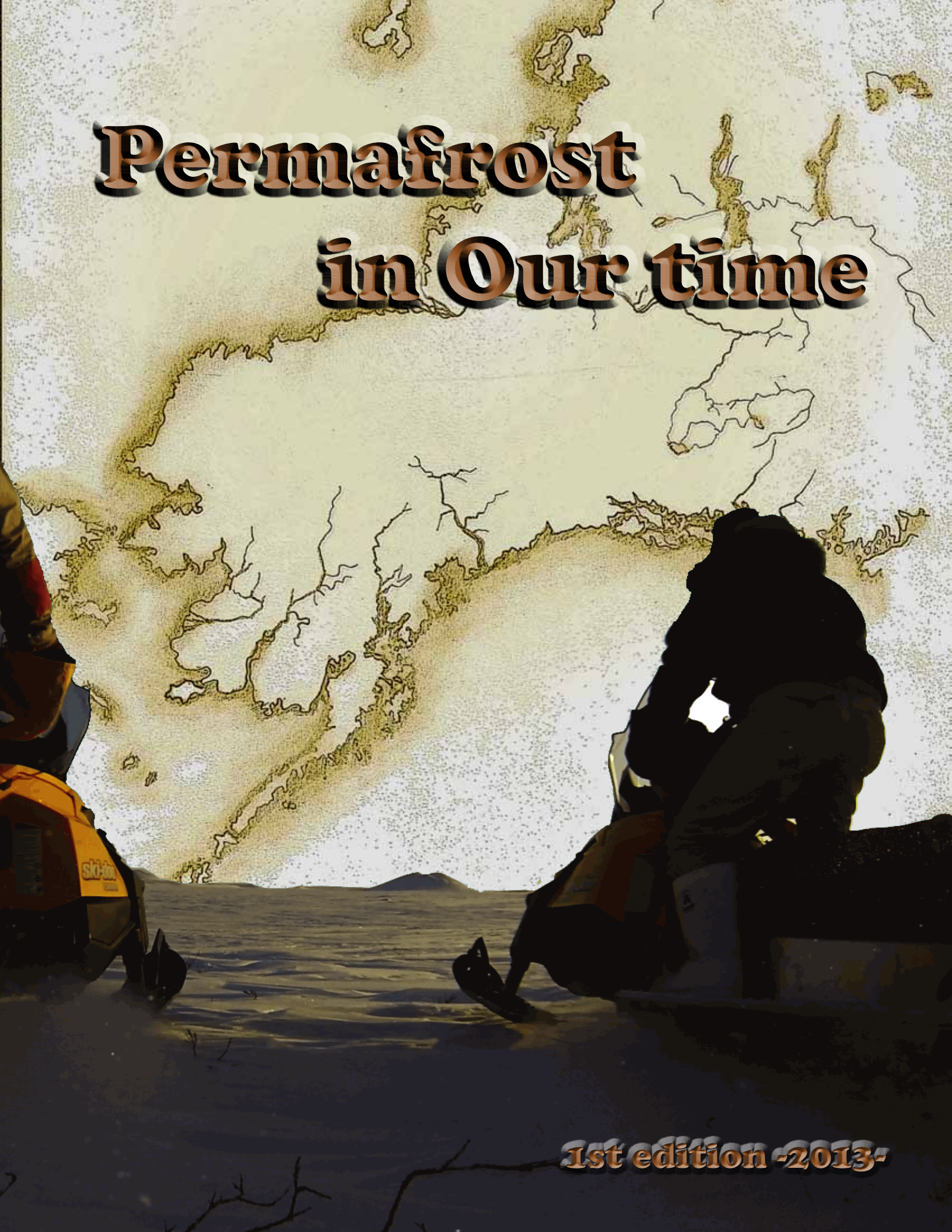
Permafrost in Our time



1st edition -2013-

Permafrost in Our time

Community-Based Permafrost Temperature Archive

Edited and Compiled by Kenji Yoshikawa

1st edition -2013-

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Text Editor: Fran Pedersen, Sandra Boatwright, Ned Rozell, Kenji Yoshikawa
Production Director: Kenji Yoshikawa
Designer: Kenji Yoshikawa
Main Photographer: Kenji Yoshikawa, Isao Yuguchi, Ryouta Kajita, Akio Hachinohe

Cover Photograph:
Front: Pingos at Tuktuyakutak during snow mobile expedition in 2013,
tracing of map from Meyer, Joseph in 1845 Neueste Karte vom Nordpol by Maya Yoshikawa
Back: Cartoon “TunnelMan Returns” by Youichi Inada
map: the permafrost monitoring network locations

Prologue

In fall 2005, Doug Goering and I had a great time in a spruce forest next to a Fairbanks school using a prototype portable drill system. The drill was so powerful it seemed to shake the entire forest. This was the first time we drilled and and also the first time we spoke about outreach activities at Pearl Creek Elementary School. It was a totally different experience for me. I used to go out and do fieldwork with a limited group of colleagues or friends or solo. That was still exciting and a chance to challenge extreme environments, but this program was a totally different experience. I saw new teachers or new students almost every day! It was exciting to see them again when I returned to the communities. Now, I have a chance to see many students who used to help me drill when they were small, only they are now playing basketball at the university rather than their village gyms. I look forward to seeing them all at different places over time; this connection gives me the most happiness as I go on to work on the same village networks and expand into new ones.

When I was in my twenties and had just attempted to paddle up the Amazon River, I figured out the following three things I should do in my life: 1) I would be an expert in some scientific field that would be benefit people; 2) I should master English, since it would allow me to reach the most people, and 3) I wanted to look back my life later and see that my life had a positive impact on the world. The program detailed in this book is fitting nicely to my ambition. I know we should keep going! Keep going to the all of the world. But sometimes I need to re-connect, and feed back to the communities that are benefitting all of us. The idea of this magazine is to show all of the data, pictures and activities in one place. This magazine idea started four years ago; its delay is my fault. As it has progressed, its contents have gotten smaller and shorter. The Program will keep going and data will keep increasing, so we will have more content later. Please accept this for now as my first edition.

Thanks you for all support,

March 1st, 2013
Kenji Yoshikawa

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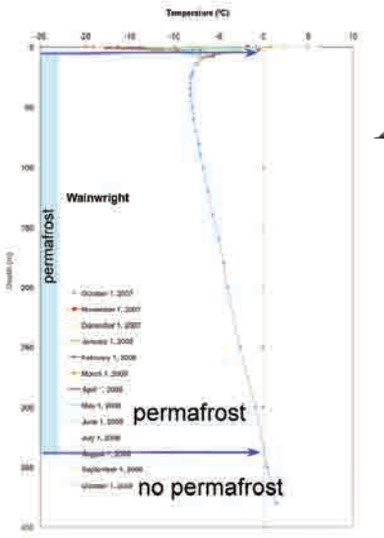
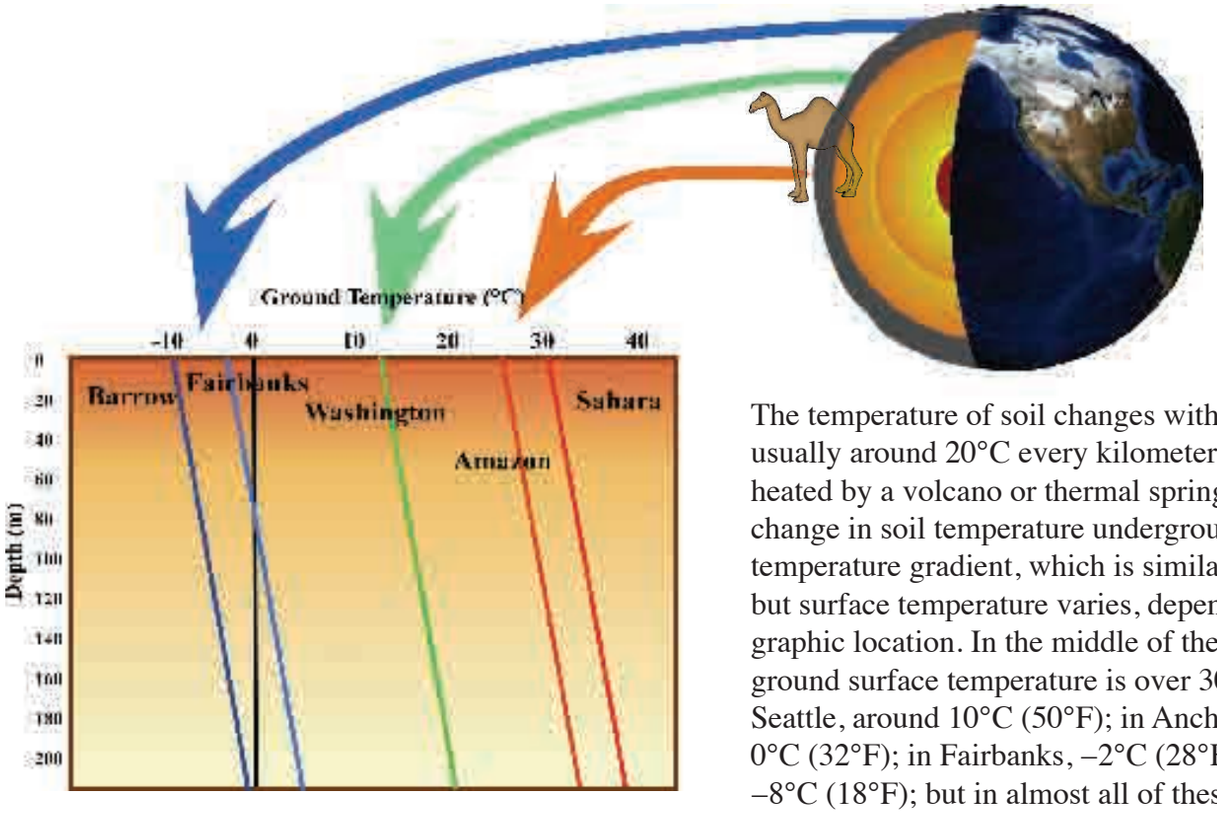
Sunset at Kwigillingok, Lower Kuskokwim School District, Alaska

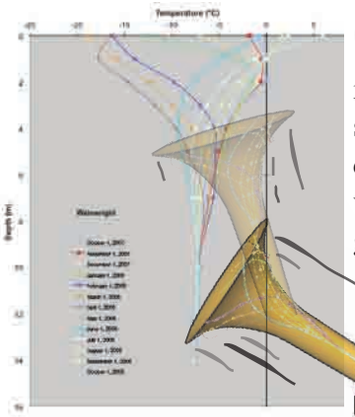
Permafrost is defined as materials that remain below 0°C (32°F) for two or more years. (Some countries use a different definition.) Permafrost forms when the ground cools enough in winter to produce a frozen layer that remains frozen throughout the following summer. The active layer (the soil near ground surface that thaws each summer) and the thickness of permafrost depend on local climatic conditions, vegetation cover, soil type and moisture content, and any effects from the heat at the Earth's center.

This graph shows the relationship between ground depth and soil temperture at the village of Wainwright in the North Slope Bolough. The horizontal line (called the x axis) represents soil temperature (°C); the vertical line (called the y axis) represents ground depth (meter). The blue area represents permafrost. Ground temperature increases (warmer) with depth. In permafrost regions, where the ground surface is below freezing, the soil temperature for many meters underground is below freezing, in this case 330m (1083 ft). Eventually, though, the underground temperature warms due to heat from the Earth's core, called heat flow.

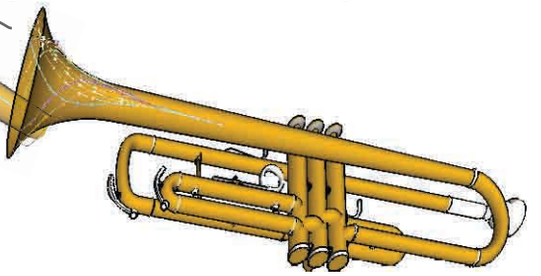




The center of Earth is hot (similar to the temperature of the sun's surface at 5800 K [9980°F]), but its average ground surface temperature year-round depends on where you live. Permafrost can be present wherever the average air temperature is around or below 0°C (32°F). The temperature of soil changes with ground depth, usually around 20°C every kilometer deep in areas not heated by a volcano or thermal springs. This rate of change in soil temperature underground is called the temperature gradient, which is similar everywhere, but surface temperature varies, depending on geographic location. In the middle of the Sahara Desert, ground surface temperature is over 30°C (86°F); in Seattle, around 10°C (50°F); in Anchorage, almost 0°C (32°F); in Fairbanks, –2°C (28°F); and in Barrow, –8°C (18°F); but in almost all of these places, ground temperature increases at a similar rate with depth.



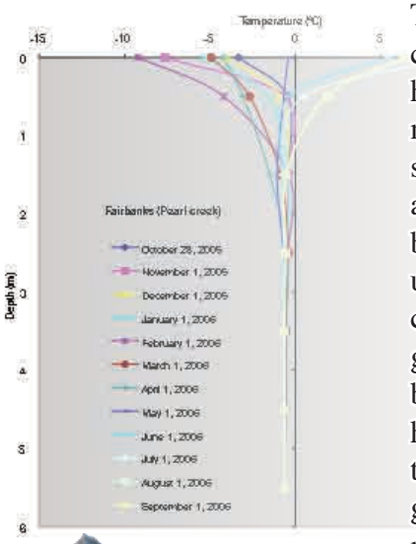
Called a Trumpet curve (because of its shape), this graph is determined by soil temperature points at certain depths during a year. The ground temperature variations show seasonal changes near ground surface at Wainwright.



Let's take a close look at the near-surface ground, the active layer. The ground surface is colder in winter and warmer in summer. The ground surface temperature fluctuates 20–30°C between seasons. Deep in the ground, however, soil temperature changes little from season to season. At 2–20 m (7–66 ft) in depth, depending on soil material, there is no seasonal change in temperature; it is the same temperature all year around. This graph shows that at Wainwright the depth of no seasonal change is 10 m (30 ft) below ground surface.

This graph of soil temperature at Fairbanks Pearl Creek School, shows that the depth of no seasonal change is 2.5 m (8 ft) below ground surface. The depth is much shallower here because the temperatures are close to the thawing point.

The summer line in the Fairbanks graph shows that the ground surface is above freezing, but at only 1 m (3 ft) below ground surface, the line crosses the 0°C (32°F) point. Beneath this point, soil is frozen. Most of the year, the upper layer is frozen, too, but this layer thaws each summer (the active layer).



The main heat transfer of ground is conduction. It takes time for loosing heat all the way. Deeper ground does not respond as quickly as the ground surface. In the middle of winter (February), ground surface is getting very cold, but the cold hasn't yet reached deeper underground. In April, though, it is the coldest time of year 1 m (3 ft) below ground. There's usually lots of sunshine by then on the surface and half the snow has melted. It is possibly the most beautiful time in Alaska! But only 1 m below ground, it is the coldest time and pipes may freeze unless they're heated.

Strange permafrost Families!?

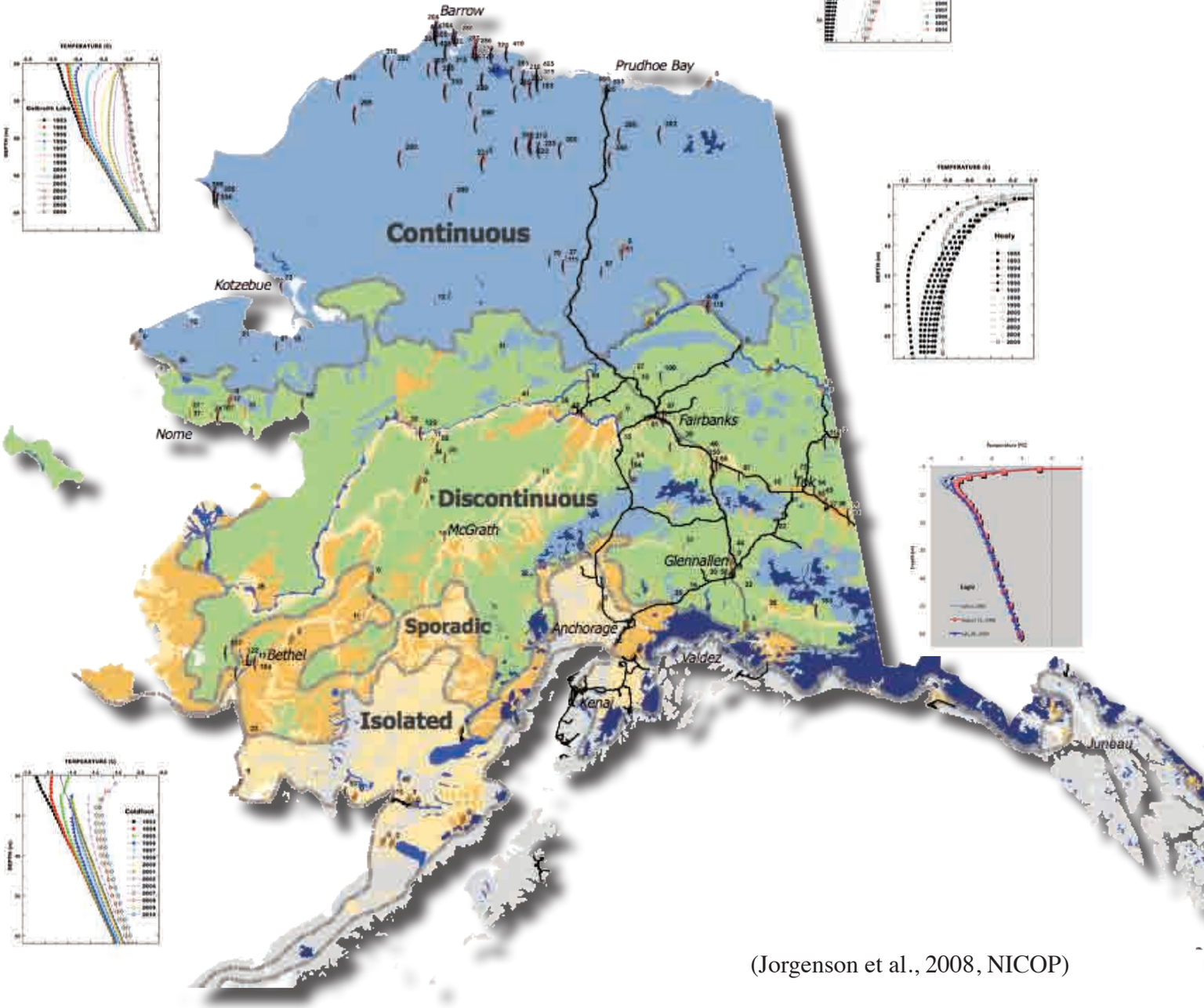
Brine: Brine is water that has salt in it. This brackish water freezes at a lower temperature than water without salt in it. The higher the salt content, the lower the temperature must be for water to freeze (up to –21°C [6°F] for NaCl), but this liquid–soft ground is still called permafrost.

Bedrock: Permafrost does not have to contain water or ice. As long as the temperature of the ground—in this case, solid rock—stays below freezing year after year, it is still considered permafrost, even if it is completely dry. This is because permafrost is defined by temperature.

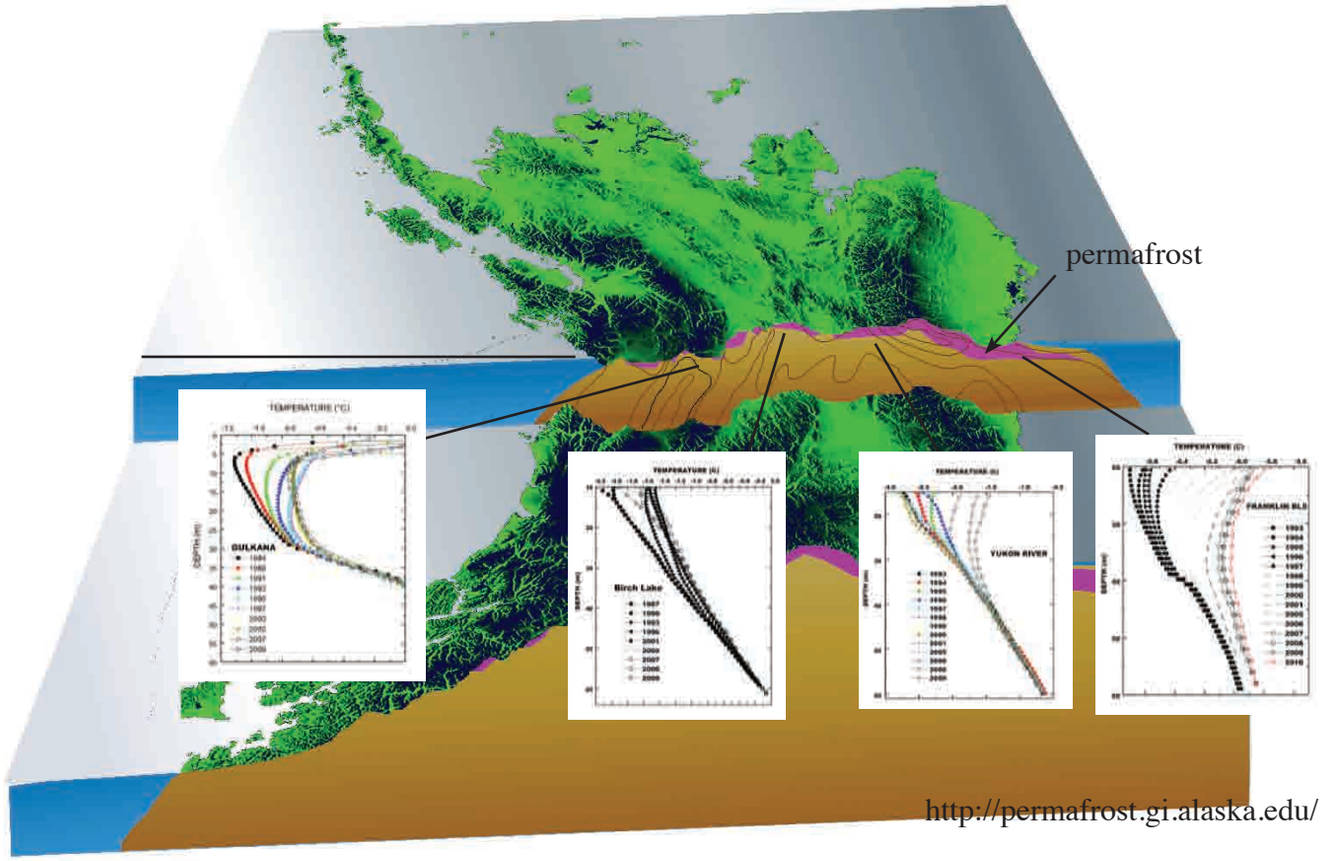
Brine at Barrow, 4.2 times higher sea water salt content. This brackish water freezes below -10 °C.

