Permafrost Monitoring in Watson Lake

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Yukon Energy, Mines and Resources

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The Permafrost Outreach Program

A permafrost outreach program has been running in Yukon since 2007. Long-term permafrost monitoring stations and/or frost tubes have been installed near public schools in Whitehorse, Faro, Ross River, Dawson, Old Crow, Carmacks and Beaver Creek (Figure 3). The program is part of a larger network of permafrost monitoring stations that have been set up at over 100 schools throughout Alaska, Yukon, Greenland, Mongolia, China, Russia, Norway and Finland.

Shallow boreholes are drilled near the schools, and data loggers are installed to measure hourly air and ground temperatures at a variety of depths. Frost tubes were also installed in fall 2008 to start monitoring seasonal freezing and thawing trends in the active layer. School students are actively engaged with field data collection and interpretation of results posted on a central website. The program provides opportunities for elementary and high school students to participate with field research, and in doing so, allows them the opportunity to learn about the complex relationships between permafrost, the active layer, global climate and the physical environment.

The program also provides baseline data that can be used by scientists to characterize local permafrost conditions and detect long-term changes. For more information and educational resources, check out our website! **http://www.uaf.edu/permafrost/**

Figure 1. Panya shows some Faro students the permafrost monitoring station.

Figure 2. Kenji points out some ice (white material on auger) found 4 m below the ground surface while drilling through permafrost near Whitehorse.

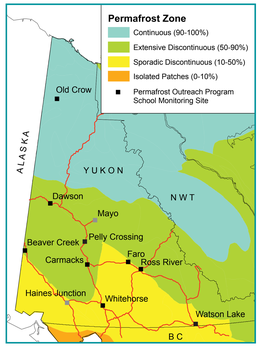


Figure 3. Map showing permafrost distribution across the Yukon, and schools participating in permafrost outreach program (black squares).

About Permafrost

What is permafrost?
Permafrost is ground that stays frozen all year round, for at least 2 years.

What is the active layer?
The active layer is the layer of soil near the ground surface that melts during summer and refreezes during winter. It lies above the permafrost and extends to the ground surface. It is usually less than 2 m thick in the Yukon.

Where is permafrost found in the Yukon?
Permafrost is not found everywhere, but it becomes more extensive in northern and western Yukon (Figure 3). It is most common on colder north-facing slopes, and beneath shady forests growing in fine silty soils. In southern and central Yukon, it is generally absent on warm southfacing slopes, in sandy soils and beneath lakes and rivers.

How thick and cold is permafrost in the Yukon?

In southern Yukon, permafrost is generally very warm (greater than -1° C) while in northern Yukon it is colder (less than -3° C).

It may be up to 10 or 20 m thick in southern Yukon, 60 m thick in central Yukon and up to 300 m thick in northern Yukon.

Why is it important to study permafrost?

Permafrost is very important for the ***ecosystem*** because it affects how water moves through the ground (water can't drain through permafrost) and therefore where certain plants and animals are found.

It is also very important for properly designing ***roads and buildings***. Construction, forest fires and flooding can cause permafrost to melt quickly which may cause the ground to settle and roads and buildings to move.

Permafrost is closely related to ***climate change*** because climate controls where permafrost can exist, and melting permafrost releases greenhouse gases (methane).

Permafrost conditions near Watson Lake

Permafrost is only found in scattered pockets in the Watson Lake area in peat bogs and fine-grained silty soils that are covered by thick moss mats. In a bog near the airport, permafrost was found 70 cm below the ground surface (Lipovsky et al., 2005).

Permafrost is very thin (up to 4 m) and very "warm" (barely below 0°C) where it has been observed near Watson Lake (EBA, 1982 & 1995).

In the early 1980's, permafrost was only found beneath approximately 5% of the Alaska Highway corridor in the Liard Basin (Rampton et al., 1983) and there may be even less in today's warmer climate.

A "drunken forest" can be found beside McDonald Creek where it crosses the Robert Campbell Highway, about 6 km north of Watson Lake airport (Figure 4). Tree roots can't grow in permafrost, which is only 50 cm below the ground surface here. Because the tree roots are so shallow, the trees tip over easily and have great difficulty growing straight.

Figure 4. Drunken forest and soil pit beside McDonald Creek. The top of permafrost, (at the bottom of the pit) is 50 cm below the ground surface.

