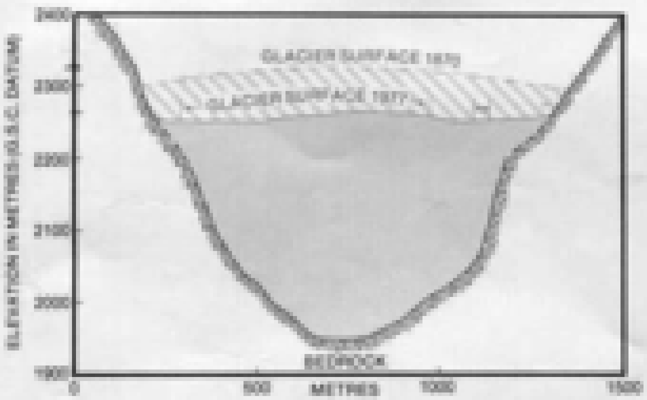
   f. 885710-960670 (a long ridge, chopped off by a glacier): ________________________________

   g. 967776 (a saddle-like depression or pass): ________________________________

   h. 900871, 907866, 903863, 901867 (a chain of small lakes):________________________________

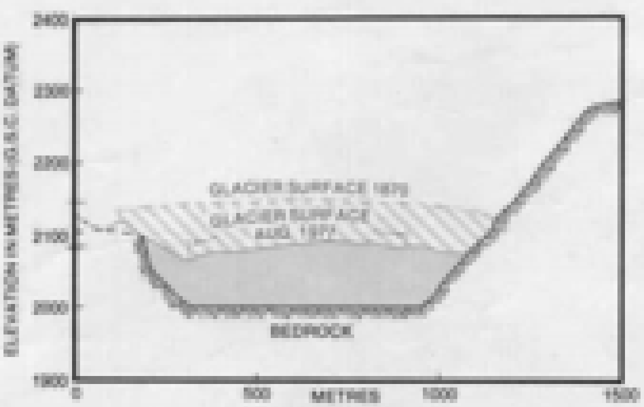
2. On the next page is a panel from a Parks Canada map of the Columbia Icefield.

   a. Using the length-wise cross section at the bottom, determine how many metres the Athabasca Glacier retreated between 1870 and 1977 (If you cannot read it clearly, here is a link to an online version: https://rossway.net/wp/wp-content/uploads/2024/03/Columbia-Icefields.jpg:



CROSS SECTION A-A

In contrast to the cross-section taken near the toe, this view shows the massive volume of ice that flows through the glacier at the base of the lowest ice fall. Because so much ice must pass through this narrow valley, it flows faster here than at the toe.



CROSS SECTION C-C

This head-on view shows how the Athabasca looks in cross-section about 600 m behind the toe. The valley bottom is much flatter here than it is at the base of the lowest ice fall (see cross-section A–A). Note how shallow the glacier is at its toe and how much deeper it was in 1870.

COLD FACTS ABOUT THE ATHABASCA GLACIER

Elevations: 2710 m at icefield rim
1925 m at toe

Lengths: 6.5 km icefield to toe
3.8 km ice falls to toe

Widths: 1100 m at ice falls
900 m at toe

Depths of Ice: 300 m just below ice falls
60 m near toe

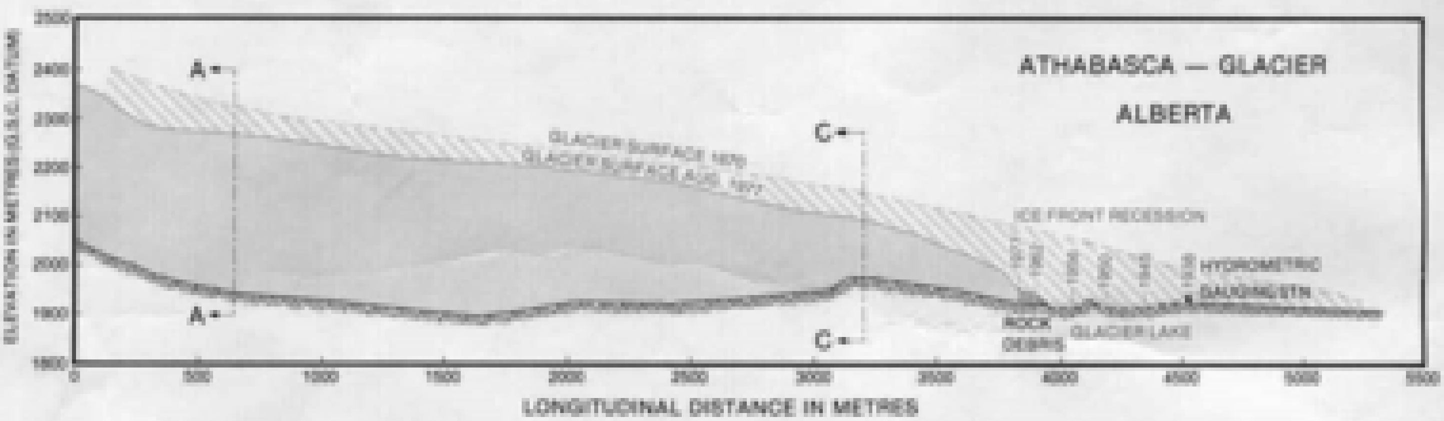
Ice Velocity: 80 m/yr at ice falls
15 m/yr near toe