Permafrost in Alaska

Permafrost observatories were established in the 1970s and 1980s by the Geophysical Institute, University of Alaska Fairbanks, along the Trans Alaska Pipeline and at other locations in Alaska. Depths of these boreholes are typically 60 to 80 m, and measurements are usually taken annually. Over the last 20 years, permafrost temperatures in Alaska have changed noticeably. Generally, the increases in permafrost temperature are more pronounced at coastal Arctic sites (from 1.5 to 3.0°C at the permafrost table) and less pronounced in Interior Alaska (from 0.5 to 1.5°C).



(Jorgenson et al., 2008, NICOP)



http://permafrost.gi.alaska.edu/

Permafrost extends widely across most of Alaska except in the Aleutian Islands and along the Gulf of Alaska, but permafrost conditions vary depending on location. Continuous and colder permafrost (3°C and lower) is mainly found on the North Slope (Barrow; Kaktovik, -9°C) and in the Brooks Range (Arctic Village, -3.8°C). Southwest of the Brooks Range, permafrost is discontinuous. Typical alluvium or glaciofluvial coarse sediments are absent of permafrost. Many villages, such as in the Kobuk and Koyukuk River valleys, are located on permafrost-free terrain (Ambler, Kobuk, or Huslia, 0 to 5°C). The Seward Peninsula and Bering Strait coastal regions have a maritime climate and a variety of permafrost conditions. Permafrost temperature is between -3°C (Kotzebue, Shishmaref, Wales) and 2°C (Teller, Nome). There is an absence of permafrost (slightly above 0°C) on the south side of the Seward Peninsula (Elim, White Mountain). Storm surge and spring river-flooding events heavily influence permafrost distribution in the Yukon-Kuskokwim Delta. Permafrost is absent in lower flooded terrain such as Nunam Iqua (Sheldon Point), Scammon Bay, Hooper Bay, Emmonak, Kotlik, and Chefornak (2 to 3°C). However, in villages located in higher (older) terrain (20–50 cm higher than flooded terrain), there is permafrost, with a temperature range between 0.8 and 0.2°C.

The distribution of permafrost in Bering Sea islands is exceptional. There is well-developed permafrost found on St. Lawrence Island and Little Diomede Island (-2°C). Permafrost appears in eolian sediments at Nunivak Island and Nelson Island (-0.3°C). Permafrost is absent in the Pribilof Islands. Volcanic activity on Saint Paul Island created several lava tube caves. Ice has not been recorded in any of the caves.

In the greater part of Interior Alaska and the Copper River Basin, permafrost is present discontinuously. For example, ground temperature may fluctuate between -2 to 2°C over a 1 km2 area. South-facing slopes do not contain permafrost (0 to 2°C), unlike north-facing slopes and valley bottoms, which do (-3 to 0°C). Permafrost distribution is strongly affected by solar radiation (slope aspect) and soil properties.

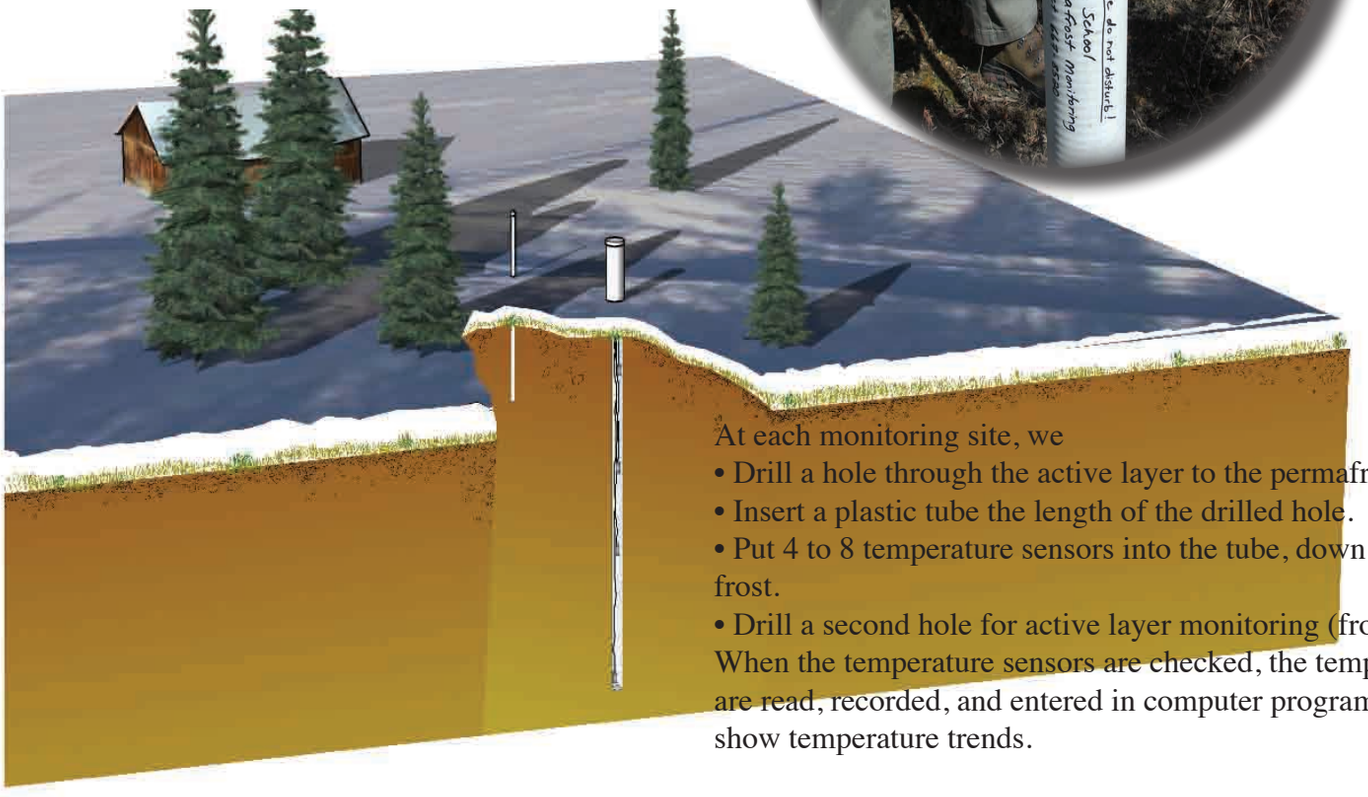
The southern boundary of permafrost in Alaska is around 60°N latitude, but it is an irregular boundary. In the Bristol Bay area, glaciofluvial and glacial history prevented the formation of permafrost, but permafrost developed in eolian sediments (Eek, Koliganek, Quinhagak) (slightly below 0°C to -0.2°C). In the Gulf of Alaska region, permafrost is absent due to heavy snowfall and warm ocean temperatures during winter, such as in Valdez (4°C). However, in some of the peat-rich marshy areas near Anchorage, ice-rich silty sediments remain frozen (-0.2°C).

The ultimate goal,

At least one hole for each village ...

The Permafrost/Active Layer Monitoring Program is a research project that keeps track of (monitors) ground temperature and the active layer depth. Information learned from this research helps us understand climate change and its effect on the natural environment and local ecosystems. The data (information) we record now will be the beginning point (a baseline) for what we learn in the future, which makes this a long-term study. We hope to collect data for many years so that we can track how the permafrost and active layer change over time.

To gather data, we set up monitoring sites near communities throughout Alaska and in other countries where there is permafrost. Students and teachers in local schools participate in the research by reading measurements at the monitoring sites and recording data. They can compare data on-line with schools in other villages and towns where there is permafrost, and discuss what they learn. Classroom lessons on permafrost have been developed for students at all grade levels. The lessons and the activities at the measuring sites offer students hands-on scientific experience and an opportunity to see the connection between science and research.

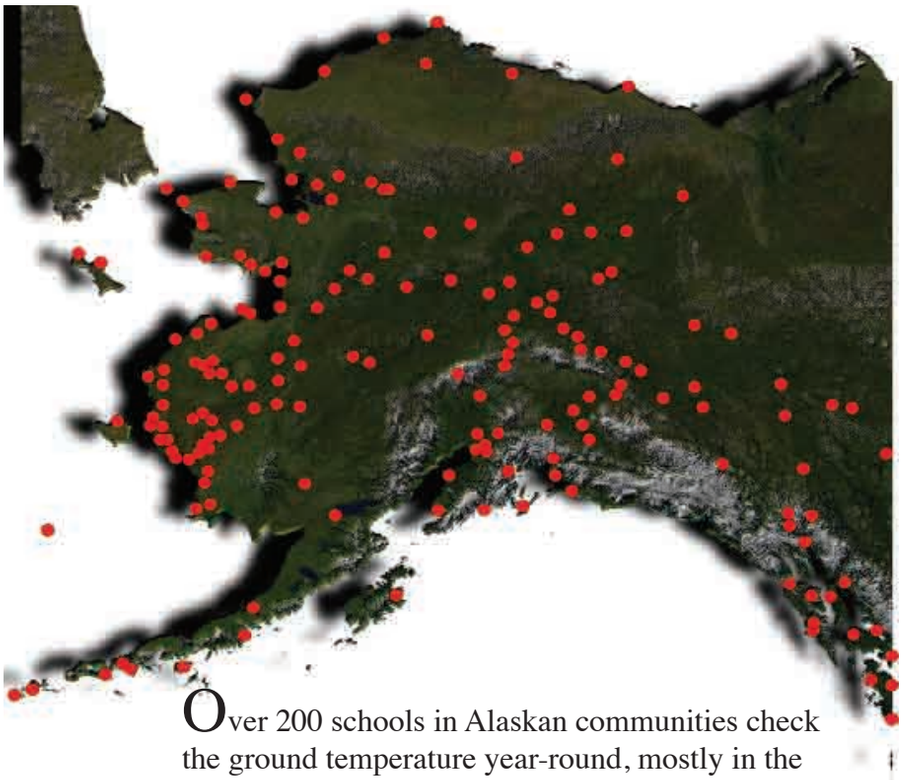


At each monitoring site, we

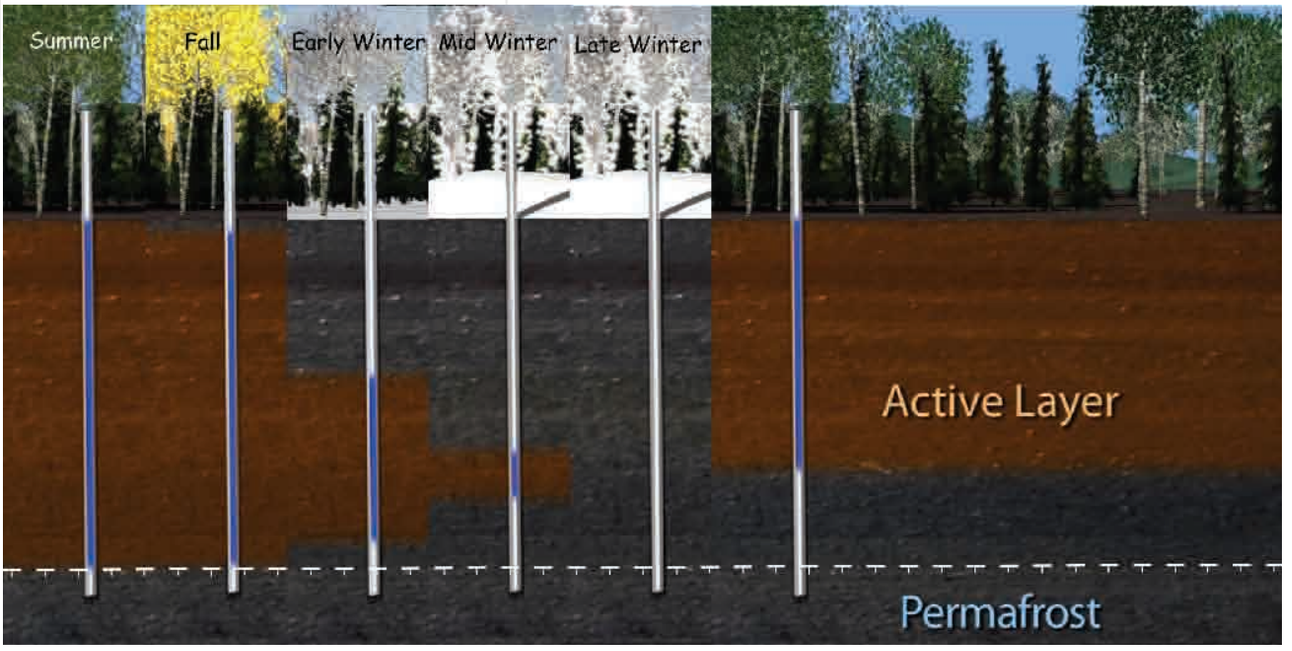
- Drill a hole through the active layer to the permafrost.
- Insert a plastic tube the length of the drilled hole.
- Put 4 to 8 temperature sensors into the tube, down to permafrost.
- Drill a second hole for active layer monitoring (frost tube).

When the temperature sensors are checked, the temperatures are read, recorded, and entered in computer programs that show temperature trends.

A Frost Tube is an instrument that measures when and how deeply soil freezes. It is made of 3 tubes that fit inside each other. The tube furthest inside is marked with measurements and filled with colored water; it fits inside a radiant heat tube (sealed on the bottom), which fits inside a PVC pipe, open on both ends. Altogether, the Frost Tube is about 12 mm in diameter. When inserted in the hole drilled in the ground (a drill hole), the Frost Tube's underground end reaches to the deepest level of frost or to the permafrost layer. The aboveground end (about 1 m long) is capped to prevent air temperature from influencing the underground temperature reading and keep snow and water out. The tube with colored water shows us where ice has formed underground. We lift that tube from the others and note where ice has formed; it is easy to see the boundary between ice and unfrozen water, because the ice looks clear and the water looks colored.



Over 200 schools in Alaskan communities check the ground temperature year-round, mostly in the permafrost region but also in southern locations, such as Homer and Juneau. This program hopes to have at least one monitoring hole in each community.



How far down does the ground freeze? It's related with soil properties, freezing degree days, etc.

Freezing degree-days (FDD) or thawing degree-days (TDD) are defined as departures of soil temperature from 0°C. When temperatures fall below 0°C, it gives a positive value, whereas it becomes negative when temperatures rise above 0°C. This index is a measure of both duration and magnitude of below-freezing (or above-thawing) temperatures during a specified period. Therefore, the cumulative values of FDD or TDD for a given winter season or summer tell how cold or warm it has been for how long.

Alaska Public School Districts
Alaska Gateway Schools (09)
P.O. Box 226
Tok, AK 99780
Phone: 883-5151
Alaska Region Schools (04)
PO Box 92230
Anchorage, AK 99509
Phone: 277-2648
Aleutians East Borough (36)
School District
P.O. Box 429
Sand Point, AK 99661-0429
Phone: 383-5222
Anchorage Schools (05)
P.O. Box 196614
Anchorage, AK 99519-6614
Phone: 742-4000
Annette Island Schools (06)
P.O. Box 7
Metlakatla, AK 99926-0007
Phone: 886-6332
Bering Strait Schools (07)
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Unalakleet, AK 99684
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Naknek, AK 99633
Phone: 246-4225
Chatham Schools (09)
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Angoon, AK 99820
Phone: 788-3302
Chugach Schools (10)
9312 Vanguard Dr., Ste 100
Anchorage, AK 99507
Phone: 552-7400
Copper River Schools (11)
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Phone: 822-3235
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Craig City Schools (13)
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Craig, AK 99921
Phone: 826-3274
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P.O. Box 527
Delta Junction, AK 99737
Phone: 895-4668
Denali Borough Schools (02)
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Healy, AK 99743
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Fairbanks, AK 99701-4756
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Phone: 766-2644
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Phone: 285-3393
Iditarod Area Schools (21)
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Phone: 524-3033
Juneau Borough Schools (22)
10014 Crazy Horse Drive
Juneau, AK 99801
Phone: 463-1700
Kake City Schools (25)
P.O. Box 450
Kake, AK 99830
Phone: 785-3741
Kashunamiut Schools (55)
985 KSD Way
Chevak, AK 99563
Phone: 858-7713
Kenai Peninsula Borough (24)
Schools
148 N. Binkley St.
Soldotna, AK 99669
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Ketchikan Gateway (25)
Borough Schools
333 Schoenbar Road
Ketchikan, AK 99901-9278
Phone: 247-2109
Klawock City Schools (27)
P.O. Box 9
Klawock, AK 99925
Phone: 755-2228
Kodiak Island Borough Schools (28)
722 Mill Bay Road
Kodiak, AK 99615
Phone: 486-9210
Kuspuk Schools (29)
P.O. Box 49
Aniak, AK 99557-0049
Phone: 675-4350
Lake and Peninsula (30)
Borough Schools
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King Salmon, AK 99613
Phone: 246-4280
Lower Kuskokwim Schools (31)
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Phone: 443-2231
North Slope Borough Schools (36)
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Phone: 852-5311
Northwest Arctic (37)
Borough Schools
P.O. Box 51
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Phone: 442-3472
Pelican City Schools (38)
P.O. Box 90
Pelican, AK 99832
Phone: 735-2236
Petersburg City Schools (39)
P.O. Box 289
Petersburg, AK 99833-0289
Phone: 772-4271
Pribilof Islands Schools (40)
P.O. Box 905
St. Paul Island, AK 99660
Phone: 546-2221
Saint Mary's City Schools (46)
P.O. Box 9
St. Mary's, AK 99658-0171
Phone: 438-2411
Sitka Borough Schools (42)
P.O. Box 179
Sitka, AK 99835-0179
Phone: 747-8622
Skagway City Schools (43)
P.O. Box 497
Skagway, AK 99840-0497
Phone: 983-2960
Southeast Island Schools (44)
P.O. Box 19569
Thorne Bay, AK 99919-8440
Phone: 828-8234
Southwest Region Schools (45)
P.O. Box 90
Dillingham, AK 99576
Phone: 842-5287
Tanana Schools (53)
P.O. Box 89
Tanana, AK 99777
Phone: 366-7203
Unalaska City Schools (47)
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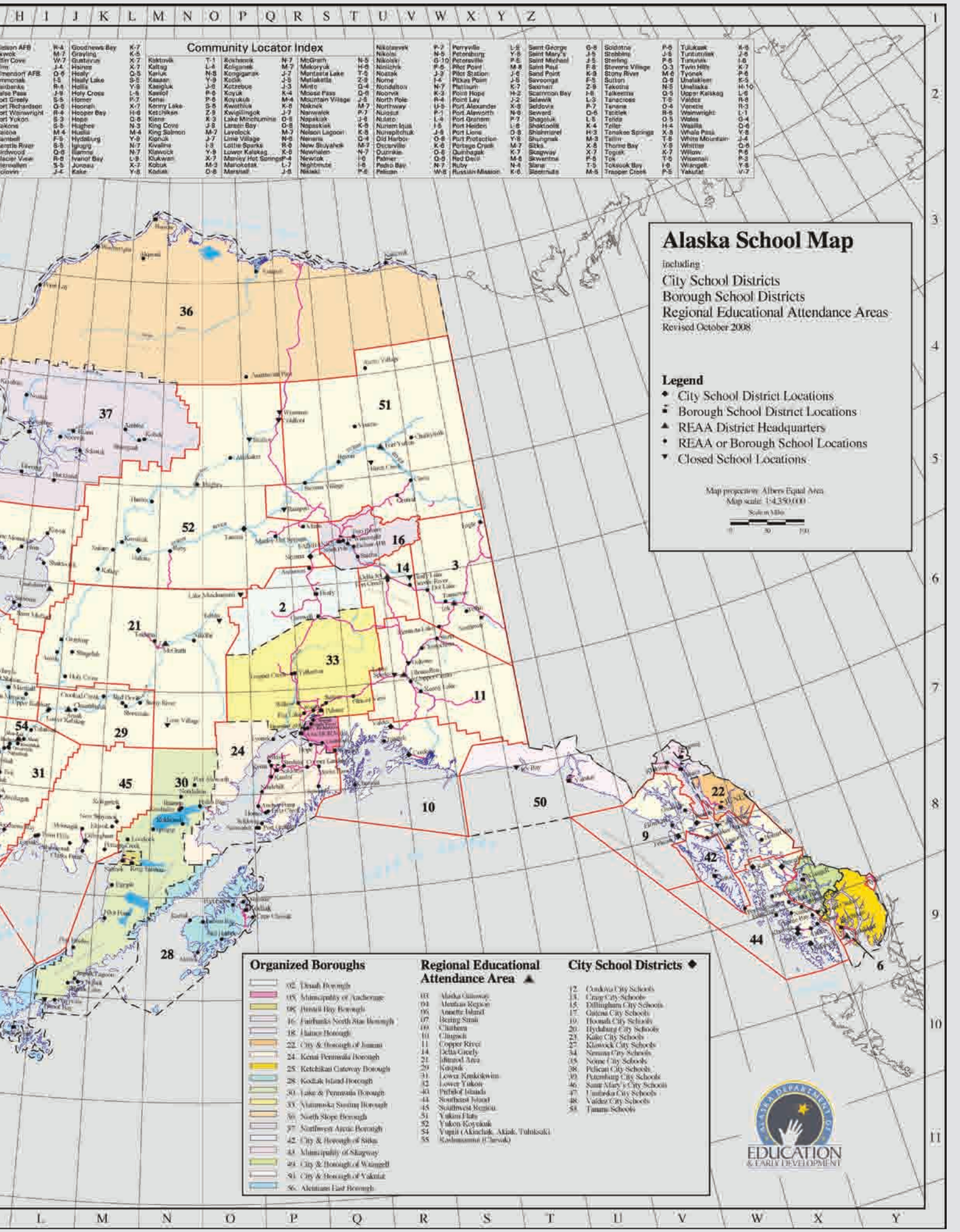
Unalaska, AK 99685
Phone: 581-3151
Yakutat City Schools (48)
P.O. Box 498
Yakutat, AK 99689
Phone: 784-3357
Wrangell City Schools (49)
P.O. Box 2319
Wrangell, AK 99929-2319
Phone: 874-2347
Yukon Flats Schools (51)
P.O. Box 350
Ft. Yukon, AK 99740
Phone: 662-2515
Yukon Koyukuk Schools (52)
4762 Old Airport Way
Fairbanks, AK 99709-4456
Phone: 474-9400
Yupiit Schools (54)
P.O. Box 51100
Akiachak, AK 99551-0100
Phone: 825-3600
Trip to the communities!!
Prepared by Department of Commerce, Community, & Economic Development
Division of Community and Regional Affairs for the Department of Education &
Early Development October 2008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Bering
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Southwest
PWS
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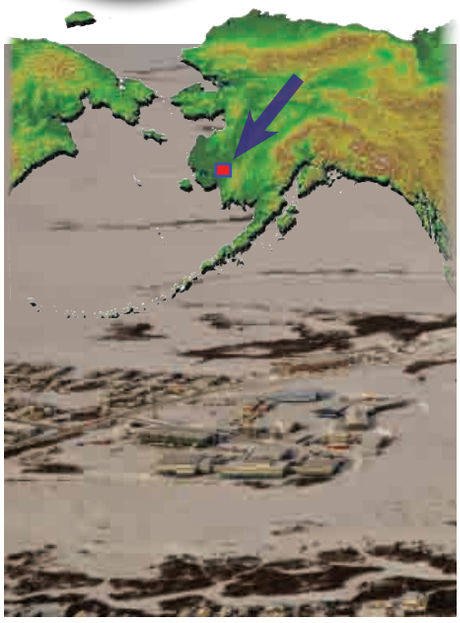
Southeast
Alutian