Permafrost Monitoring

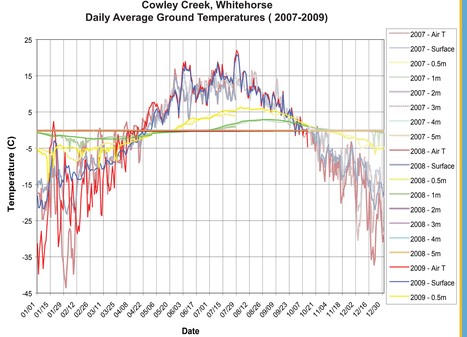
In October 2009, we are hoping to drill a ground temperature borehole near Watson Lake to monitor air and permafrost temperatures down to a depth of about 5 m for the next several years.

The graphs below show some sample data collected in 2007 and 2008 in a borehole near Whitehorse (Figure 5).

They illustrate the typical variation in temperatures you would see at different depths in the ground throughout the year. You can see that at deeper depths, the temperature changes less throughout the year. You can also tell how deep the active layer is and how cold the permafrost is.

You would likely see similar ground temperatures and patterns of fluctuation in Watson Lake.

By collecting this data for the next several years, we can find out if the temperature of the permafrost is changing.



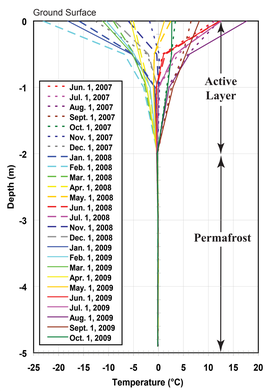


Figure 5. Example of a permafrost monitoring station and results from data collected in Whitehorse.

Active Layer Monitoring

Frost tubes are simple devices that allow us to measure how deep and how quickly the ground freezes in the active layer throughout the year. Depth of seasonal freezing depends on surface conditions such as local climate, snow depth, amount of sun exposure and shading, moss thickness, and soil moisture.

Changes in frost depth, the seasonal timing of ground freezing and thawing, and the length of the freezing period are very important for the growth of both wild and garden plants, and for building foundations and burying pipes.

The frost tube is constructed by filling a length of 6 mm (1/4-inch) clear flexible plastic tube with water (Figure 6). The water is tinted with a small amount of food colouring to make the boundary between frozen and unfrozen liquid in the tube more obvious. The tube is inserted down a small hole in the ground that is lined with a white PVC pipe.

Graduations are marked on the tube every 5 cm below the ground surface level.

At weekly intervals, students briefly remove the clear tube from the PVC pipe and measure the depth of freezing.

This is indicated by the lowest depth of frozen water in the clear tube.

In October 2009, we plan to install a frost tube near Watson Lake so students can measure seasonal ground freezing patterns.

The graph below shows some sample frost tube data collected by students in Whitehorse (Figure 7).

Figure 6. Typical frost tube installation.

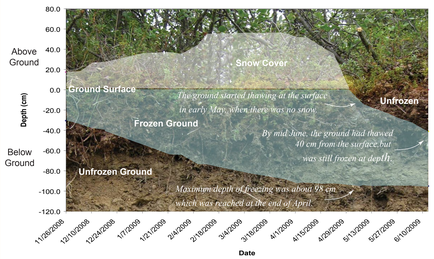


Figure 7. Frost tube data measured by Grade 5-7 students in Whitehorse show surface ground freezing patterns for winter 2008/2009.

Highlights

- Watson Lake is in the sporadic discontinuous permafrost zone, and permafrost is only found in certain locations where the soil, moisture, vegetation and climate conditions keep the ground cool enough.
- Permafrost is very thin (up to 4 m) and very "warm" (barely below 0°C) where it has been measured near Watson Lake.
- Permafrost exists 70 cm below the ground surface in a peat bog near the airport, and 50 cm below the ground surface beneath a "drunken forest" near McDonald Creek.
- In the early 1980's, permafrost was only found beneath approximately 5% of the Alaska Highway corridor in the Liard Basin and there may be even less today, as the climate warms.
- A permafrost monitoring station and frost tube will be installed in Watson Lake in October 2009 so that local students can monitor permafrost and active layer temperatures and be able to detect changes in the future.

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Sources of Further Information

Learn more about permafrost and climate change on these websites:

1) National Snow and Ice data center (US): http://nsidc.org/sotc/permafrost.html and http://nside.org/frozenground/.
2) Environment Canada: http://www.msc-smc.ec.gc.ca/crysys/education/permafrost/permafrost_edu_e.cfm
3) Northern Climate Exchange (Whitehorse): http://www.taiga.net/nce/education/resources.html and http://www.taiga.net/nce/schools/teachers.html
4) Arctic Climate Impact Assessment: http://amap.no/acia/ and check out http://www.taiga.net/acia/index.html

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http://www.uaf.edu/permafrost/

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