Permafrost Monitoring at Ross River School

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.

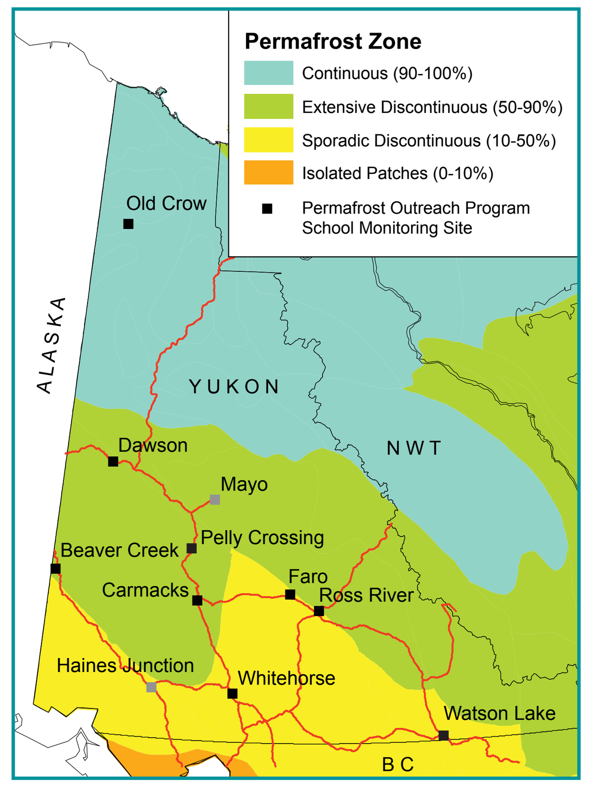


Figure 3. Map showing permafrost distribution across the Yukon, and schools participating in permafrost outreach program (black squares).

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 (Figure 4).

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

Permafrost conditions near Ross River

The base of permafrost extends from 15-25 m below the ground surface in the Ross River area (EBA, 2007, unpublished data & Stanley, 1986), and 24.5 m below the ground at the Ross River School.

Permafrost thaw resulting from ground disturbance has caused the Ross River School to settle and crack since it was built in 2000 (Figure 4).

"Thermosiphons" were installed around the outside of the school to help cool the ground and keep the permafrost from melting.

Figure 4. Permafrost melting beneath the Ross River school has caused the building to settle, and cracks to form in the foundation, walls and floors.

References:

Stanley Associates Ltd., 1986. Groundwater supply investigation, Ross River, Yukon. Report to Department of Community and Transportation Services, Yukon Territorial Government, Whitehorse, Yukon, 9 p.

