Permafrost Monitoring at Del Van Gorder School, Faro

Panya Lipovsky[1] and Kenji Yoshikawa[2]

[1]Yukon Geological Survey, [2]University of Alaska Fairbanks

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

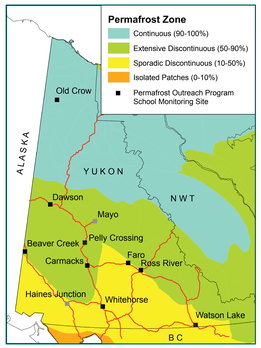


Figure 2. Map showing permafrost distribution across the Yukon, and schools participating in permafrost outreach program (black squares).

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 2). 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 Faro:

Permafrost is found in scattered pockets in the Faro area. It is commonly found close to the ground surface in peat bogs and in fine-grained silty soils that are covered by thick moss mats.

Depth to the base of permafrost in the Faro area has been reported to be approximately 10 m (EBA, 1981).

Permafrost thaw has caused the ground to settle beneath Del Van Gorder school gymnasium, as well as near the baseball diamond (Figure 3).

Figure 3. Permafrost melting has likely caused the ground to sink and a surface depression to form near the baseball diamond.

References:

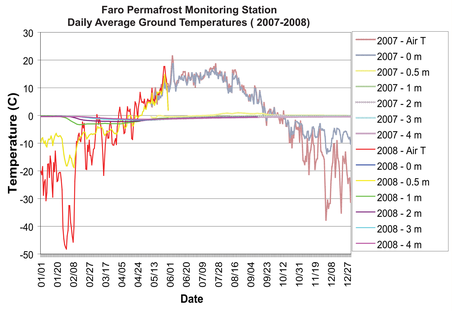
EBA Engineering Consultants Ltd., 1981. Geotechnical evaluation, proposed 1981 trailer park, Faro, Yukon. Report to Department of Municipal and Community Affairs, Yukon Territorial Government, 12 p.

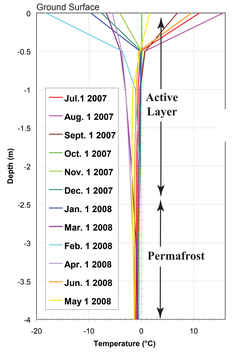
Permafrost Monitoring

On May 8, 2007, a ground temperature borehole was drilled to 3.9 m depth approximately 600 m southeast of Del Van Gorder School in Faro. The site is located 50 m southeast of a small track that cuts between Douglas Drive and Blind Creek Road.

- **location:** 62° 13' 24.5" N latitude, 133° 20' 31.3" W longitude, elevation 720m.
- **vegetation:** young white spruce forest with scattered birch, thick moss and Labrador tea shrubs.
- **soil:** ash, fine sand and silt with occasional stones and higher clay content areas.
- **temperature sensors:** installed at 50 cm, 100 cm, 200 cm, 300 cm and 390 cm depths in the ground, and at the ground surface (0 m) and 100 cm above ground to monitor air temperature.

The graphs below show data collected from this site between May 2007 and September 2008 (Figure 4).





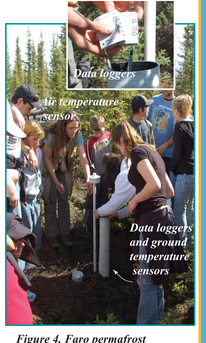


Figure 4. Faro permafrost monitoring station and results.

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.

On November 18, 2008, a frost tube borehole was drilled to 2.1 m depth in a forested area just behind the Del Van Gorder School. The site is approximately 25 m east of the northeastern corner of the swimming pool building.

The frost tube was constructed by filling a length of 6 mm (1/4-inch) clear flexible plastic tube with water (Figure 5). 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.

The graph below shows frost tube data collected by students in Faro (Figure 6).

Figure 5. Typical frost tube installation.

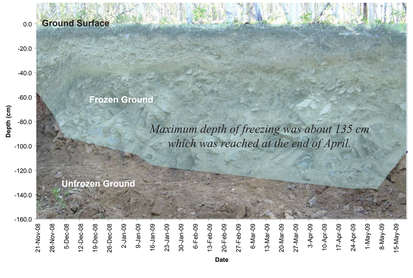


Figure 6. Frost tube data measured by the Grade 9-12 Del Van Gorder students from November 2008 to May 2009.

Highlights

- Faro is in the sporadic discontinuous permafrost zone, and permafrost is only found in certain locations where soil, moisture, and climate conditions keep the ground cool enough.
- A frost tube was installed at Del Van Gorder School in November 2008.
- Frost tube measurements made by students show that the ground froze down to a maximum depth of 135 cm by April 23, 2009.
- A permafrost monitoring station was installed at Faro in May 2007. Permafrost temperatures are measured once every hour at various depths in a 390 cm deep borehole.
- The active layer at the Faro monitoring station is 2.4 m thick.
- The temperature of permafrost measured in Faro is slightly less than -0.8° C, which is very close to melting!
- The average annual air temperature at the Faro monitoring station is -3.1° C.
- The warmest air temperature measured at the Faro monitoring site was 33° C on June 4, 2007, while the coldest air temperature was -51.4° C on January 31, 2008.
- Permafrost melting has caused settlement problems beneath the school gymnasium in the past.

Acknowledgements

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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

For more information, contact:

Panya Lipovsky
867-667-8520
Panya.Lipovsky@gov.yk.ca
www.geology.gov.yk.ca

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

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