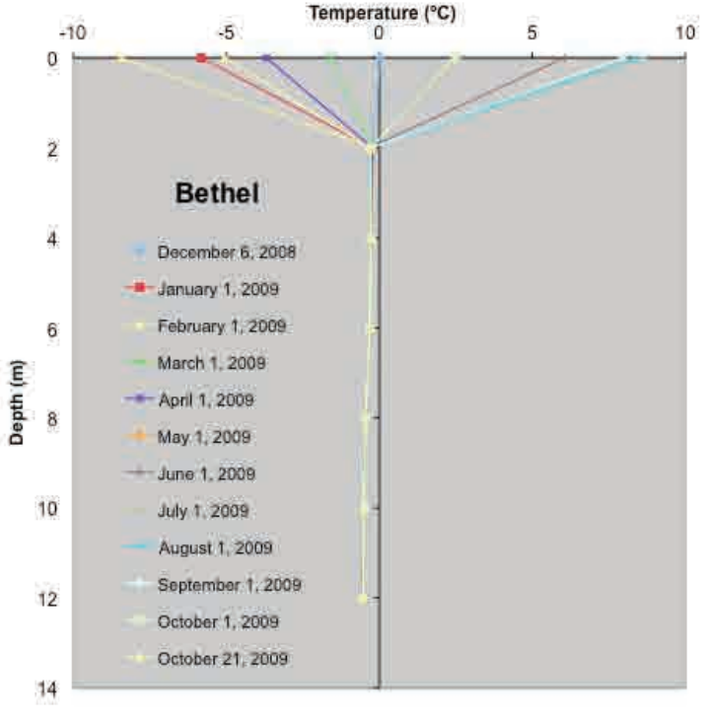
Bethel

Lower Kuskokwim School District



Student population: 1,375

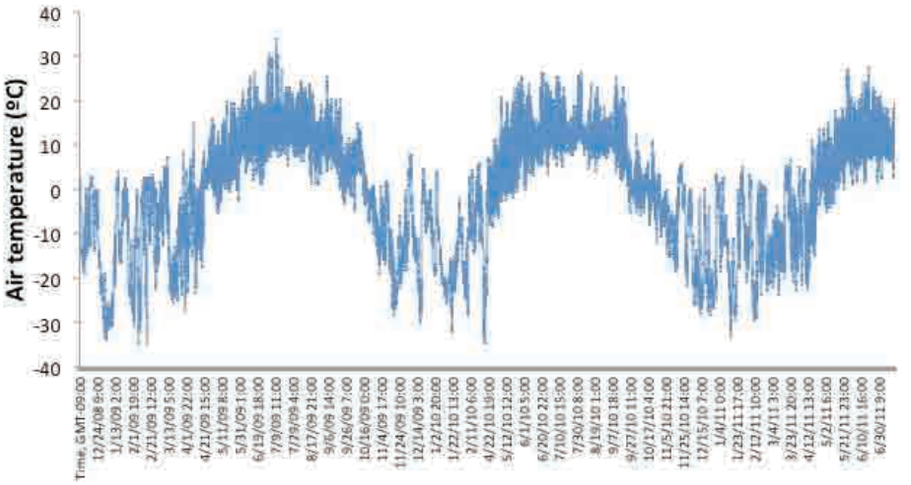
Bethel, a town with 6,080 residents (2010 U.S. Census), is located on the Kuskokwim River, 64 kilometers (40 miles) inland from the Bering Sea. Yup'ik Eskimo settled here, calling the original village site Mumtrekhlogamute, which means “smokehouse people.” The present townsite was chosen after erosion became a problem at the original village site. By 1880, the Alaska Commercial Company had established a trading post. Soon thereafter, the Moravian Church opened a mission. Over time, Bethel has developed into the regional center of the Yukon-Kuskokwim Delta for trading, transportation, and services. Regional offices for state and federal agencies are here. The community has a boat harbor, two floatplane bases, and an airport that accommodates passenger airlines, cargo carriers, and air taxi services. Most residents of Bethel are Alaska Native or part Native. Yup'ik language and culture are predominant. Subsistence activities and commercial fishing contribute importantly to residents' livelihood. Bethel is not on the state road system, but has about 64 kilometers (40 miles) of local roads. Travel by river to nearby villages occurs year-round.



Key Facts:
Annual mean ground temperature: -0.8°C
Freezing days: 181 days
Freezing degree-days: 2048°C days
Thawing degree-days: 1759°C days

In the Bethel area, permafrost is absent from the lower terraces and recent alluvium. A terrace escarpment west of the floodplain and lower terraces separates them from an older part of the Kuskokwim delta, where permafrost is present.

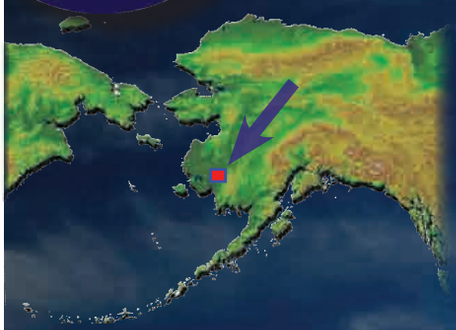
Bethel 12m borehole site



The temperature of permafrost at Bethel is warmer than -1°C. Near the sewage lagoon, the temperature of the ground 12 m deep indicates recent warming. The minimum temperature is recorded at 12 m. The active layer is about 80 cm thick at the back of Bethel High School. The active layer frosts completely by the end of January.

Kwethluk

Lower Kuskokwim School District



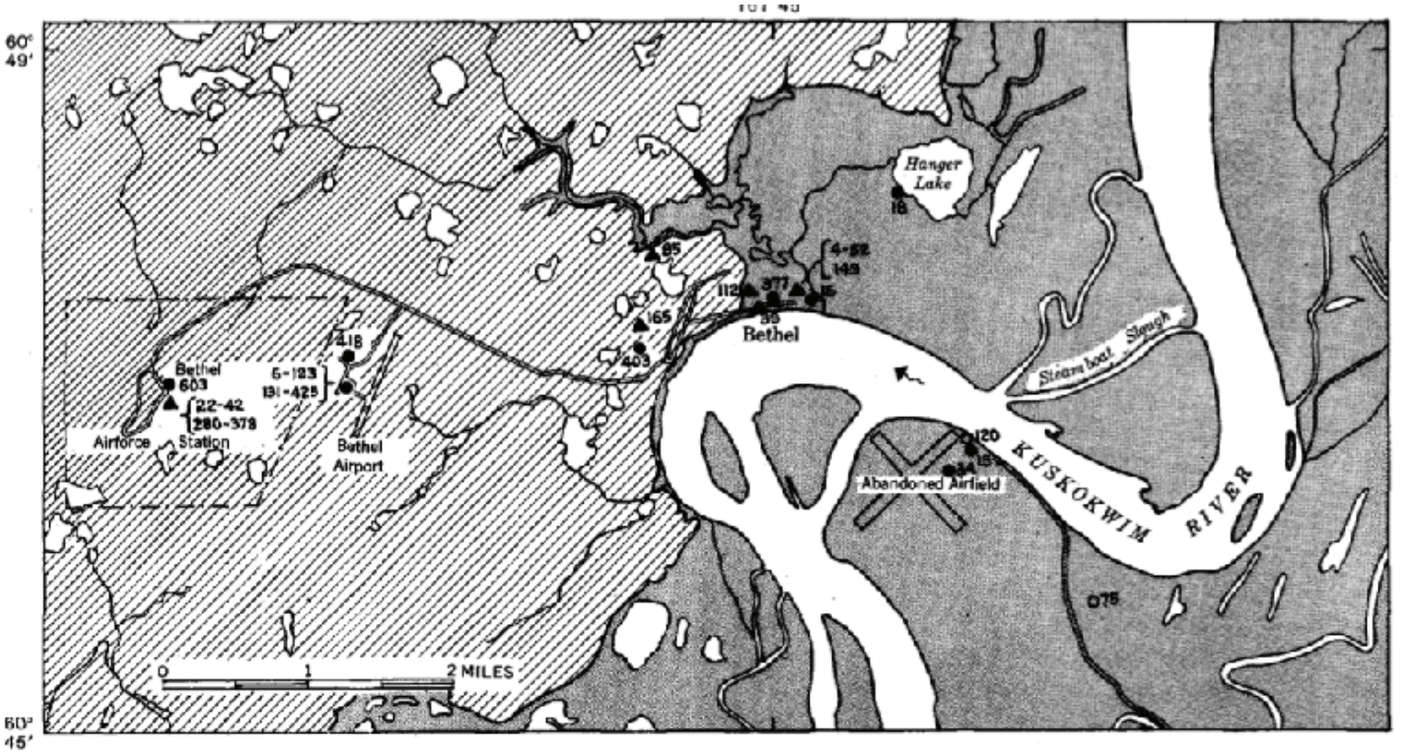
Student population: 247

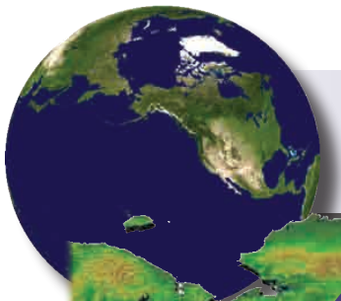
Kwethluk, a Yup'ik village with 721 residents (2010 U.S. Census), is located near the confluence of the Kwethluk and Kuskokwim Rivers. This area has been inhabited since prehistoric times. By the early 1900s, the Moravian Church and the Russian Orthodox Church had located chapels here, and gold prospectors had begun arriving. Miners worked a placer deposit on the upper Kwethluk River until World War II. A BIA school opened in 1924, and in the next decade, reindeer herding was introduced. Employment is found in the school, village corporation, store, and health clinic; some residents commercial fish for a living. Traditional subsistence activities provide food and are culturally important. Kwethluk is not on the state road system, but a gravel airstrip and a seaplane base allow air carriers. Bulk cargo arrives by barge in the summer. Residents travel the Kuskokwim River year-round. Overland trails are marked to Eek, Three Step Mountain, and Columbia Creek.

Key Facts:
Annual mean ground temperature: lost
Freezing days: lost
Freezing degree-days: lost
Thawing degree-days: lost

Data is not available in this location.

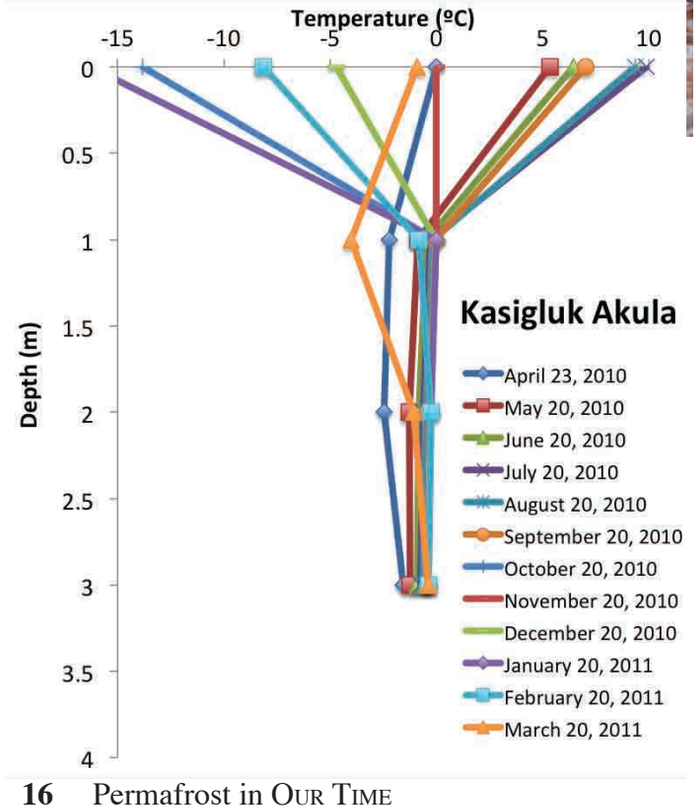
Kwethluk is located along the Kuskokwim River floodplain. Permafrost is absent where the community is located, but is present at an upper terrace near the airport. Between the school building and the river bank, seasonal frost reaches about 1 m.





Kasigluk

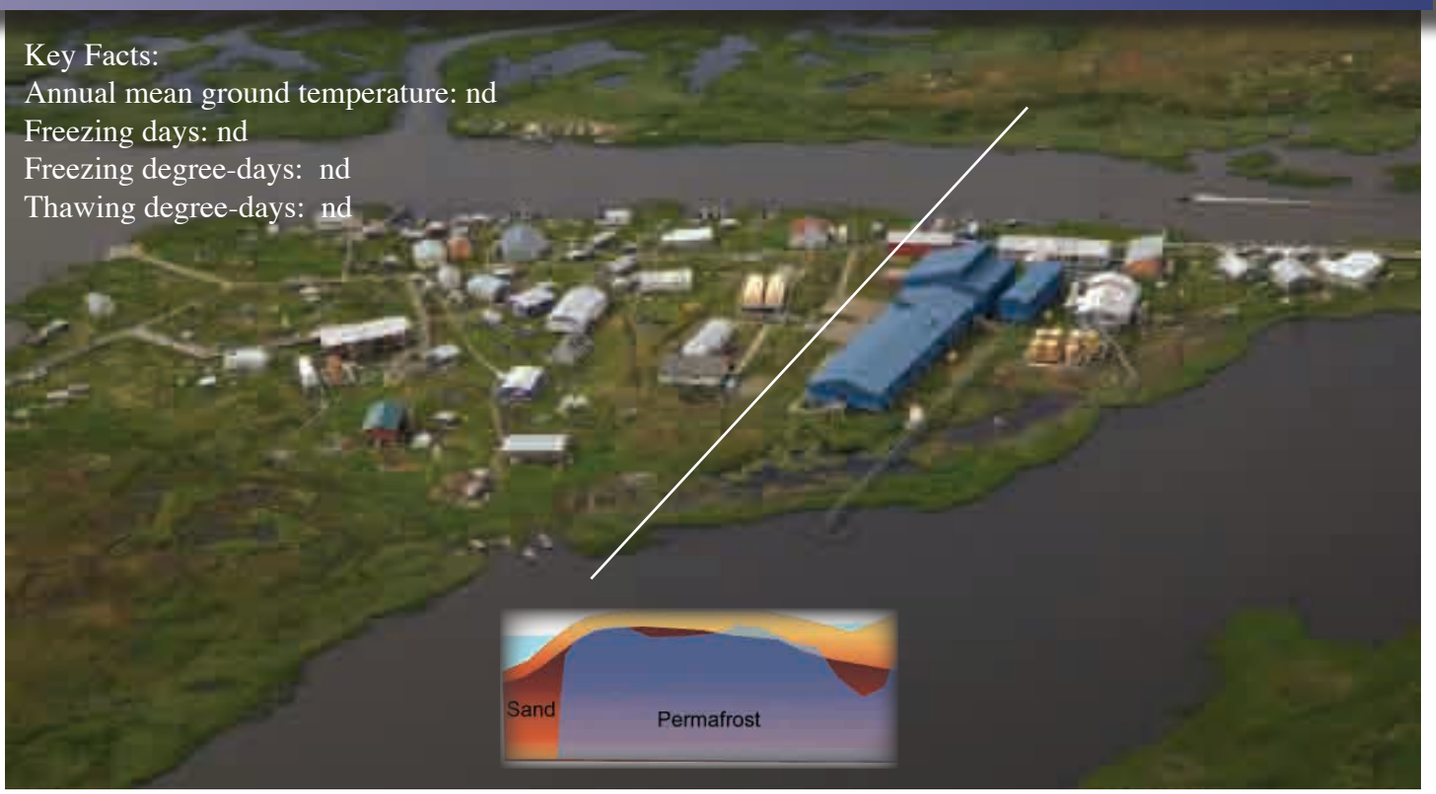
Lower Kuskokwim School District



Student population: 194

Kasigluk has two village sites, with 569 residents (2010 U.S. Census): Kasigluk-Akiuk (the older site) and Kasigluk-Akula (the newer site). The village sites are located along the Johnson River, which flows through the Kuskokwim River Delta, about 42 kilometers (26 miles) northwest of Bethel. Kasigluk is a traditional Yup ik community. Subsistence activities are culturally important and help provide food. The school, retail businesses, and village government are sources of employment. Many residents commercial fish. Barges travel from Bethel during summer to deliver fuel and supplies, and a gravel airstrip is available for chartered flights and private air carriers. Kasigluk is not on the road system, but a winter trail leads to Chefornak. River travel takes place year-round.

Location: 60.87° N, 162.52° W

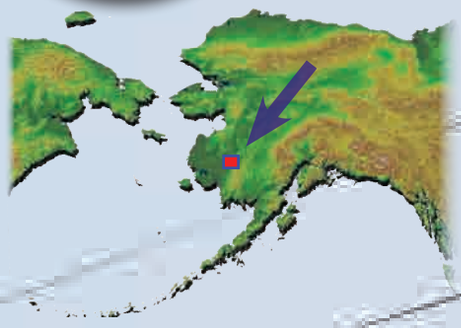


Kasigluk-Akiuk is an island located in the Johnson River. The permafrost here is warmer. The active layer is 1.5 m deep near the school. Kasigluk-Akula is located along the shore of the river, next to old delta deposits (on the airport side). At Kasigluk-Akula, the permafrost is warmer but stable.

Whitefish is an important source of protein in this community.