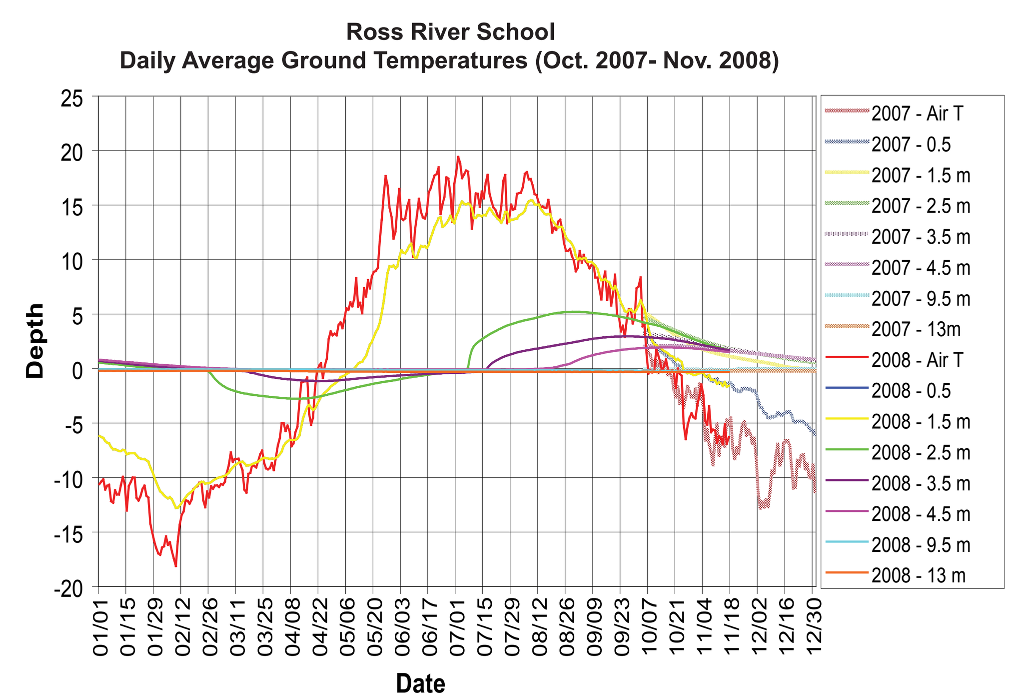
Permafrost Monitoring

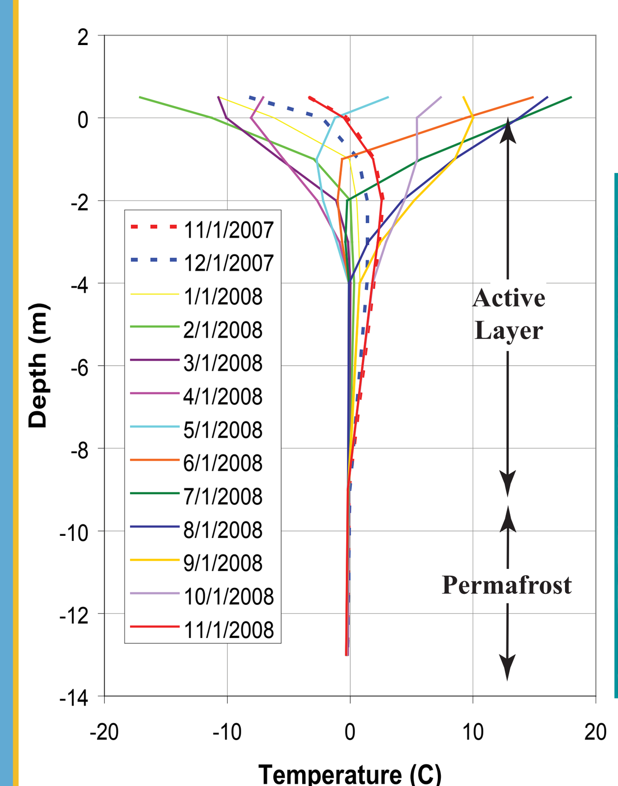
On June 13, 2007, a deep ground temperature borehole was drilled by EBA Engineering at Ross River School to a depth of 27.7 m.

The site is located inside the school yard approximately 15 m west of the school gymnasium doors.

- **location:** 61° 58' 46.5" N latitude, 132° 27' 9.5" W longitude, elevation 659m
- **ground cover:** gravel and grass
- **soil:** unfrozen sand from 0-4 m depth; unfrozen gravel from 4-6 m depth; silt and clay from 6-20 m depth (frozen and ice-rich below 7 m, and ice lenses up to 20 cm thick); frozen sand and clay from 20-24.5 m depth; and unfrozen wet silt and clay below 24.5 m
- **temperature sensors:** installed at 0.5 m, 1.5 m, 2.5 m, 3.5 m, 4.5 m, 9.5m, and 13 m depths in the ground, as well as 50 cm above ground to monitor air temperature.

The graphs below show the data collected at this site from October 2007 to November, 2008 (Figure 5).





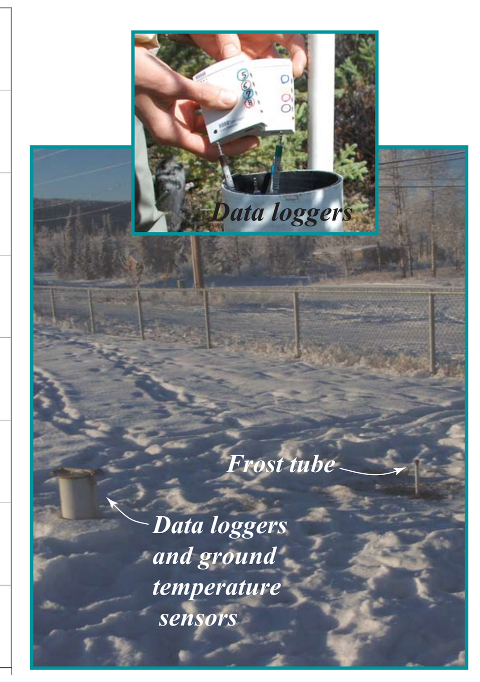


Figure 5. Permafrost monitoring station at Ross River School.

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.

A frost tube was installed to 200 cm depth on November 18, 2008. The site is located inside the school yard approximately 15 m west of the school gymnasium doors.

The frost tube was 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.

Figure 6. Typical frost tube installation.

Figure 7. Kenji shows Ross River students how to take a frost tube measurement.

The frost tube showed that the ground had frozen 72 cm by October 15, and 165 cm by January 13, 2009.

Note tall thermosiphons to cool the ground in the background.

Highlights

- Ross River is in the discontinuous permafrost zone, and permafrost is only found in certain locations where the soil, moisture, vegetation and climate conditions keep the ground cool enough.
- A permafrost monitoring station was installed at Ross River School in June 2007. Permafrost temperatures are measured once every hour at various depths in a 27.7 m deep borehole.
- The data show that the active layer at the school is 9.5 m thick, which is unusually thick. Disturbance of the ground surface during construction and the lack of natural ground cover may explain why the active layer is so thick.
- A frost tube was installed in the Ross River School yard on November 18, 2008.
- Frost tube measurements made by school students show that the depth of freezing progressed from 87 to 165 cm below the ground surface between November 2008 and mid January 2009.
- High ice contents were found in the permafrost monitoring borehole below 7 m depth at Ross River.
- Melting ice in the permafrost has caused the school to settle and the floors and walls to crack.

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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://nsidc.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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