Average Annual Snowfall on Icefield: 7 m +

Estimated Volume of Ice: 640 million cubic metres

Below is a cross-section of the Athabasca Glacier taken along a line running up the middle of the glacier from the toe to the foot of the lowest ice fall. Note that the glacier grows thinner gradually toward the toe and that the land beneath the glacier is lower a kilometre back from the toe than it is right at the toe.

The estimated height of the 1870 ice surface is also shown on this cross-section along with the approximate locations of the toe over the last 110 years. The other two cross-sections also show the approximate ice height in 1870 and the lines where the other two cross-sections were taken are marked by the vertical lines through the glacier on this cross-section.



If the glacier is continuing to retreat at this rate (which it is – or faster!), how much further will it have retreated by 2027?

Figure out the ***rate*** [how many metres per year it retreated: you know from **2.a.** that the glacier retreated ***x*** metres over 107 years … so

- **Divide *x*** {from **3.a**.} **by 107** to get an **average distance of retreat per year**.
- **Now multiply** that distance/year **by 50**, to figure out the distance over the 50 years from 1977-2027

NOTE: At this rate, the glacier will disappear (a longitudinal distance of 0 m) in about 220 years!

b. Using either Cross Section A-A or C-C, at the top of the page, how much lower (in elevation) was the center of the glacier in 1977 than 1870?

c. If the glacier continues to shrink at this rate, how much lower will the glacier be in 2027 than 1977 (use calculations similar to 3.b.)?

(Moral of the exercise – if you have not yet visited the Columbia Icefield, do it soon!!! It looks MUCH different now than when I remember it as a university student)

e. On the previous page are some *"Cold Facts About the Athabasca Glacier"*: note the ***ice velocity***. These figures are given in ***metres/year***. Because glaciers move so slowly, this is hard to really imagine! Using your math skills and a calculator (don't worry, I'll help you!), calculate:

i. velocity at the ice falls in ***metres/day***: ______________________ metres/day
(divide by 365 days per year)

ii. velocity at the toe (snout) in ***metres/day***: ______________________ metres/day
(divide by 365 days/year)

3. On 83 C/3 locate the Athabasca Glacier and the Saskatchewan Glacier. The Athabasca Glacier has ***moraines along the side*** (use the text and online notes to refresh your memory); these are called:

____

The Saskatchewan Glacier has both these same moraines along the sides, and ***moraines down the middle***; these moraines in the middle are called:

____

The Saskatchewan Glacier has this second kind of moraine because:
____ it begins at a higher altitude than the Athabasca Glacier
____ it faces a different direction than the Athabasca Glacier
____ other glaciers flow into the Saskatchewan Glacier
____ it is faster moving than the Athabasca Glacier
____ it is longer than the Athabasca Glacier

4. The firn line/equilibrium line on the Athabasca Glacier is about 2400 m.

   i. the zone above this line is called the zone of net ______________________________

   ii. the zone below this line is called the zone of net ______________________________

   iii. Glacial ice would flow from _______________________ to __________________________

   (fill in the blanks with "**Athabasca Glacier**" or "**Snow Dome**" as appropriate – which is higher? Ice flows downhill by gravity!)

Continental Glaciers

Currently, some parts of the world are still covered by huge continental glaciers. At some point in the past, evidence suggests that sheets of ice covered much of North America, too. Regions such as Amherst, NS, while no longer glaciated, appear to have once been covered by huge ice sheets.