Nunapitchuk

Lower Kuskokwim School District



Student population: 178

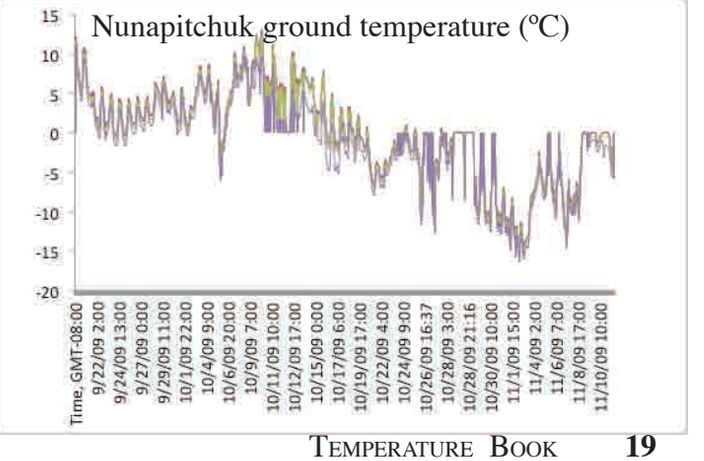
Nunapitchuk, also known as Akolmiut, is a village with 496 residents (2010 U.S. Census), located on either side of the Johnson River in the Yukon-Kuskokwim Delta. The village is 35 kilometers (22 miles) northwest of Bethel. Nunapitchuk is a Yup'ik Eskimo village. Traditional subsistence activities provide food and are culturally important. Residents work with the school, in local businesses, and with the city government. Some residents commercial fish. Nunapitchuk is not on the state road system, but is connected by winter trails to Atmautluak and Akula Heights. Air carriers to the village use its gravel airstrip or its seaplane landing area on the Johnson River. Nunapitchuk also has a dock and small boat harbor on the river.

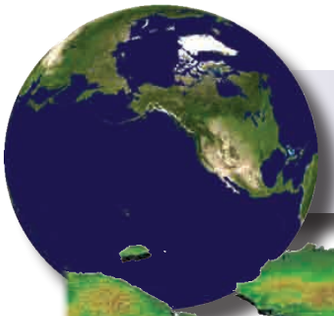
Permafrost is present in most of the land at Nunapitchuk, but not at the bottom of the Johnson River. The seasonal frost layer of the marshy area around Nunapitchuk has a strong effect on the groundwater and moisture content of the soil. The frost layer is usually 0.6–1.8 m deep by the end of March. Permafrost here has been as thick as 69 m (227 in.) (April 18, 1978, from PHS well log).

Location: 60.90° N, 162.46° W

Key Facts:
Annual mean ground temperature: nd
Freezing days: nd
Freezing degree-days: nd
Thawing degree-days: nd

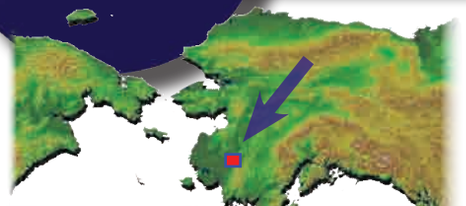
Southwest





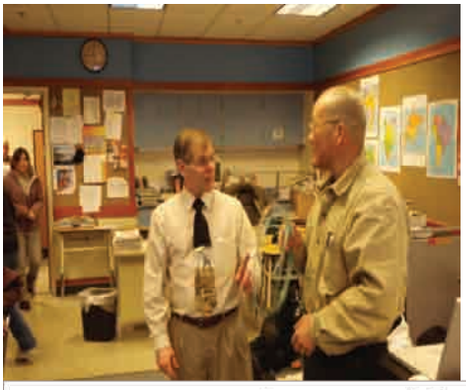
Atmautluak

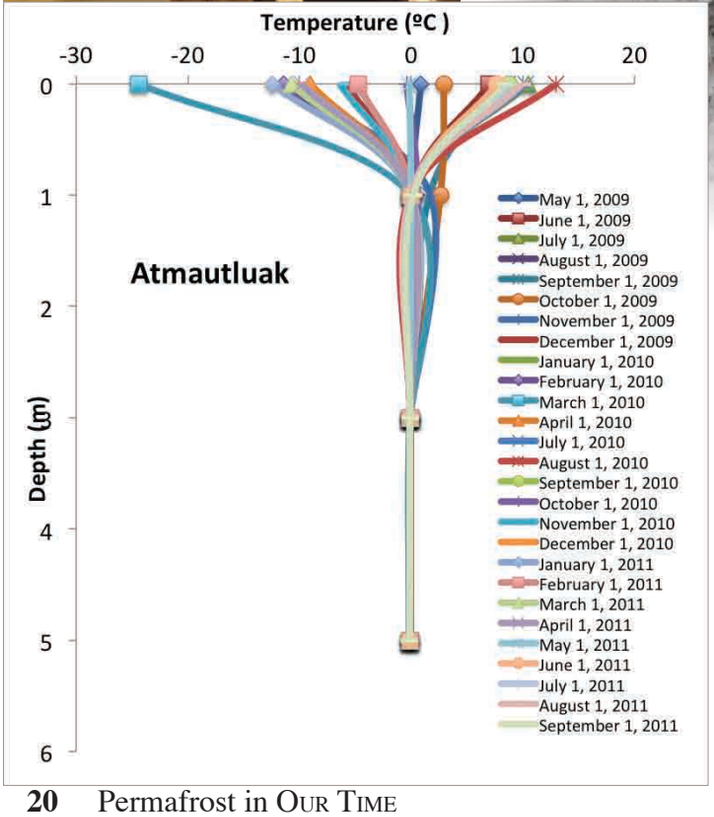
Lower Kuskokwim School District

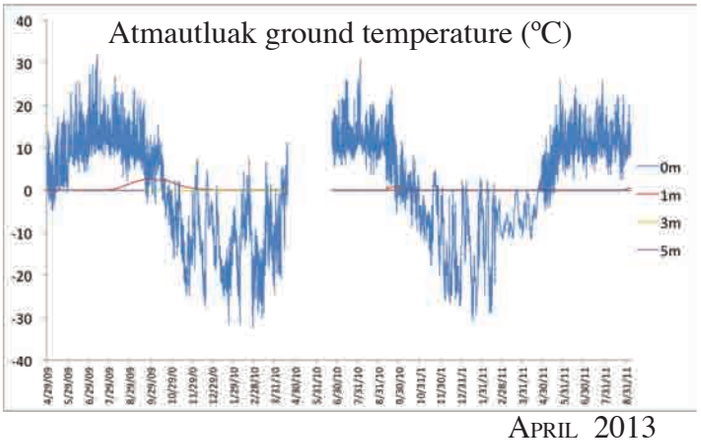


Student population: 100

Atmautluak, a village with 277 residents (2010 U.S. Census), is located on the west bank of the Pitmiktakik River in the Yukon-Kuskokwim Delta. The village is 32 kilometers (20 miles) northwest of Bethel. Atmautluak is a traditional Yup'ik Eskimo village. The present village site was established in the 1960s to avoid flooding that occurred at the original village site. Residents are employed in the school, in village government, and in stores. Some residents commercial fish. Subsistence activities provide food and are culturally important. Atmautluak is not on the state road system, but has a gravel air strip for air carriers. River travel is common year-round, and a winter trail leads to Nunapitchuk, a village to the northwest.



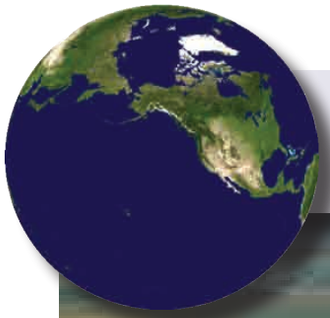




Key Facts:
Annual mean ground temperature: -1.1°C
Freezing days: 172 days
Freezing degree-days: 2101°C days
Thawing degree-days: 1697°C days

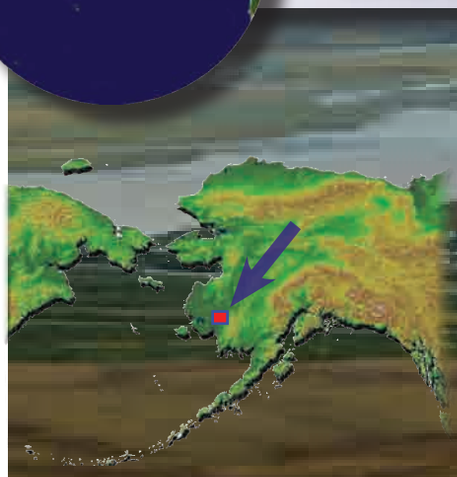
Permafrost is present in most of the land, but is absent from the riverbed.

The temperature of permafrost at Atmautluak is close to the thawing point. The active layer is over 1 m thick. At the parabolic antenna next to the school, the freeze-thaw extent is deeper (close to 2 m).



Napakiak, Napaskiak, Oscarville

Lower Kuskokwim School District



Student population: 110

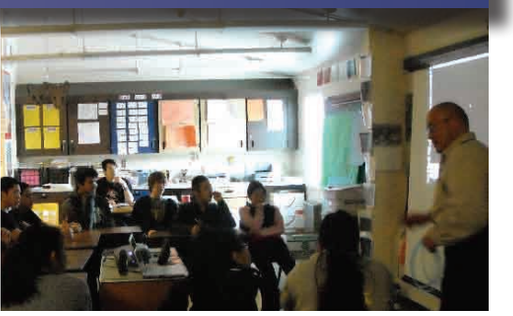
Napakiak, a Yup'ik village with 354 residents (2010 U.S. Census), is located on an island formed by the Kuskokwim River to the south and Johnson's Slough to the north. The village is 24 kilometers (15 miles) southwest of Bethel. The Moravian Church located here in the late 1920s and built a chapel. In 1939, a BIA-operated school opened, and over the next twenty years, the village grew to include a Native-owned village cooperative store, a post office, and a National Guard Armory. Traditional subsistence activities provide food and are culturally important. Residents find employment with the school and government and, seasonally, in commercial fishing and construction. Trapping and selling native crafts provide income for some. Napakiak is not on the state road system, but a winter trail connects it to Bethel. The community also has a gravel airstrip and floatplane base for air carriers. The Kuskokwim River provides a transportation route to camps and neighboring villages, and residents travel it year-round. Cargo arrives by barge during the summer.

Permafrost is mostly absent in these three communities because of their location either at a lower terrace or in the floodplain of the Kuskokwim River.

Napakiak

Student population: 28

Oscarville, also known as Kuiggayagaq, is a village with 70 residents (2010 U.S. Census) located on the north bank of the Kuskokwim River, across the river from Napaskiak. Oscarville was named for Oscar Samuelson, who moved with his wife from Napaskiak in 1908. The couple opened a trading post, and other families settled nearby. The BIA built a school in the village in 1964. The village has a health clinic, but residents cross the river to Napaskiak for postal, air passenger, and cargo service. Most residents of Oscarville are Alaska Native or part Native, mainly Yup'ik Eskimo. Subsistence activities are essential for providing food and are important culturally. Some residents find employment in the school and health clinic; some earn income from their Native crafts and from trapping. Oscarville is not on the state road system. The Kuskokwim River is an important transportation route for residents year-round. Once a year, a barge delivers supplies.



The frost tube recorded a seasonal frost depth of 65 cm at Oscarville and 70 cm at Napakiak in late April 2009.

Oscarville

Napaskiak

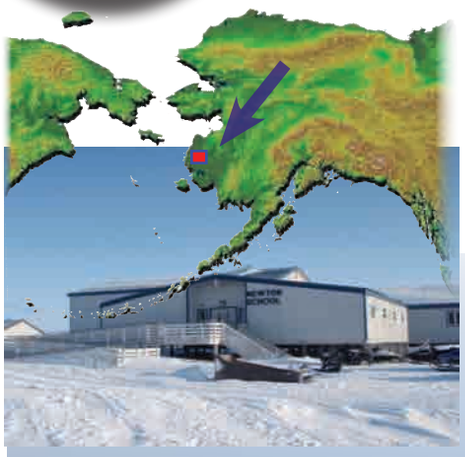
Student population: 152

Napaskiak, a village with 405 residents (2010 U.S. Census), is located on the south bank of the Kuskokwim River, along Napaskiak Slough. The village is 11 kilometers (7 miles) south of Bethel. Napaskiak is a Yup'ik Eskimo village. Residents work in the school and in local businesses; some commercial fish. Traditional subsistence activities are an important part of the local culture and an essential means of providing food. The village is not on the state road system, but has a gravel airstrip and a seaplane landing area for air carriers. Cargo is brought to the village by barge on the Kuskokwim River during summer. Residents use the river year-round as a transportation route.

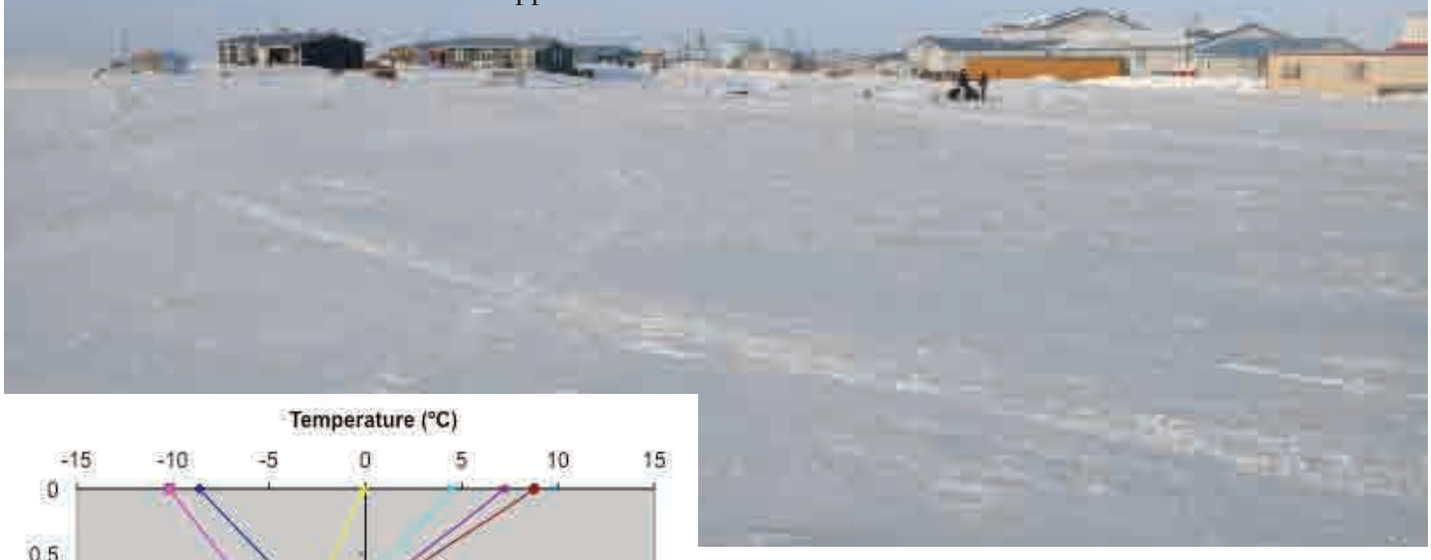
Newtok

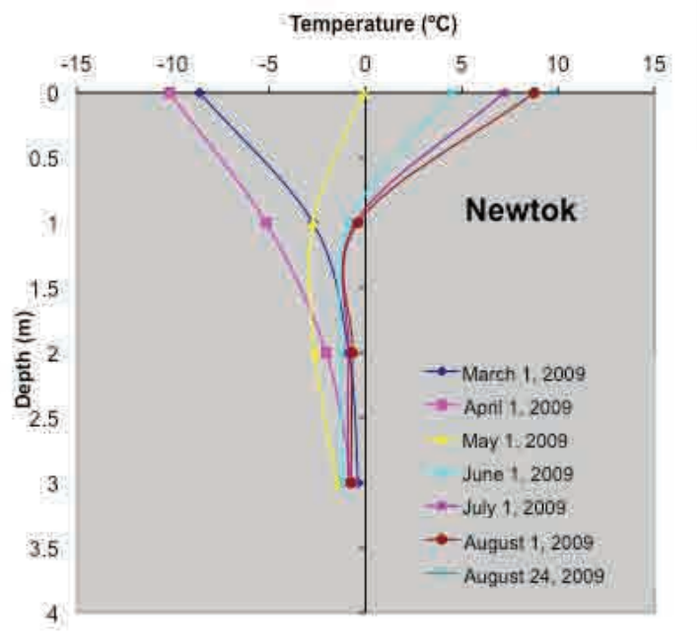
Lower Kuskokwim School District

Student population: 137

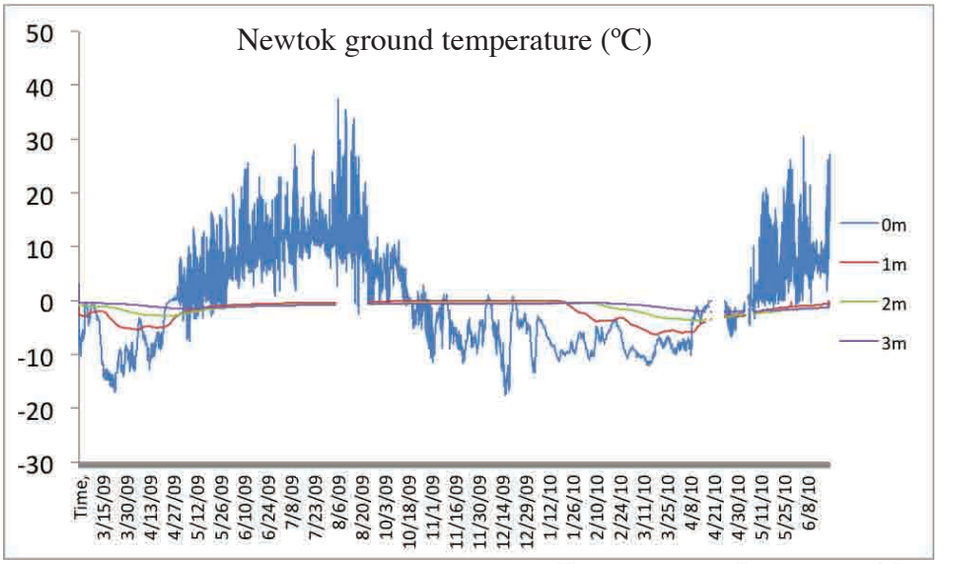


Newtok is a Yup'ik Eskimo village with 354 residents (2010 U.S. Census); it is located on the Ninglick River, just north of Nelson Island in the Yukon-Kuskokwim Delta. Ancestors of the residents of Newtok have lived along the Bering Sea coast for at least 2000 years. Newtok was settled in the late 1950s, when villagers moved from a site called Old Kealavik, ten miles away, because of flooding. The community had a school by 1958, though until the 1980s, students had to travel elsewhere to attend high school, in Bethel, St. Mary's, Sitka, or Anchorage. Newtok is a relatively isolated location, which has helped preserve the traditions and customs of its Yup'ik residents. Subsistence activities are culturally important and provide food for the community. Employment includes work in the schools, clinic, and village services, and commercial fishing. Newtok is not on the state road system, but is connected by marked winter trails to Chevak, Tununak, Toksook Bay, Nightmute, and Manaryarapiaq. The community has a gravel airstrip and a seaplane base for air carriers. During summertime, barges deliver supplies.





Newtok has warmer permafrost at higher elevations, and is free of permafrost at lower elevations and in the drained-lake basin. The village is located between higher and lower terrain, and unstable ground is a problem. River erosion is considered severe in this area near the Ninglick River.

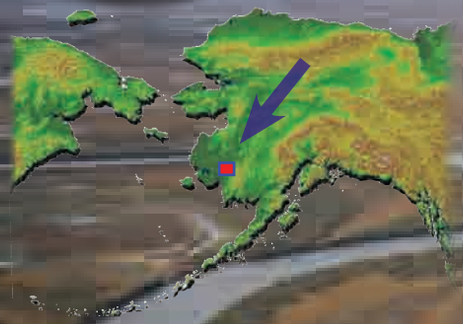


Key Facts:
Annual mean ground temperature: nd
Freezing days: nd
Freezing degree-days: nd
Thawing degree-days: nd

www.uaf.edu/permafrost

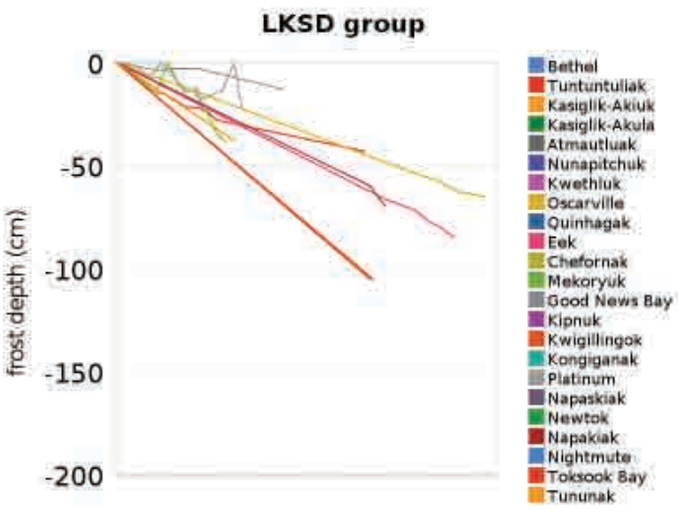
Tuntutuliak

Lower Kuskokwim School District



Student population: 149

Tuntutuliak, a Yup'ik village with 408 residents (2010 U.S. Census), is located on the Qinaq River, about 5 kilometers (3 miles) from the river's confluence with the Kuskokwim River. Tuntutuliak, which means "place of many reindeer," was established in 1945, when residents of Qinaq moved to higher ground. A BIA school opened in 1957; three years later, a post office opened. Traditional Yup'ik culture is predominant here. Through the third grade in school, children are taught in the Yup'ik language; in the higher grades, students are taught in English. Subsistence activities are an essential means of providing food. Employment is found in the school and with local services. Commercial fishing and fish processing provide seasonal employment. Some residents produce and sell Native artwork; some earn income from trapping. The community relies on air transportation for mail and cargo, and on barges for bulk supplies. Tuntutuliak is not on the road system; marked winter trails lead to Kipnuk, Toundra, and Kongiganak.



The school in Tuntutuliak is located in the middle of the community, between the river and lakes. The temperature of permafrost here is very cold, about -1.5°C at a depth of 8.5 m. The deeper ground is still colder, even with recent temperature warming.

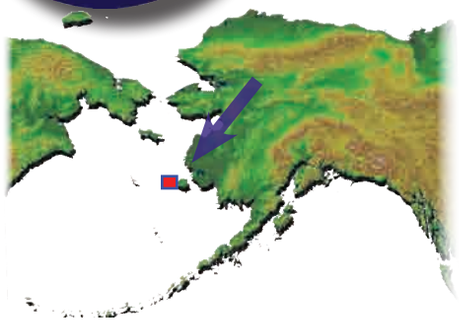
Location: 60.34° N, 162.67 ° W

In January 2009, the frost tube at the school, which is near the bridge, recorded frost depth at 44 cm. The groundwater level of the slough affects this shallow frost depth.

Frost mounds visible from the airport look like pingos, but probably are ice lenses, called palsas or lithalsas.

Mekoryuk

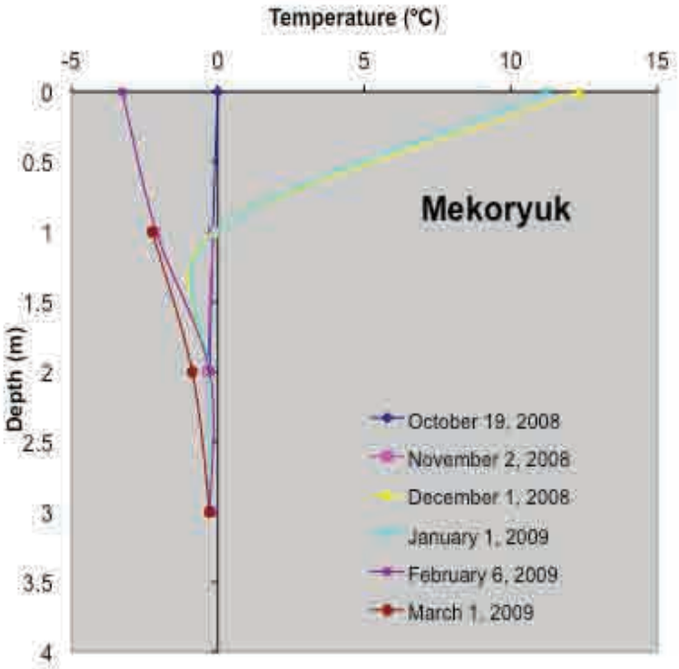
Lower Kuskokwim School District



Around the village of Mekoryuk are small mounds of eolian origin, that is, windblown sand or dunes. The mounds are frozen year-round and have lower ice content.

Student population: 31

Mekoryuk, a village with 191 residents (2010 U.S. Census), is located at the mouth of Shoal Bay on the north shore of Nunivak Island in the Bering Sea. Nunivak Island has been inhabited for more than 2,000 years; its residents are Nuniwarmiut ("residents of Nunivak Island"), or Cup'it Eskimo. When explorers with the Russian American Company arrived in 1821, there were several villages around the island. Mekoryuk was a camp used in the summer by the Cup'it. In 1900, an epidemic drastically reduced the Cup'it population. After a BIA school was built in Mekoryuk in 1939, people from around the island relocated to be near it. Reindeer and musk ox were introduced to the island: reindeer for herding, and musk ox to help preserve the species. Villagers maintain both herds. Employment is found in the school, local government, village corporation, and Bering Sea Reindeer Products Company. Some residents commercial fish or work construction. Traditional subsistence activities provide food and are culturally important. Air transportation is vital to the community for mail and supplies, and for passenger travel. The community has a gravel airstrip. During summer, barges bring supplies from Bethel.



Mekoryuk is the only community on Nunivak Island today. In the Bering Sea, the southern limit of permafrost is probably Nunivak Island. Permafrost is present at islands north of here (that is, at St. Lawrence Island and Diomede Island), but permafrost is absent from islands to the south (St. Paul Island and the Aleutian Islands).

Key Facts:
Annual mean ground temperature: nd
Freezing days: nd
Freezing degree-days: nd
Thawing degree-days: nd

Dwellings at Nash Harbor, near the mouth of the Elikarrmiut River on Nunivak Island in 1927. (Published in: The North American Indian / Edward S. Curtis. [Seattle, Wash.] : Edward S. Curtis, 1907-30, v. 20, p. 16. Library of Congress, Edward S. Curtis Collection.)

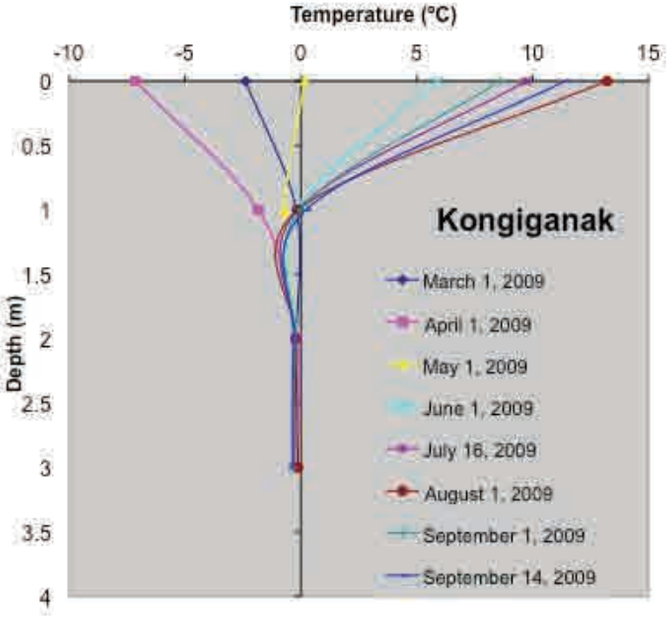
Kongiganak

Lower Kuskokwim School District

Student population: 144

Kongiganak, a village with 439 residents (2010 U.S. Census), is located near the shore of Kuskokwim Bay, west of the mouth of the Kuskokwim River. Kongiganak was settled in the 1960s by some residents of Kwigillingok who wanted to avoid recurring floods. Kongiganak is a traditional Yup'ik Eskimo village. Subsistence activities are culturally important and help supply food. Residents work at the local school and in village services and stores. Some residents earn income commercial fishing or trapping. Kongiganak is not on the state road system. Winter trails connect the village to Kwigillingok and Tuntutuliak. A gravel airstrip is available for air carriers. During the summer, cargo is delivered by barge.

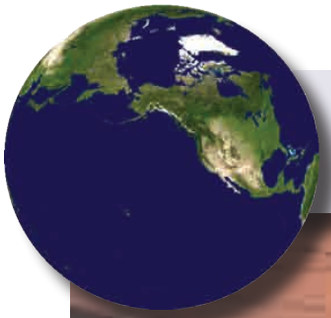
The southwestern region of Alaska is a land of windblown tundra. Most of the ground is underlain by permafrost. The permafrost temperature is warmer than -1°C, which is close to the thawing point. Village infrastructure is strongly affected by permafrost conditions.



Location: 59.96° N, 162.89° W

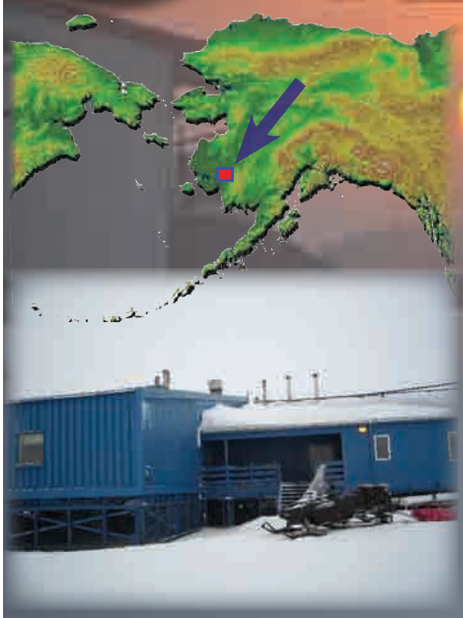
Key Facts:
Annual mean ground temperature: -0.9°C
Freezing days: 179 days
Freezing degree-days: 1706°C days
Thawing degree-days: 1388°C days

The active layer in Kongiganak is 60–90 cm deep. The temperature of permafrost at 12 m deep is about -0.72°C. The rich organic layer has a thermal offset effect on permafrost temperature; that is, in summer, the organic layer insulates permafrost from heat; in winter, it helps permafrost stay frozen by conducting cold.



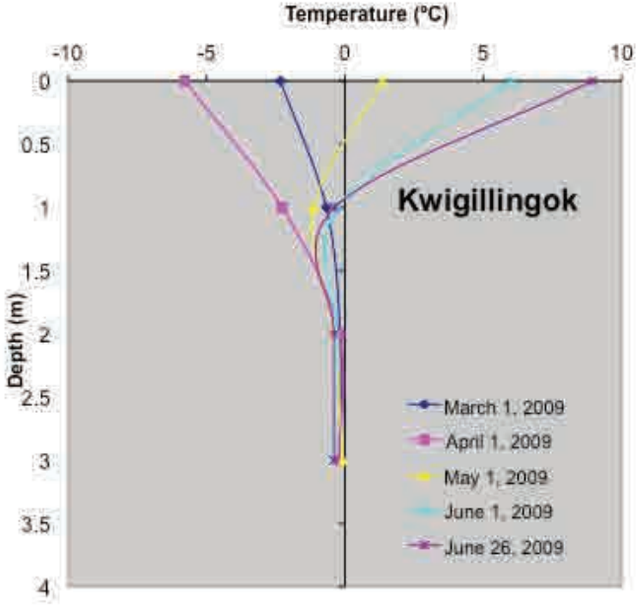
Kwigillingok

Lower Kuskokwim School District



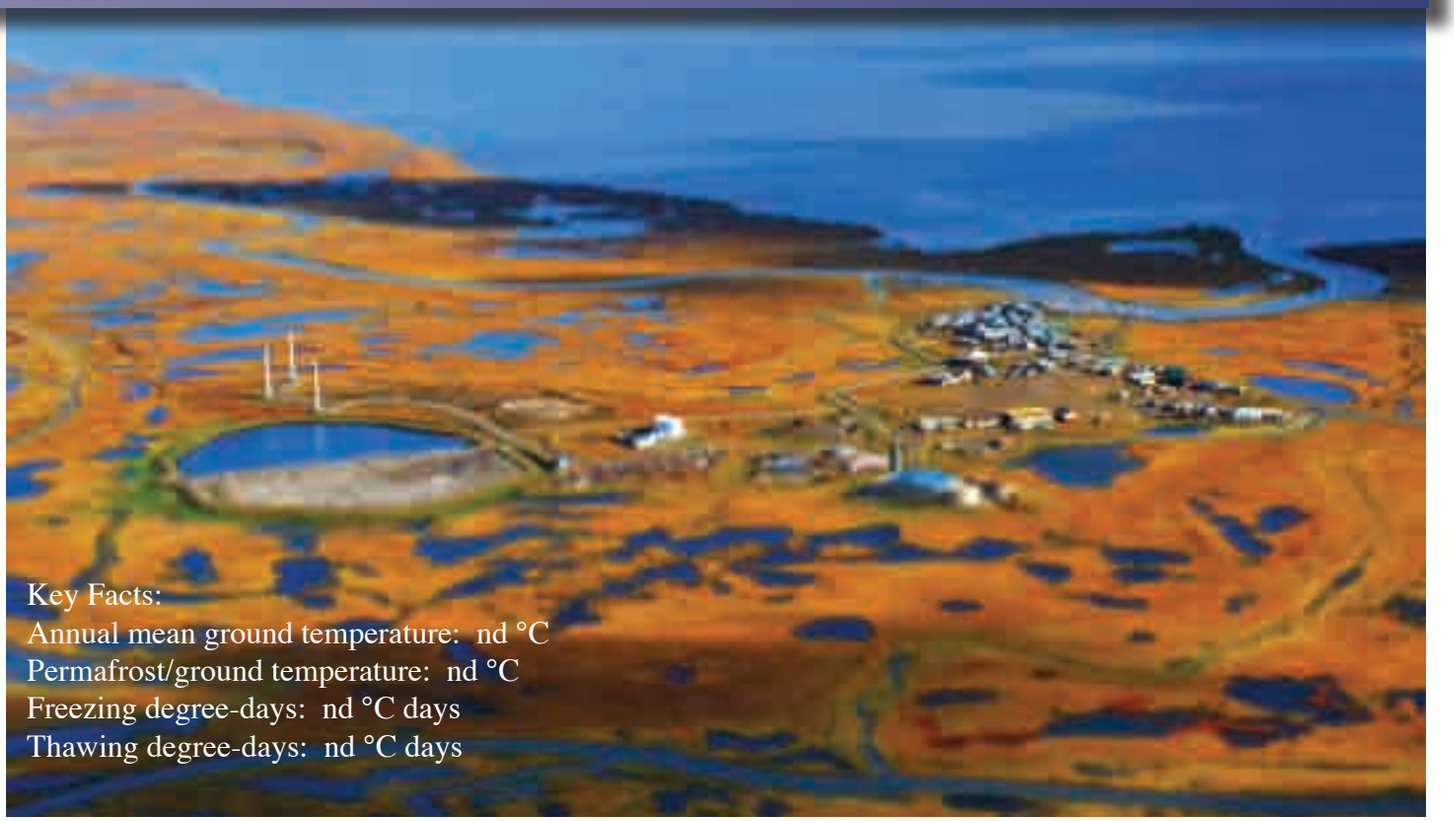
Student population: 109

Kwigillingok, a village with 321 residents (2010 U.S. Census), is located near the shore of Kuskokwim Bay, west of the mouth of the Kuskokwim River. The village is 124 kilometers (77 miles) southwest of Bethel. Kwigillingok is a traditional Yup'ik Eskimo village. Residents work in the school, village government, or stores; some residents commercial fish. The village has a cooperative market for local Native arts and crafts. Subsistence activities are important to the way of life here and help provide food. Though Kwigillingok is not on the state road system, it is connected to Kipnuk and Kongiganak by winter trails. Residents regularly travel by skiffs and other boats in summer and by snow machine and ATV in winter. A gravel airstrip and a seaplane base are available for air carriers.



About 7–10 m belowground, the temperature is -0.5 to -0.7°C, but the soil seems unfrozen. The softening of permafrost at the bottom part of the boreholes is due to the presence of salt in the range of 5–8 parts per thousand (ppt). Salt content of 8 ppt depresses the freezing point by almost 0.5°C. In such conditions, even when the soil is frozen, a large amount of unfrozen water is present in the permafrost.

Location: 59.88° N, 163.16° W



Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd °C
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

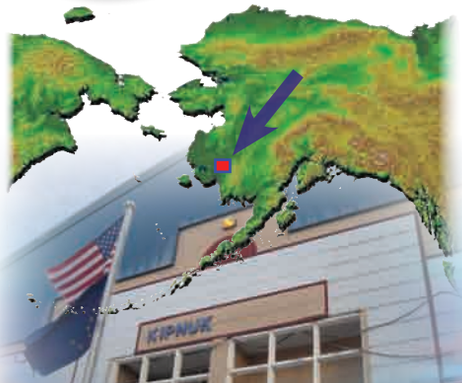
The ground profile above shows that the upper 6 m of permafrost contain more ground ice. The ground below contains more sand, so it contains less ice. The permafrost is unconsolidated.

The active layer is 60–90 cm deep in Kwig (Kwigillingok). Though the permafrost temperature is similar to that in Kongiganak, about -0.72°C 12 m below ground, one big difference in Kwig is the soil's salinity (amount of salt). Most of the sediment is beach sand.

Kipnuk/ Chefornak

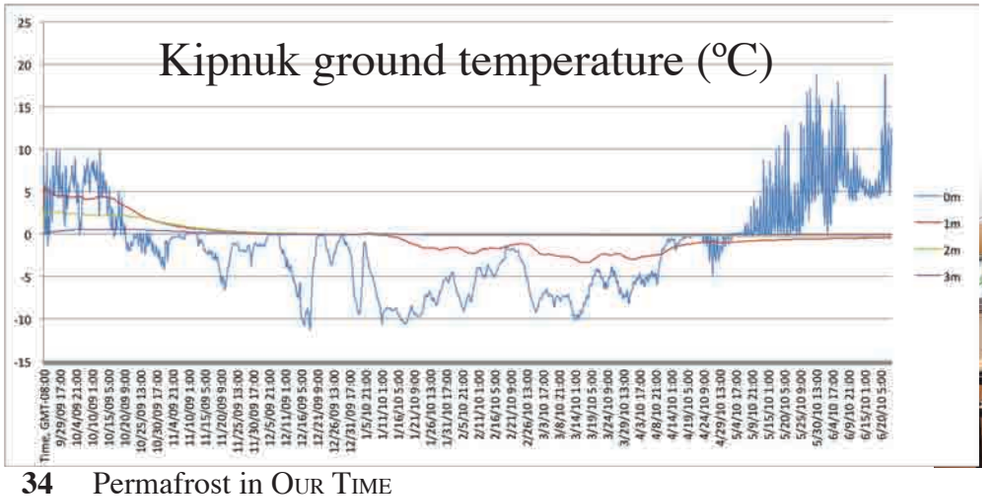
Lower Kuskokwim School District

Student population: 211



Kipnuk, also known as Kanganak, is a village with 639 residents (2010 U.S. Census), located on the west bank of the Kugkaktlik River in the Yukon-Kuskokwim Delta. Kipnuk is 6 kilometers (4 miles) inland from the Bering Sea. Yup'ik Eskimo have occupied the area around Kipnuk for thousands of years; some settled permanently at this site by 1922. Kipnuk is a traditional Yup'ik community, where subsistence activities are important culturally and provide food. Employment is seasonal and includes work in commercial fishing, fish processing, and construction. The community, with a gravel airstrip and seaplane base, has scheduled air taxi service all year. Bulk cargo arrives by barge during the summer. Kipnuk is not on the state road system, but winter trails lead to Tuntutuliak, Chefornak, and Kwigillingok. River travel occurs year-round.

Permafrost temperature 6 m belowground at Kipnuk High School is -0.7°C. Near the ground surface, a 1 m thick layer of peat, high in organic content, overlies the silt layer.



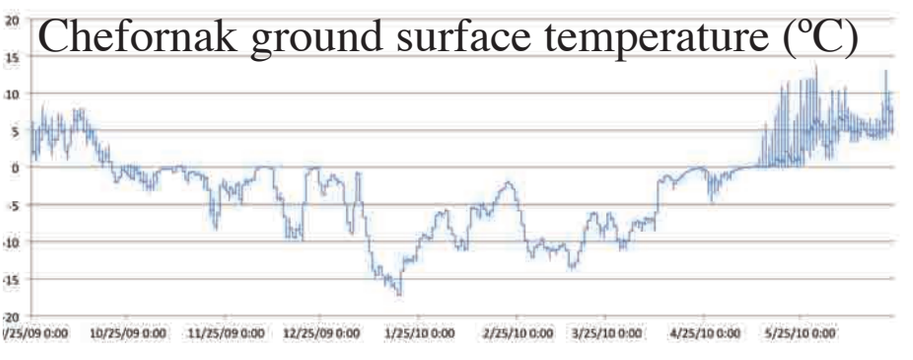
Permafrost is absent from the riverbed. Permafrost under the village is controlled by groundwater level and an impermeable layer of lava (basalt) 3–15 m below the ground surface. Permafrost is 60 m thick at the school.

Location: 59.94° N, 164.04° W

Student population: 163

Chefornak, a village with 418 residents (2010 U.S. Census), is located on the south bank of Kinia River in the Yukon-Kuskokwim Delta. The community is 158 kilometers (98 miles) southwest of Bethel by air. In the early 1950s, Alexie Amagiqchik moved from the Bering Sea coast to this inland location to avoid flooding. He built a small general store, and other residents from his Bering Sea village joined him. Chefornak is a traditional Yup'ik Eskimo village. Subsistence activities are culturally important and provide food. Aside from work with the village government, employment is seasonal, with jobs related to commercial fishing. The community is not on the state road system, but has a gravel airstrip and a seaplane base for air service. Transportation routes include the Kinia River and marked overland winter trails, which lead to the neighboring villages of Kipnuk and Kasigluk.