5. Using your notes and the text (4CE Figure 17.16, p. 548 [3CE Figure 17.17 p. 529]) give an appropriate geomorphic term for the following features on the Amherst (NTS 21 H/16)map:

   i. 145930 (a large, streamlined hill of deposited till): ____________________________________

   ii. 027672-058706 (a curving ridge of coarse sand and gravel, now a dyke): ____________________

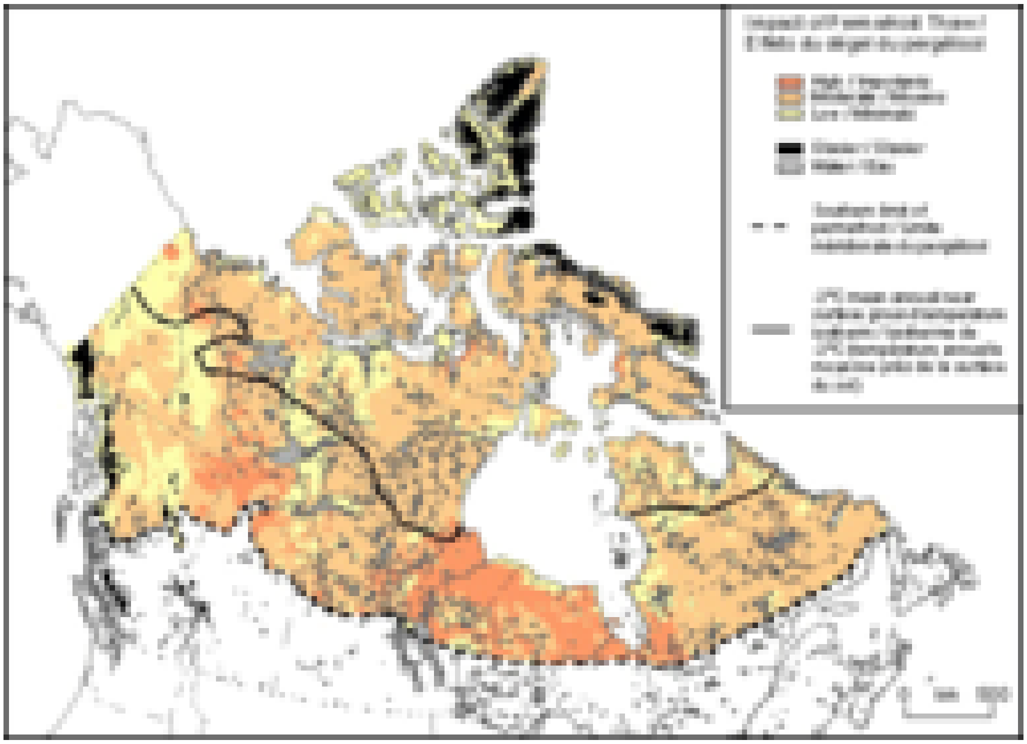
   iii. 089820 (a small lake formed by a melting block of ice in the outwash plain): __________________

   iv. ***Striations*** on exposed rocks on the Leicester Ridge (215690) run NW to SE. Would glacial movement have been from

   ______ NW to SE, or ______ NE to SW? (pick one)

   This is because striations form
   ____ in the direction of ice movement
   ____ at right angles to the direction of ice movement

Periglacial Processes



General circulation models predict that as atmospheric concentrations of carbon dioxide due to human activity, average annual air temperatures may rise up to several degrees over much of the Arctic. In the discontinuous permafrost region, where ground temperatures are within 1-2 degrees of melting, permafrost will likely ultimately disappear as a result of ground thermal changes associated with global climate warming. Where ground ice contents are high, this will have substantial physical impacts: subsidence, earthflows, and soil creep. These would have serious implications for the landscape, ecosystems, and human transportation and infrastructure.

6. If you were had a home in an area where permafrost may disappear, what would be the implications (see **http://gsc.nrcan.gc.ca/permafrost/communities_e.php** if you need ideas)

   a. for your foundation?

      _____ it would be more stable
      _____ it might shift

   b. for your utilities (water, sewer, power?)?

      _____ the water/sewer pipes/power poles will be more stable
      _____ the water/sewer pipes/power poles will shift

   c. for your transportation (road? Airfield?)

      _____ the road/airfield will be smoother and more stable
      _____ the road/airfield will be rougher and more broken

   d. most of the Arctic transportation happens along ice roads, formed when the rivers freeze solid (did you ever notice, there are no roads to most northern communities – flying supplies in is too expensive – most goods arrive in winter, by truck, on the ice roads/rivers). As global warming happens will the ice road season:

      _____ be longer – thus better for transporting goods/services and oil/gas exploration
      _____ be shorter – thus worse for transporting goods/services and oil/gas exploration