Key Facts:
Annual mean ground temperature: -2.9 °C
Freezing days: 197 days
Freezing degree-days: 1090°C days
Thawing degree-days: 291+°C days

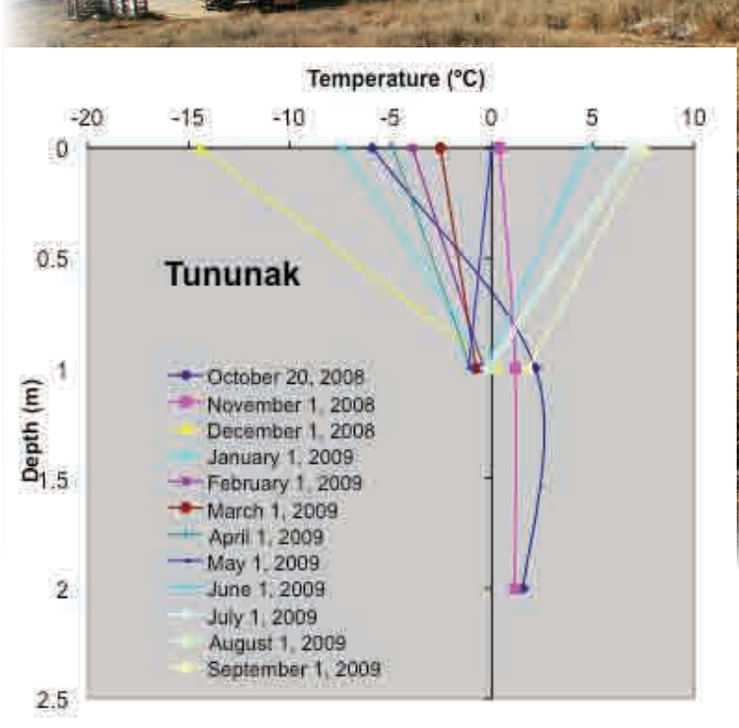


Southwest

Tununak

Lower Kuskokwim School District

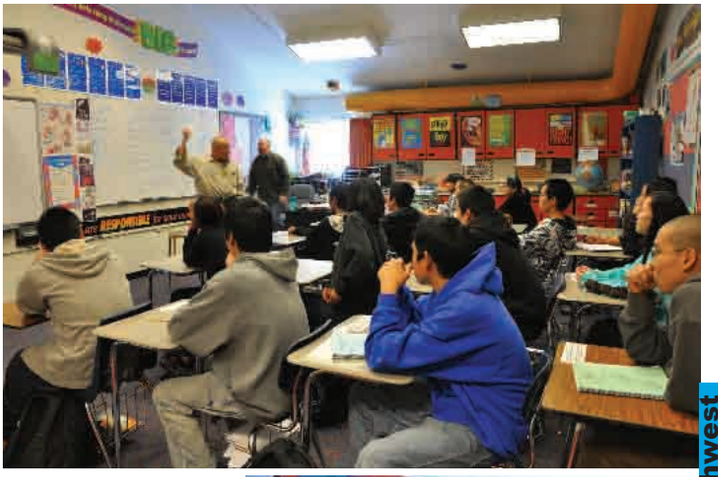
Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd °C
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



The school building in Tununak has foundation problems, most likely caused by the ice-rich sediments in the permafrost.

Student population: 136

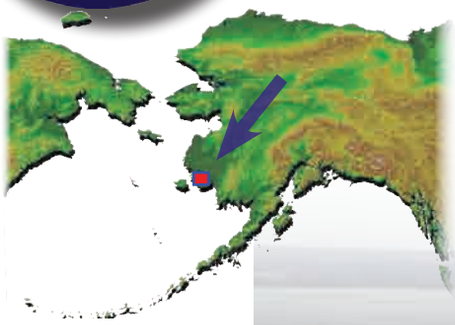
Tununak, a village with 327 residents (2010 U.S. Census), is located on the northwest coast of Nelson Island on the Yukon-Kuskokwim Delta. Tununak is a traditional Yup'ik Eskimo village. Edward Nelson, a Smithsonian naturalist, visited here in 1878; the island is named after him. A school was built in 1925, and the Northern Commercial Company opened a store in 1929. Residents work in the school, the village corporation, and in stores. Seasonal employment includes commercial fishing and fish processing. Many residents produce and sell artwork; some earn income by trapping. Subsistence activities remain culturally important and a way to provide food. Tununak is not on the state road system. The community has a gravel airstrip, and mail and cargo arrive year-round by air carrier. Barges deliver bulk supplies during summer.



Permafrost at the school site is warm: -0.94°C at 6 m depth. The permafrost is -0.33°C at 3 m and -0.66°C at 6 m below ground surface. Colder temperatures at deeper depth indicate recent warming.

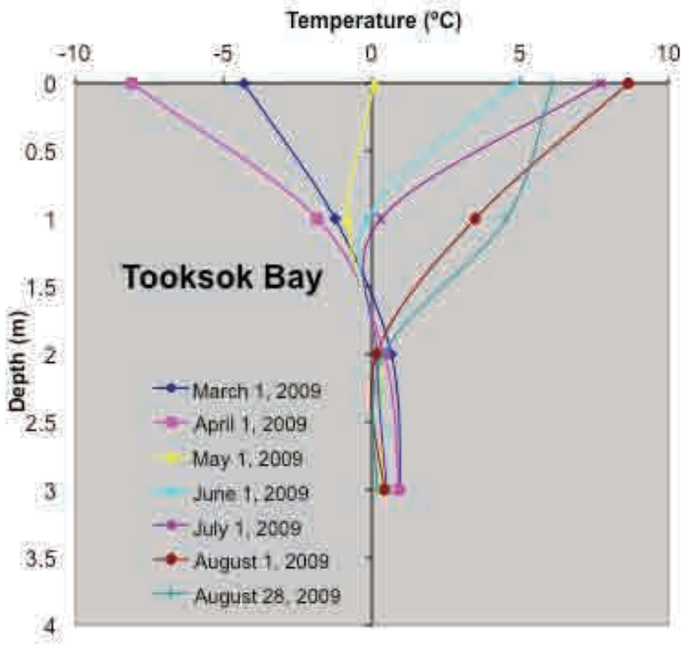
Toksook Bay

Lower Kuskokwim School District

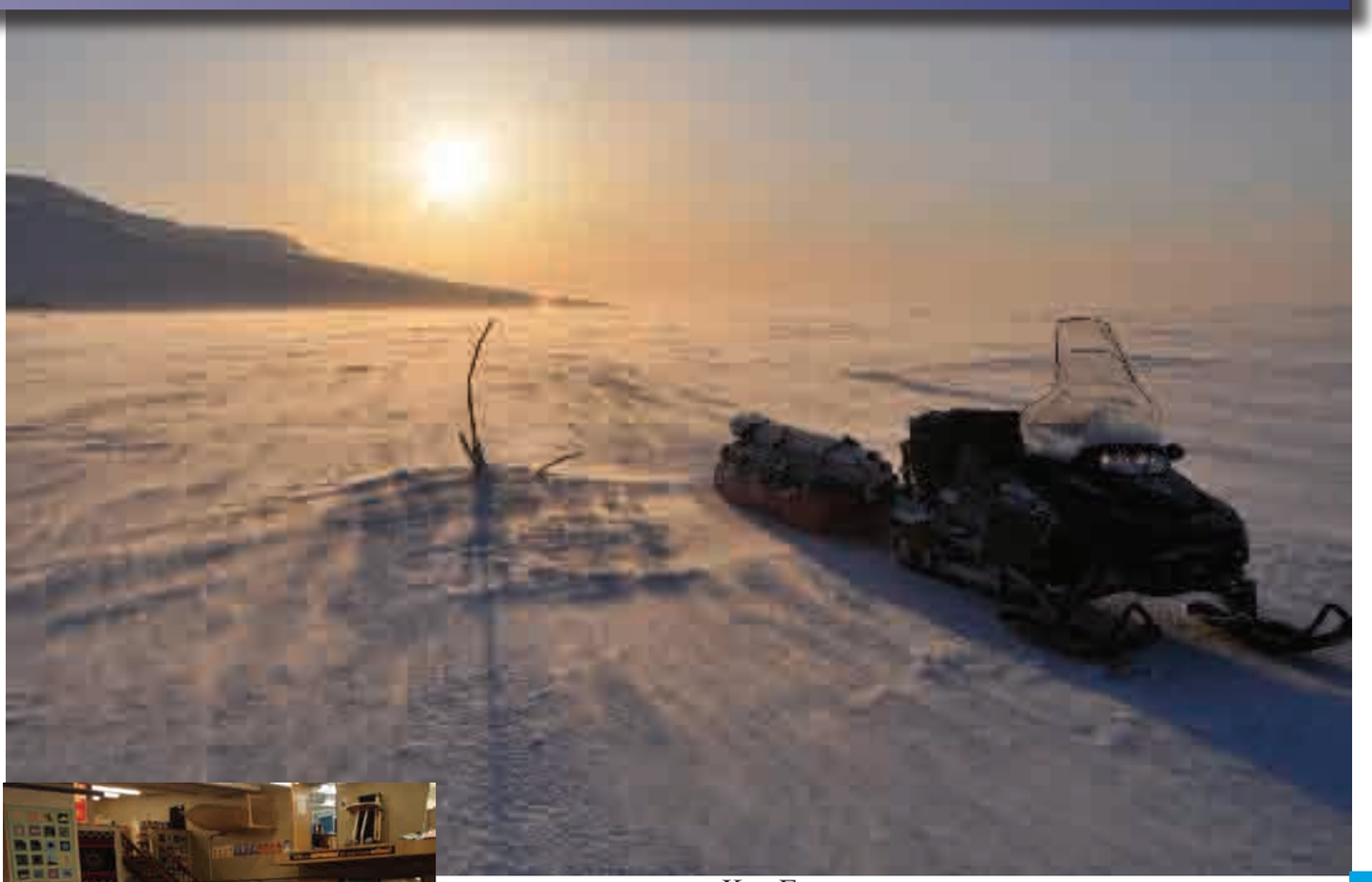


Student population: 219

Toksook Bay, also known as Nunakauyak, is a village with 590 residents (2010 U.S. Census), located along the Tuksuk River on Nelson Island at the north shore of Kangirlvar Bay. Yup'ik Eskimo have lived in this area for thousands of years. Settlement at Toksook Bay began in 1964 when some residents of Nightmute, which is southeast of here and more inland, relocated for greater accessibility to supply ships. Toksook Bay is a traditional Yup'ik Eskimo village. Subsistence activities are culturally important and provide food. Employment is found with the government, school, or tribal council; some residents commercial fish or work at fish processing. Toksook Bay has a gravel airstrip with year-round scheduled and chartered air service. Supplies are delivered in the summer by barge. Though not on the state road system, the community is connected to Nightmute, Tununak, Newtok, and Chefornak by marked winter trails.



Toksook Bay is unusual in that the ground beneath it is not frozen. Under the village is a shallow layer of sediment (only 1–3 m), which overlies sedimentary bedrock. Dry permafrost has been reported in the bedrock, but not measured for temperature. The active layer (seasonal frost layer) measures 105 cm at the school frost tube.

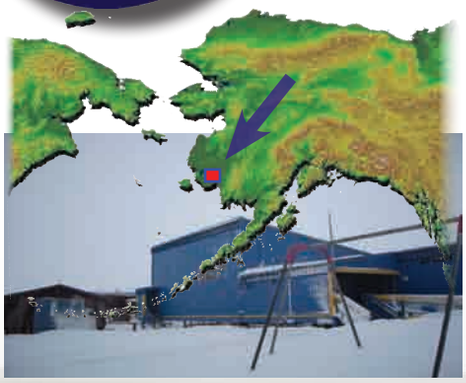


Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd °C
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Toksook Bay

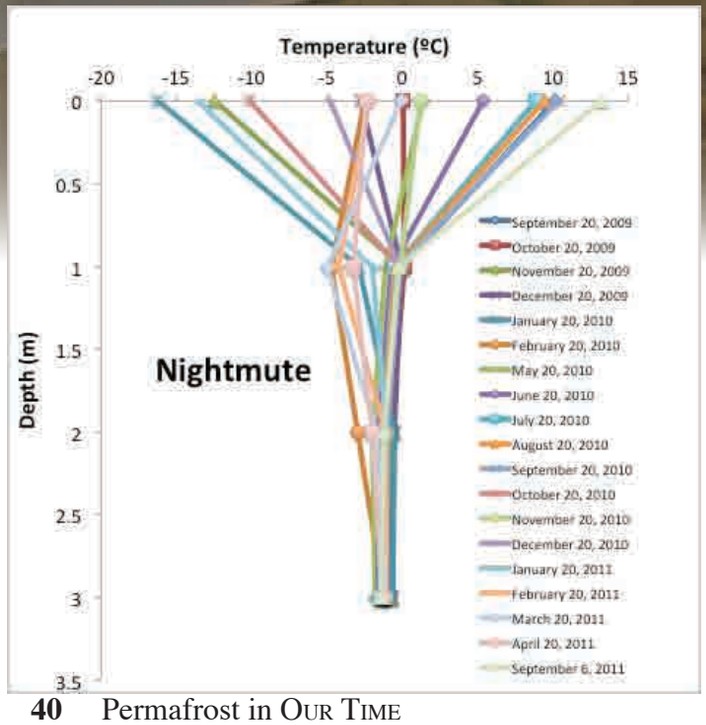
Nightmute

Lower Kuskokwim School District



Student population: 102

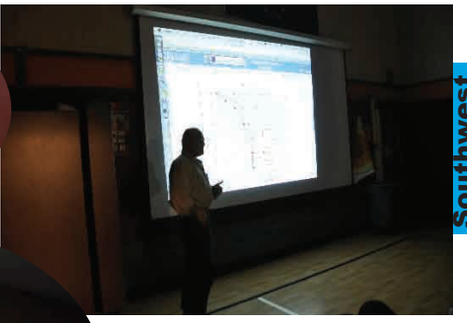
Nightmute, a village with 280 residents (2010 U.S. Census), is located on Nelson Island on the bank of the Tuqsuk River in the Yukon-Kuskokwim Delta. Nightmute is one of three communities on Nelson Island, and is the furthest east. The Qaluyaarmiut, or "dip net people," have lived on Nelson Island for at least 2,000 years. Nightmute is a traditional Yup'ik Eskimo village. Subsistence activities are culturally important and central to providing food. Residents find work with the city and school. Commercial fishing and construction provide seasonal employment. Nightmute is not on the state road system, but has a gravel airstrip and seaplane landing area for air transportation. Marked winter trails connect the village to Toksook Bay, Cak'caaq, and Baird Inlet. Supplies are lightered to Nightmute on the Tuqsuk River.

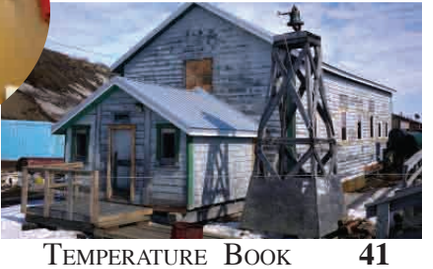


Permafrost temperature along the boardwalk in the village is very warm, between 0 and -0.2°C at 3–4 m below the ground surface. Permafrost at the school site is colder, -0.7°C at 3 m depth. At the airport, permafrost is coldest, -1.2°C to -1.4°C.

Location: 60.48° N, 164.72 ° W

Key Facts:
Annual mean ground temperature: -0.1 °C
Freezing days: 184 days
Freezing degree-days: 1487°C days
Thawing degree-days: 1448°C days





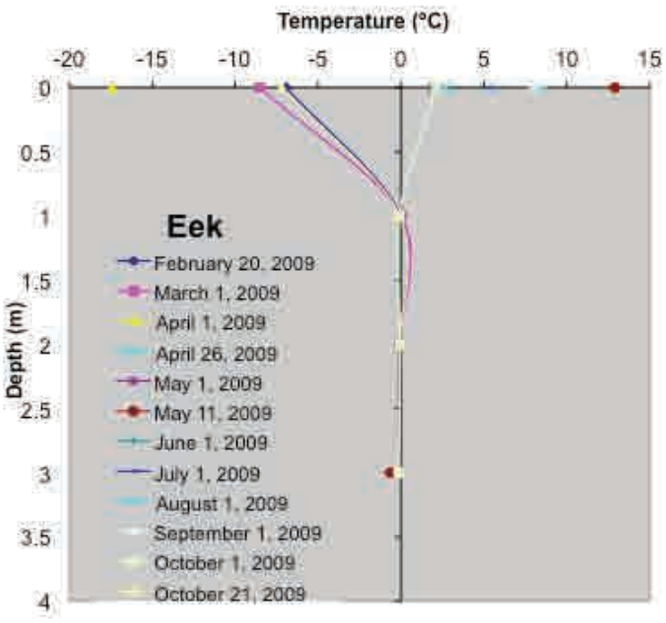
Southwest

Eek

Lower Kuskokwim School District

Student population: 89

Eek, a village with 296 residents (2010 U.S. Census), is located on the south bank of the Eek River, 19 kilometers (12 miles) east of the mouth of the Kuskokwim River. Eek was established at its present site in the 1930s after flooding and erosion at its original location on the Apokok River forced residents to relocate. A Moravian church located here, and the BIA established a school. By 1949, Eek had a post office. Eek is a traditional Yup'ik Eskimo village. Subsistence activities are culturally important and provide food. Commercial fishing and work at the school and in local government are the main sources of employment. The community has a gravel airstrip for chartered flights and private aircraft; seaplanes use the Eek River. Barges travel the river during summer, delivering fuel and supplies. Eek is connected to Quinhagak, Eek Island, and the Kwethluk River by marked winter trails.



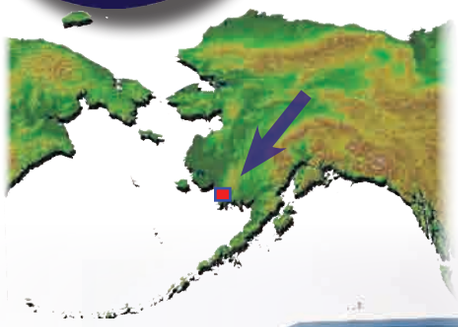
At the end of September, the active layer measured 1–1.5 m deep at the village. The frost tube site has insulating materials during summer months. The active layer here measures 80–90 cm. The upper part of the permafrost is ice-rich silt and has a thicker peat layer (60–80 cm), which causes a shallower active layer.

Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd °C
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Eek is similar to Quinhagak, in that during the Ice Age (the last time the earth grew very cold), it was not glaciated (covered by glaciers). However, glaciers covered the Kilbuck Mountains, east of Eek. Colder atmospheric temperatures and windblown (eolian) silt during the Ice Age led to ice-rich permafrost at Eek and Quinhagak.

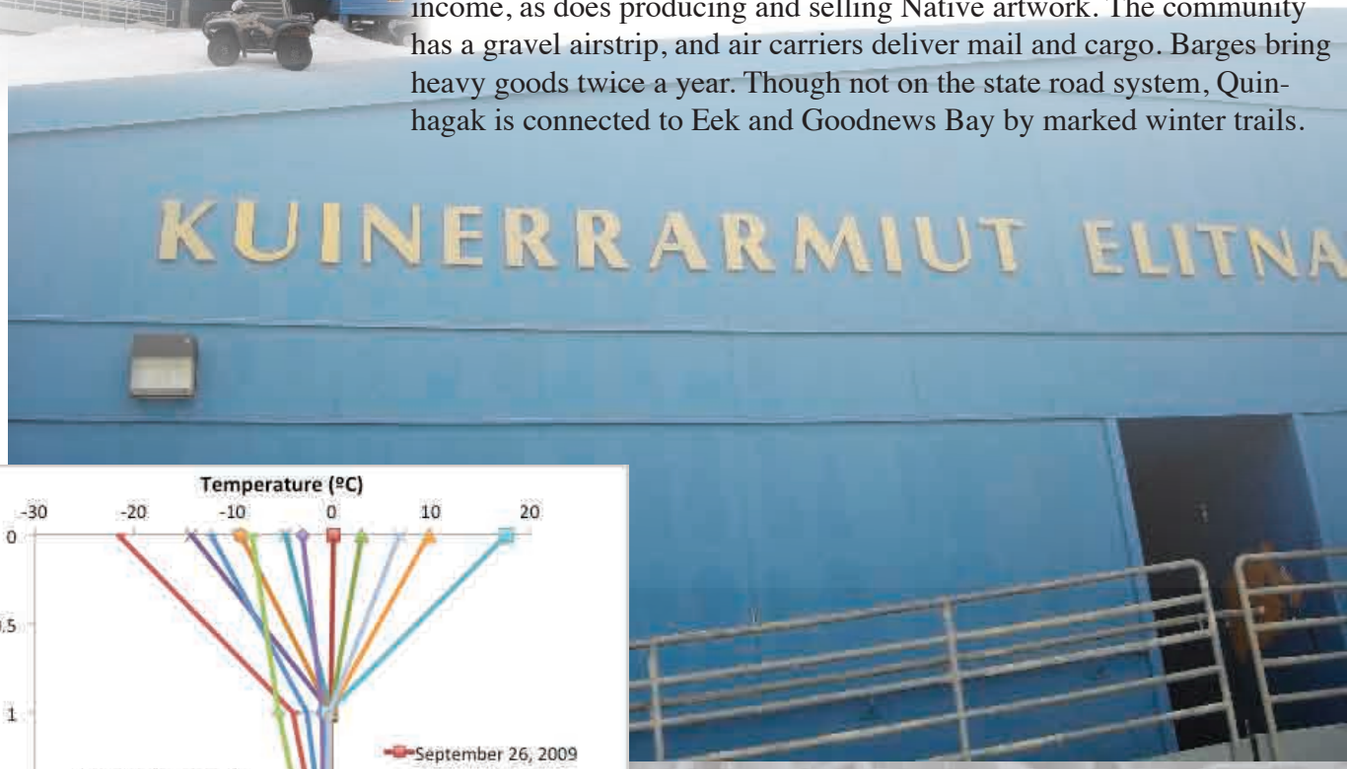
Quinhagak

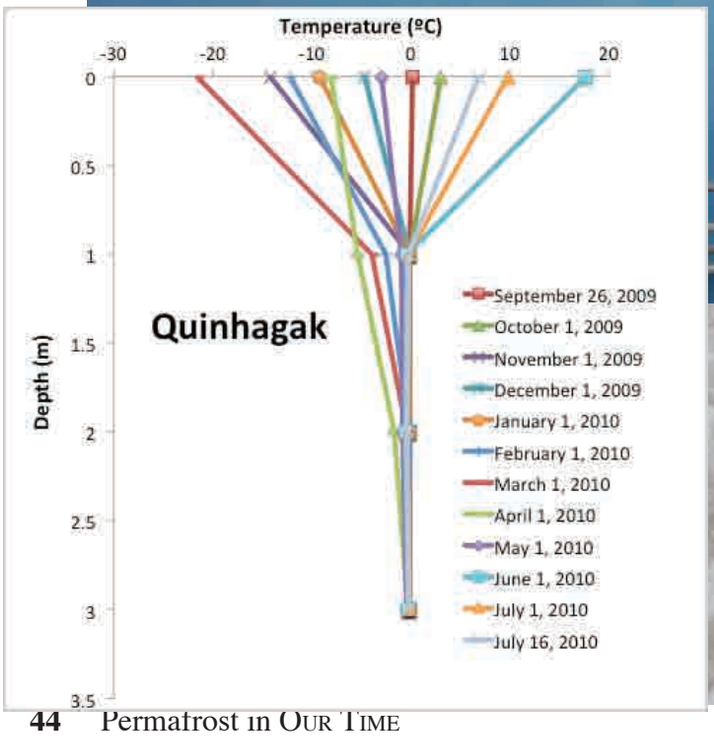
Lower Kuskokwim School District



Student population: 225

Quinhagak, a village with 669 residents (2010 U.S. Census), is located near the Kanektok River on the east shore of Kuskokwim Bay. This village site is over a thousand years old. The Yup'ik name for the location is Kuinerraq, which means "new river channel." Russian explorers visited here as early as 1826. After the U.S. purchased Alaska, ships belonging to the Alaska Commercial Company stopped here yearly with supplies for trading posts on the Kuskokwim River. The Moravian Church established a mission in 1893. Many non-Natives waited here for passage up the Kuskokwim River. By 1909, the village had a store, post office, and school. Reindeer herding was introduced in the early 1900s and lasted about forty years before the herd dispersed. Traditional subsistence activities are important for providing food. Residents work with the school or with local businesses and government; some commercial fish. Trapping produces income, as does producing and selling Native artwork. The community has a gravel airstrip, and air carriers deliver mail and cargo. Barges bring heavy goods twice a year. Though not on the state road system, Quinhagak is connected to Eek and Goodnews Bay by marked winter trails.





At the end of September, the active layer at the frost tube site measured 70–80 cm deep. The frost tube site is a little colder than the village. The permafrost is ice-rich silt. At the school, the silt layer is more than 40 m thick. Toward the airport, this silt layer becomes thinner.

Location: 59.75° N, 161.90° W

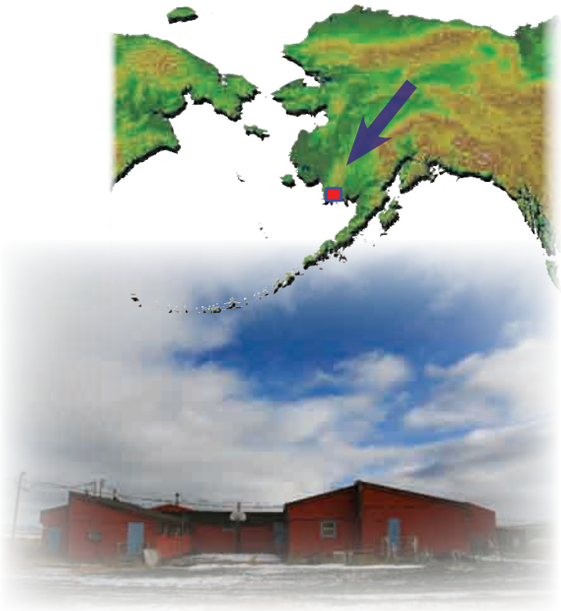
Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd °C
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

www.uaf.edu/permafrost

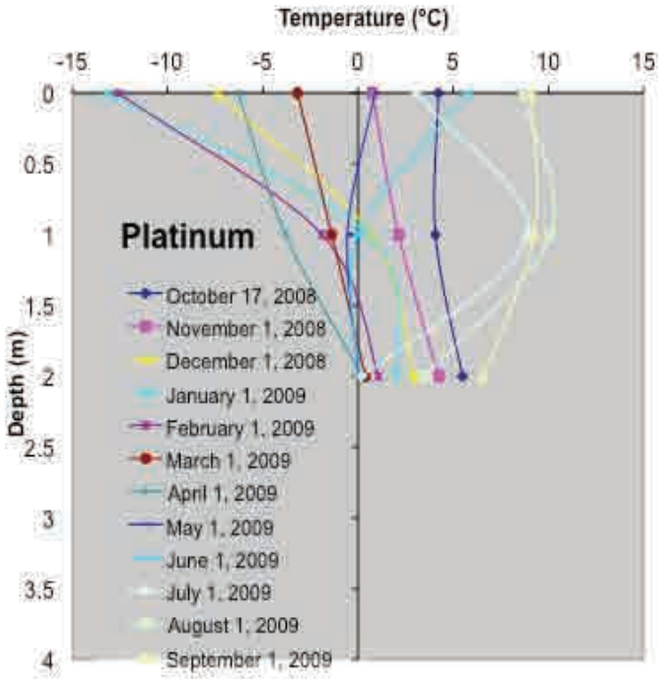
Platinum

Lower Kuskokwim School District

Student population: 12



Platinum, a village with 61 residents (2010 U.S. Census), is located on the south spit of Goodnews Bay. The community developed near Arviq, a traditional village site, after the discovery of platinum ore in 1926. For years, small placer mines operated in nearby creeks. In 1936, a large deposit of platinum was discovered about 16 kilometers (10 miles) from the village, attracting many prospectors and, eventually, the attention of two large mining companies that built a dredge at the site of the deposit to mine the deeper ore. Bunkhouses, a recreation hall, offices, and other buildings were built in support of the mining operation, and Platinum developed as a commercial center. A school opened in 1960. Mining continued until 1990. Residents of Platinum work in the school and in local government and businesses. Some residents commercial fish. The village is not on the state road system, but has a gravel airstrip and seaplane landing site. Air carriers deliver mail and cargo, and barges deliver bulk supplies twice a year.



The seasonal frost layer at the school site in 2008 measured 22 cm. This area (the spit) likely has no permafrost. The mean annual ground temperature at 2 m depth measures positive year-round, averaging +2°C. The upper part of the sediment layer is mainly sand. The deeper sediment includes gravel.

Location: 59.01° N, 161.83° W

Key Facts:
Annual mean ground temperature: 2.1 °C
Freezing days: 179 days
Freezing degree-days: 1048°C days
Thawing degree-days: 1826°C days

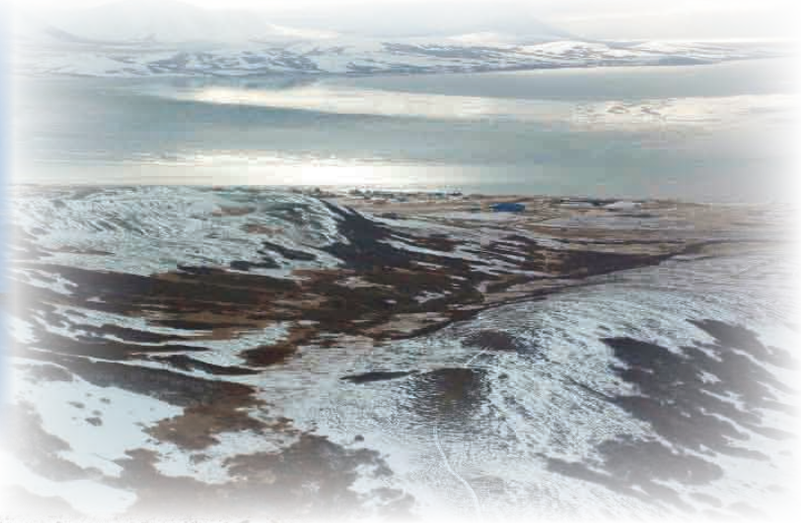
Many thermal contraction polygons are observed at the spit. Polygons developed during the Ice Age, when the winter temperature was much colder than it is today. Ground temperature data and observations of the disturbed ground during airport construction indicate that these polygons are sand wedge polygons (no ice in the cracks). Windblown sand filled the frost cracks during wintertime.

Goodnews Bay

Lower Kuskokwim School District

Student population: 59

Goodnews Bay, a Yup'ik village with 243 residents (2010 U.S. Census), is located near the mouth of Goodnews River at a bay called Goodnews Bay. This bay opens to the Bering Sea. The site for this village was chosen to avoid recurring floods and storms at the previous village site, which was called Mumtraq. A school and a post office opened in the 1930s. Residents find employment in local government, businesses, and the school. Commercial fishing provides seasonal employment, and some residents earn income from trapping. Subsistence activities provide food and are important culturally. Goodnews Bay is not on the state road system, but has a gravel airstrip. Air transportation is available with chartered flights and private air carriers. Residents frequently travel by boat and skiff in the summer. Two well-marked trails lead from the village: the Coastal Trail and the Arolik Trail, both about 97 kilometers (60 miles) long. During the summer, fuel and supplies arrive by barge.

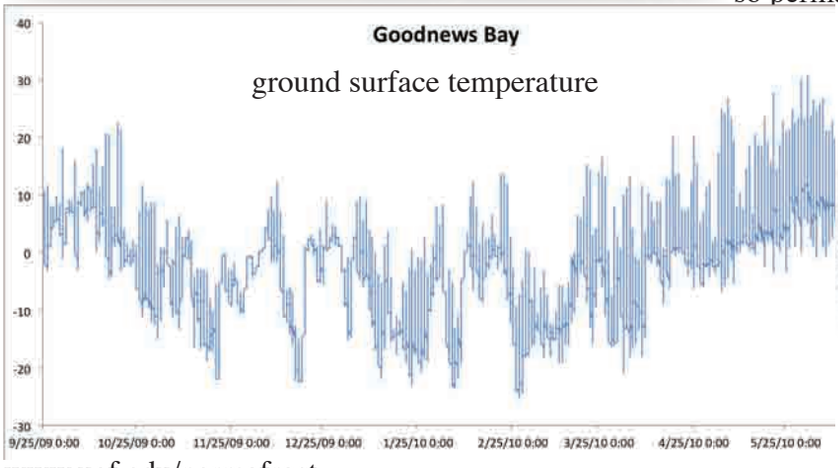


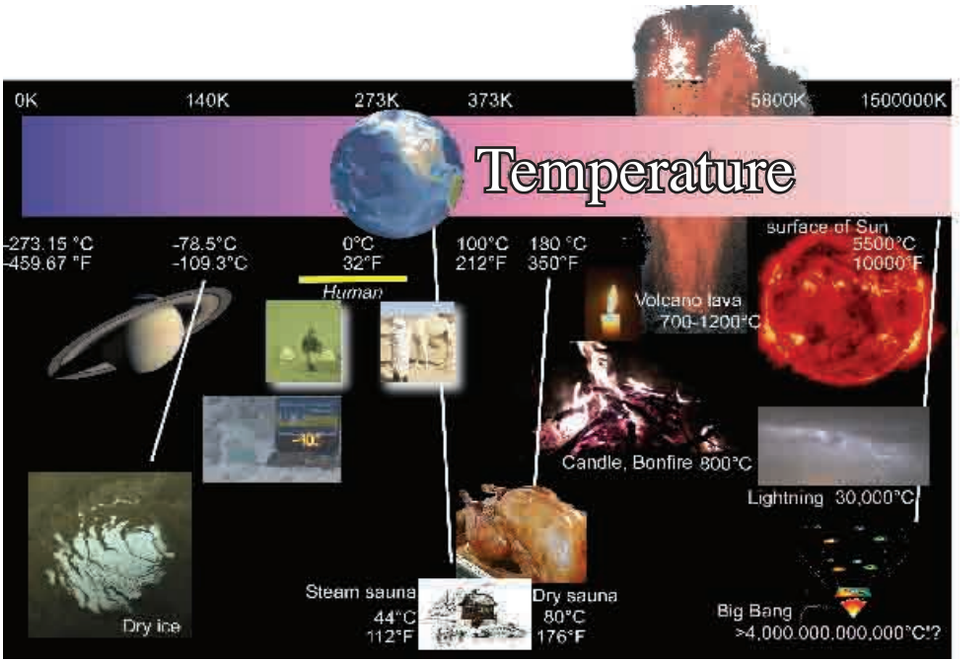
In January 2009, the seasonal frost layer at the school site measured 13 cm. The community is likely free of permafrost.

Key Facts:
Annual mean ground temperature: 0.96 °C
Freezing days: 146 days
Freezing degree-days: 1126°C days
Thawing degree-days: 1480°C days

Solifluction lobes at Mumtraq Hill

Goodnews Bay is located at the edge of the limit of glaciation. Most of the village is permafrost-free, but on the north slopes of the nearby Kiglapak Mountains and Mumtraq Hill, solifluction lobes, which are typical permafrost features, are visible. At Quinhagak and Eek, north of Goodnews Bay, the land was not glaciated during the Ice Age, so was exposed to subfreezing temperatures for thousands of years, leading to the formation of permafrost. Southeast of Goodnews Bay, at places such as Togiak and Dillingham, the land was glaciated. This glacial cover, though frozen, was not as cold as the air temperature, so permafrost is not as likely.





On the Fahrenheit scale, the freezing point of water is 32° degrees (32°F) and the boiling point is 212 degrees (212°F).

Temperature is a one of the measureable important parameters for understand the conditions of the materials. Scientists worldwide use the Celsius and Kelvin scales to measure temperature. In the U.S., Burma, and Liberia, the Fahrenheit scale is also used, but mostly for non-scientific purposes.

The Celsius scale, also called the centigrade scale, is based on the metric system. There are one hundred measurement intervals between the freezing point of water at zero degrees (0°C) and the boiling point of water (at sea level) at one-hundred degrees (100°C). Using the Celsius scale, if you are outdoors, 0–10°C feels cold, 10–20°C feels mild, 20–30°C feels warm, and 30–40°C feels hot.

The Kelvin scale is similar to the Celsius scale, but its starting (0) point is different. The Kelvin scale begins at what is called absolute zero, the point at which there is no molecular movement (no heat of any measurement). Absolute zero on the Kelvin scale equals −273.15° on the Celsius scale.

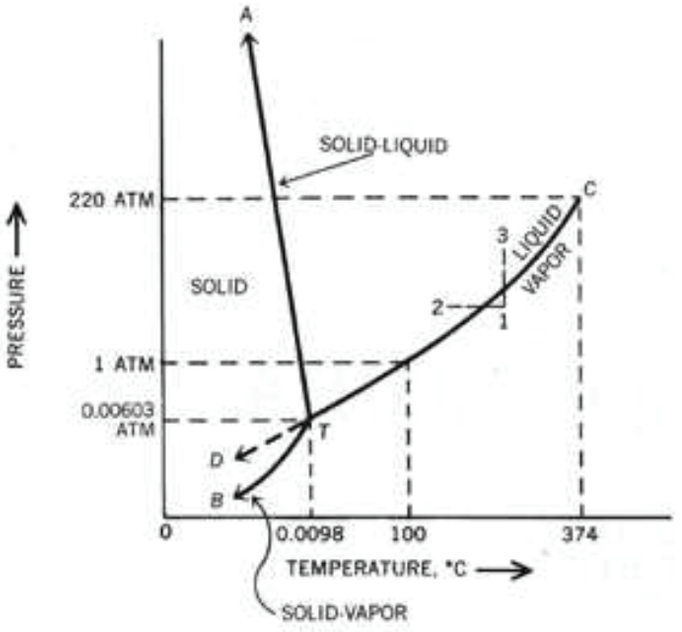
The range of temperature in the universe is huge. The Kelvin scale is used to determine extreme temperatures, for example, of astronomical objects, such as the sun's surface at 5800 K or the sun's core at more than 15 million K (note that the degree symbol isn't used with Kelvin).

Earth's average temperature is about 17°C (63°F), a temperature most humans feel comfortable in. The temperature range we live in is not wide compared to temperature variations in the universe. We can live in a range of only −50°C to 50°C (-58°F to 122°F)(range 100°C), and that's with clothing for cold temperatures. For the naked condition, the temperature range we can live in is only 10° to 35°C (50°F to 95°F)!!

The Celsius and Fahrenheit scales were invented in the 1700s and named after their inventors, Anders Celsius (a Swedish astronomer) and Daniel Gabriel Fahrenheit (a German physicist). Celsius developed his measurement scale based on 100 measurement intervals between the freezing and boiling points of water (the metric system). The story behind the idea of "Fahrenheit" is uncertain. Many stories exist, and they differ from country to country. One explanation is that Fahrenheit created the measurement scale of 64 intervals using the freezing point of salty water and the temperature of the human body as reference points.

We don't feel atmospheric pressure in everyday life, but it's all around us. You are receiving 1 kg (2 lb) of air every 1 cm2 (1⁄2 inch square). It's the same pressure you'd feel diving into water 10 m (33 ft) deep. This depth is 100 kilopascal, also called 1 atmospheric pressure (atm).

High on a mountain, the atmospheric pressure is lower because there is less air above you. For example, at the top of Denali—6,194 m (20,322 ft) high—the atmospheric pressure is much lower than at sea level where most people live; it is 48 kilopascal. If you could feel the atmospheric pressure at this elevation, it would be similar to pressure felt when diving into water 5 m (16 ft) deep. This pressure is half of the atmospheric pressure we experience in everyday living. It would be harder for you to run here than near sea level.



If you were to try to cook on Mars, the boiling point of water would be around 20°C (68°F) depending on the season, because the atmospheric pressure is 10–18 times lower than on Earth. The hard-boiled egg you plan to eat for breakfast will remain uncooked in the boiling water, no matter how long it's in the pot.

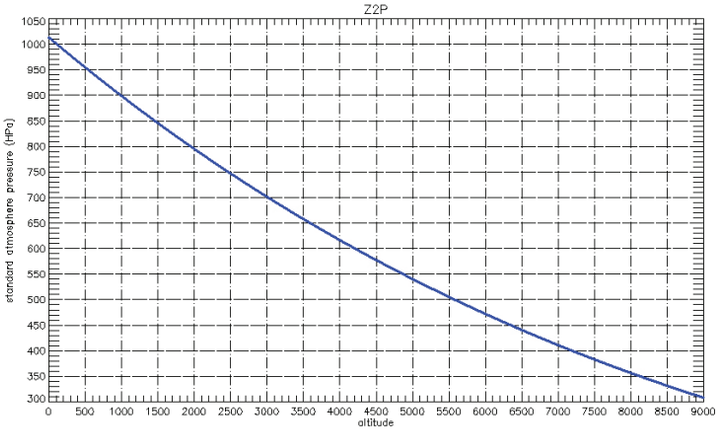
if pressure is 107 kPa, boiling point increases to 122°C (252°F).

The point at which temperature is 0.01°C (slightly more than 32°F) and pressure is 611.73 pascal (a unit of pressure measurement) is called the triple point of water; this is the point that water, ice, or gas can exist in their individual form at the same time. It takes only a small change in pressure and temperature to quickly turn water, ice, and gas to either one or the other.

In atmospheric pressure that is lower than this triple point, for example, that of a small planet or in the thin air of a satellite, liquid water cannot exist. If you were to throw liquid water into this thin atmosphere, it would instantly become gas or ice.

Atmospheric pressure affects boiling temperature, so at the summit of Denali, if you want to boil water, the water will boil but its temperature will not rise above 70°C (158°F). If you toss potatoes or rice in a pot of boiling water, they won't cook because the water doesn't get hot enough. It is better to use a pressure cooker at such high elevations to increase pressure in the pot to more than 120 kilopascal (1.2 atm, 15 psi), which forces the temperature to heat beyond 100°C (212°F).

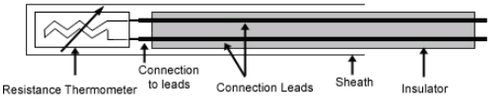
At sea level or at the top of Denali, there is little difference in the temperature of when snow melts because, unlike the boiling point of water, the freezing point isn't affected much by atmospheric pressure.



Let's check temperature !

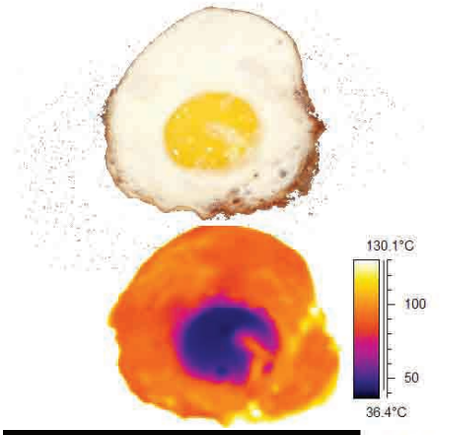
Temperature can be measured using many different types of sensors: liquid, metal, ceramic, polymer, and electronics, for example.
A glass thermometer is a classic accurate temperature-measuring device that uses the characteristics of fluid-expansion to show temperature change. Common household thermometers use alcohol or mercury in a glass tube. As temperatures increase, the fluid expands, rising up the scale; as cooling begins, the fluid contracts, moving down the scale.

This picture shows Norwegian explorer, Fridtjof Nansen, leader of the Fram's 1893–96 Arctic expedition, measuring seawater temperature at various depths in the middle of the Arctic Ocean. Nansen is using his accurate glass thermometer (the fluid-expansion type with mercury), reading the scale with the help of a magnifying glass. Weights were used to sink the sensor deep in the water, over 3000 m down. These are the first recorded water temperatures near the North Pole. In the 1890s the fluid-expansion thermometer was the only way to measure temperature.



Many different principles are used for measuring temperature, but for scientific purposes, we need accuracy and high resolution (ease of reading). For this, four types of sensors are commonly used: the thermistor, thermocouple, platinum resistor, and IC sensor.
A thermistor is a semiconducter product, like a transistor; its electric resistance changes with temperature. Thermistors are sensitive, and produce a unique curve when graphed. They are good for a specific temperature range, meaning they are accurate, but their temperature range is narrow.
Thermocouples are widely used in the engineering field. They aren't as accurate as thermistors, but they produce a nearly linear relationship over a wide temperature range, including temperatures over 1000°C. In a thermocouple, two different types of metal wire connect at their ends. If the temperature is different between both ends, the wires generate a small amount of electricity. A voltmeter detects this voltage and converts it to temperature. The voltage itself is small, so resolution depends on how accurately the voltmeter reads the voltage.
Platinum resistor sensors are commonly used in Europe and Japan, but not in the U.S. Metals are conductive materials that show electrical resistance in response to a change in temperature. However, platinum produces a stable linear relationship between temperature and resistance, which is why many scientists use it. But platinum is expensive!
IC sensors are getting popular. Though less accurate than other types of sensors, the IC sensor provides digital output. Other sensors provide only analog output, which then needs to be converted to digital for reading devices. This step is unnecessary with an IC sensor. In the end, the IC sensor is simpler, smaller, and cheaper to use.

Bi-metallic thermometer (such as a round outdoor temperature thermometer) is one of the most common, inexpensive thermometers available. The principle of this thermometer is simple. Two different thin metal foils attach in a spiral structure. When temperatures change, the expansion/contraction rate of the two metal foils is different, which changes the tightness of the spiral structure. Aside from use in round outdoor temperature thermometers, bi-metallic sensors are commonly used for oven thermometers and indoor room thermostats. The bi-metallic thermometer is simple, strong, and inexpensive to make, but it's not as accurate as other thermometers.



Digital thermometers have developed dramatically over the last two decades because of growth in the silicon industry; they are inexpensive to make and accurate. Digital devices can connect to analog sensors such as infrared sensors, thermistors, and thermocouples and/or digital sensors. The infrared digital thermometer is becoming popular for measuring body temperature. This sensor is even capable of determining body temperature by just measuring heat emitted from the eardrum.

Thermal cameras (thermography) show temperature distributions (images), not just one temperature point like other sensors. An example of one use of thermography is that of airports, in their effort to prevent the spread of flu. They use thermal cameras to detect fever in passengers.

And let's look at eggs, as another example. Some people like hard-boiled eggs, some like soft-boiled, and some like eggs somewhere in between. This thermal image of sunny-side up eggs shows that egg white cooks faster than the yolk. When the first heat bubble rises in the yolk, the yolk temperature is about 43°C.

When you look at a thermal image of a campfire, the fire appears hot. The thermal scale shows that people facing the fire are warmer. Fires produce radiant heat.

Heat transfers in many ways: there is radiant heat, conductive heat, and convective heat, among others. When frying an egg or meat, the heat going through them from the pan is conductive. When cooking soup in a pot, the liquid is warmed by convective heat. When baking in an oven, the heat is radiant. Modern ovens also have a convection heat option.

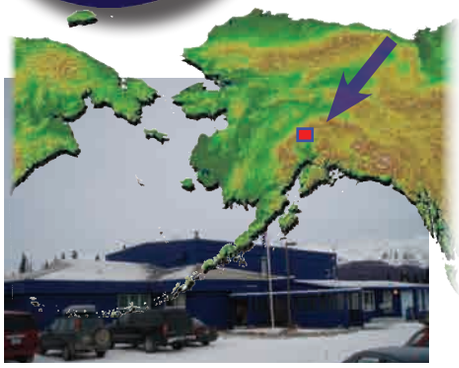
Look at the thermal image of the toaster. We know there's quite a bit of heat inside the toaster, but the heat shield outside the toaster prevents overheating, so the image doesn't show much warmth. Note that the electrical outlet shows warmth; this is because it heats up with use.

Calibration

All sensors need calibration because no sensor is entirely accurate. A known temperature is needed to calibrate a sensor. We know that pure water freezes at 0°C (32°F), and we know that typical ocean water (3.5% salinity) freezes at –1.8°C (29°F). To calibrate a sensor, we combine pure water and crushed ice from pure water to make an ice bath; then we put the sensor into this well-mixed ice bath. The sensor should show a temperature of 0.00°C; if it doesn't, we can see how much the temperature reading shifts from 0°C.

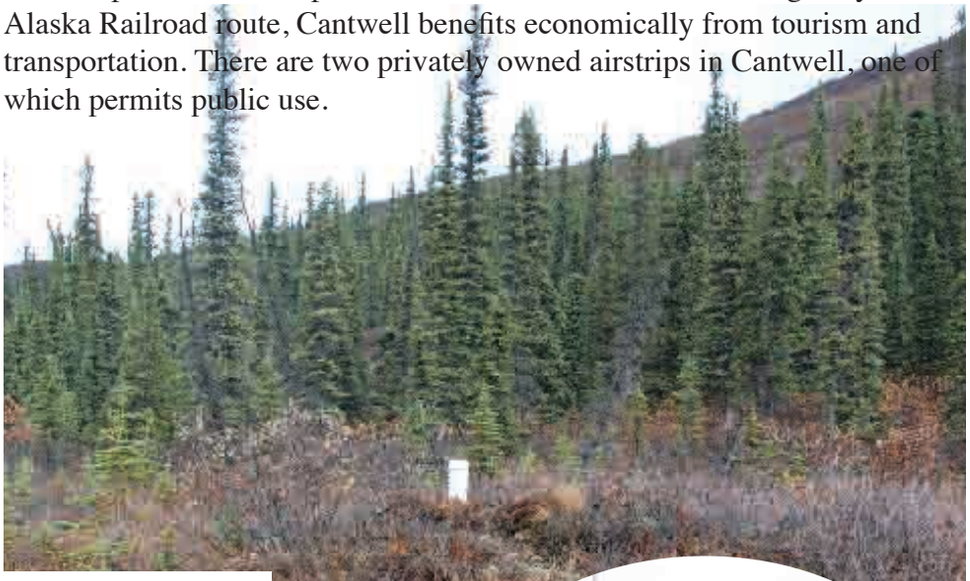
Cantwell

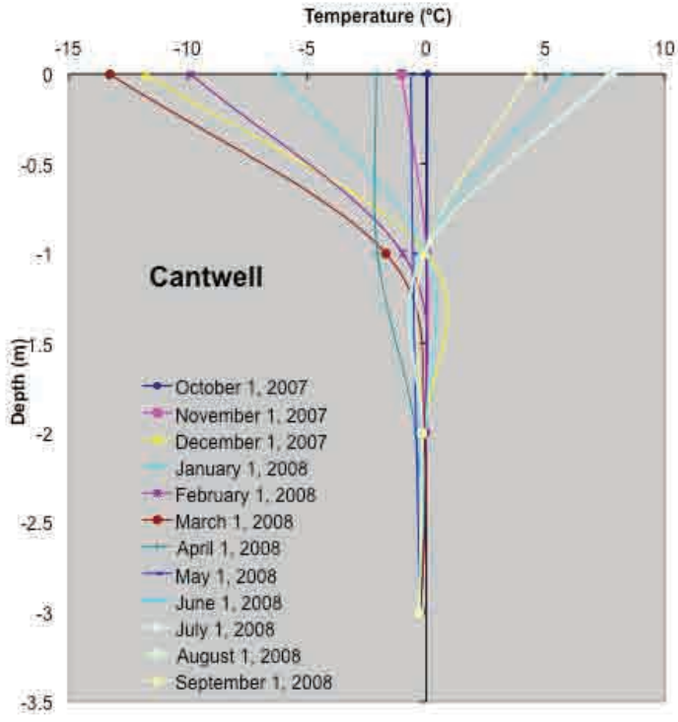
Denali Borough School District



Student population: 35

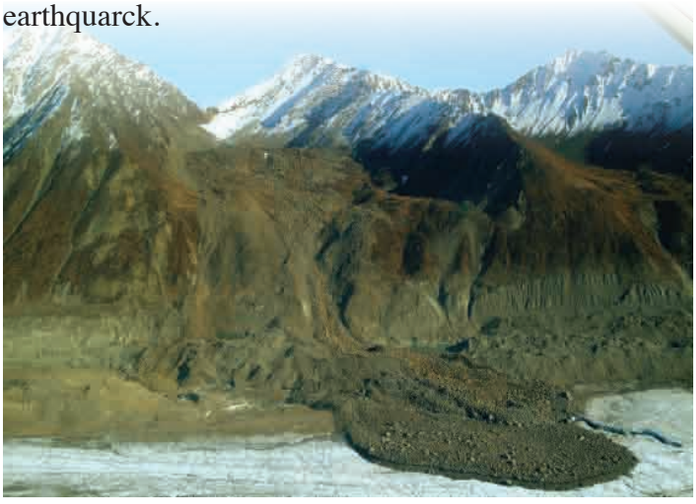
Cantwell, a community with 192 residents (2008 Estimated Population, not Certified), is located along the George Parks Highway, 340 kilometers (211 miles) north of Anchorage, at the west end of the Denali Highway. Athabascans, the people who lived in this area originally, hunted, trapped, and fished throughout Interior Alaska. When the Alaska Railroad was built in the early 1900s, this particular location along the route, just south of the Nenana River, was established as a flag stop, and the town of Cantwell grew from there. Over a quarter of the population in Cantwell today is Alaska Native or part Native, mainly Athabascan, for whom traditional subsistence practices are important. Situated on both the Parks Highway and Alaska Railroad route, Cantwell benefits economically from tourism and transportation. There are two privately owned airstrips in Cantwell, one of which permits public use.





Permafrost is sporadicly presence at Cantwell, most of the tundra surface, rerect dune forest is abcence of the permafrost. In spide of the seasonal frost layer has very deep (>3m) in glacier till. this area is widely covered by glacier during the last ice age that reflect glaciel deposits most of the land. The frost layer is unknown at the station, however, temperature is almost thawing point and glaciated area expect around 10m thick.

One of the most active faults (Denali Fault) in Alaska crossing north side of the Cantwell (red dot on this picture). It move Trans-Alaska pipeline nore than 6m on November 3rd, 2002 (magnitude 7.9). At the same time, many land slide was observed by the earthquarck (picture avobe). This land slide picture was taken several weeks after the earthquarck and debris are covered on Susitna Glcier wher is the center of the earthquarck.

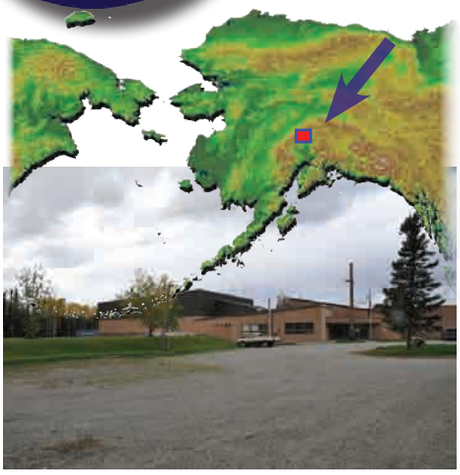


Key Facts:
Annual mean ground temperature: -0.7 °C
Freezing days: 188 days
Freezing degree-days: 1886°C days
Thawing degree-days: 1628°C days

Permafrost is present in only small spruce colony not on tundra South side of Cantwell. The reason of this distribution is unknown.

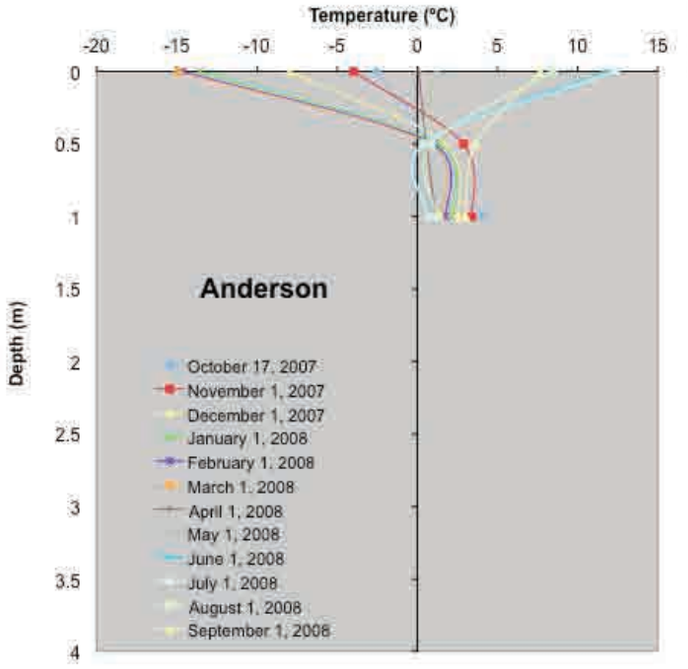
Anderson

Denali Borough School District



Student population: 43

Anderson, a community with 295 residents (2008 DCCED Certified Population), is located on a spur road off the George Parks Highway, 122 kilometers (76 miles) southwest of Fairbanks. The town is named for Arthur Anderson, one of the original homesteaders who settled in the area in the late 1950s. Mr. Anderson subdivided his 80 acres in 1959 and sold the lots, mostly to employees working at Clear Air Force Station, which was being established at the time. Clear Air Force Station is an intercontinental ballistic missile early warning site, and is one of the main employers for military and civilian employees who live in Anderson. Both the Alaska Railroad and the George Parks Highway link Anderson to Anchorage and Fairbanks. The annual mean air temperature in Anderson is -5°C (23°F). Average annual precipitation is 33 centimeters (13 inches); average annual snowfall is 1.2 meters (49 inches).



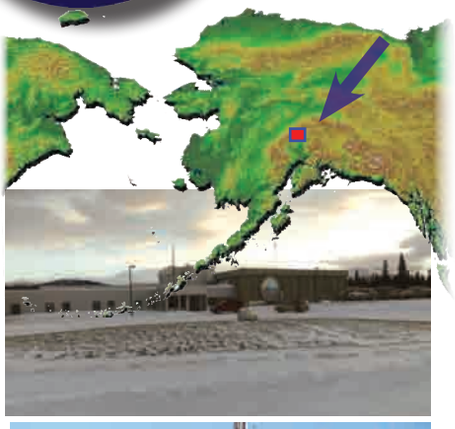
Key Facts:
Annual mean ground temperature: -0.3°C
Freezing days: 187 days
Freezing degree-days: 1898°C days
Thawing degree-days: 1800°C days

Permafrost is sporadicly presence at Cantwell, most of the tundra surface, rerect dune forest is abcence of the permafrost. In spide of the seasonal frost layer has very deep (>3m) in glacier till. this area is widely covered by glacier during the last ice age that reflect glaciel deposits most of the land. The frost layer is unknown at the station, however, temperature is almost thawing point and glaciated area expect around 10m thick.

www.uaf.edu/permafrost

Healy

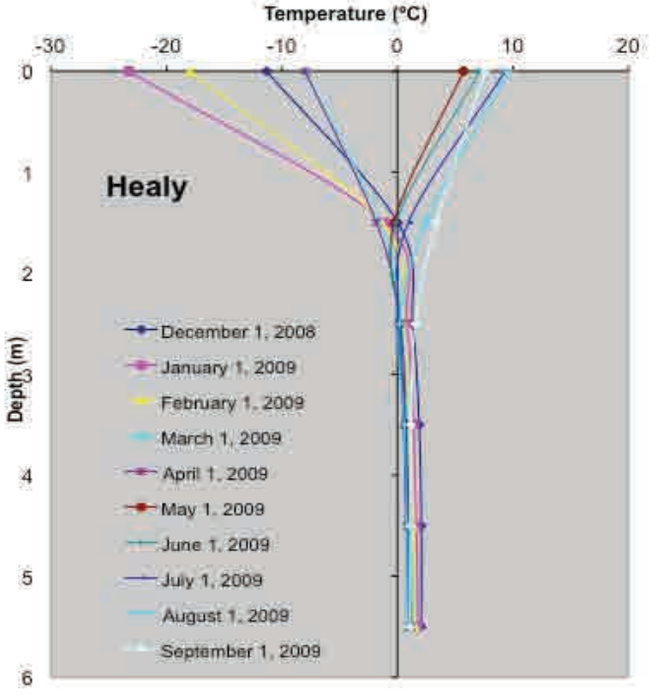
Denali Borough School District



Student population: 347

Healy, a community with 1,025 residents (2008 Estimated Population, not Certified), is located along a 4 kilometer (2.5 mile) spur road off the George Parks Highway, about 78 miles southwest of Fairbanks. Healy Creek and the Nenana River are near this town, which is a short distance from the north entrance of the Denali National Park and Preserve. Healy was established as a mining camp in 1905. The site's proximity along the route of the Alaska Railroad, constructed years later, allowed its development into a railway station and supply point. The Usibelli Coal Mine, which produces 1.3 million tons of coal per year, is located just northeast of Healy, on the other side of the Nenana River. Healy benefits from tourism, with its location along the highway. Services for motorists and travelers are provided here. Besides highway and rail access, Healy is accessible by air; the community has a paved runway.

During installation, Healy school had difficult materials by glacier deposids, where contained gravel and boulder. We use bigger drill rig to drill 6m.



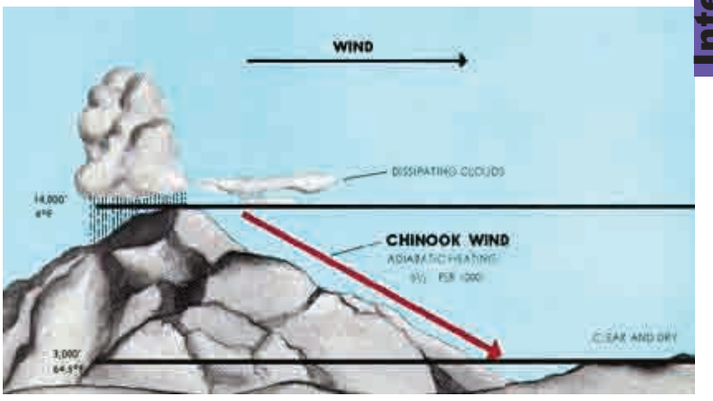
Key Facts:
Annual mean ground temperature: 0.3°C
Freezing days: 174 days
Freezing degree-days: 1590°C days
Thawing degree-days: 1682°C days

Permafrost is discontuously presence at Healy, most of the tundra surface presence of the permafrost (about -0.8 C). In spide of the seasonal frost layer has very deep (>2m) in glacial fluvial deposits, permafrost is abcent or recently disappear such as school property. Permafrost temperature strongly affect winter temperature and snow depth. Healy and Delta Junction are ideal Chinook (Foehn) winds area which windy but warmer than other parts of Interior. It freequently above freezing during Chinook winds that Native said "snow eater".

Icing formation is serious problem in winter road. State DOT had special team "Steam Steam" to making water pass way.

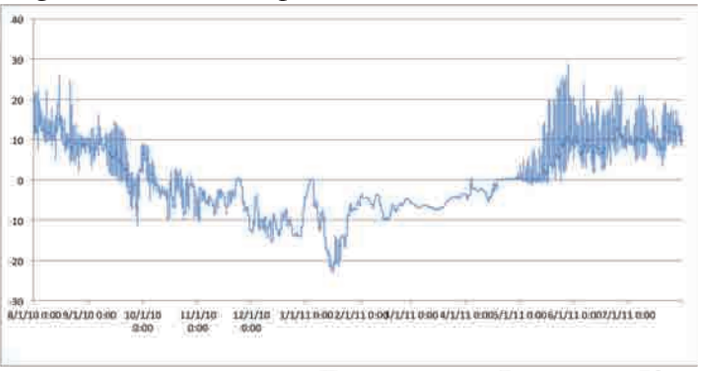
One of the most striking features of the chinook is the chinook arch, which is a band of stationary stratus clouds caused by air rippling over the mountains due to orographic lifting.

The Chinook wind is a rain shadow wind which results from the subsequent adiabatic warming of air which has dropped most of its moisture on windward slopes. As a consequence of the different adiabatic rates of moist and dry air, the air on the leeward slopes becomes warmer than equivalent elevations on the windward slopes. As moist winds from the Pacific are forced to rise over the Alaska Range, the moisture in the air is condensed and falls out as precipitation, while the air cools at the moist adiabatic rate of 6°C/1000 m. The dried air then descends on the leeward side of the mountains, warming at the dry adiabatic rate of 10°C/1000m.



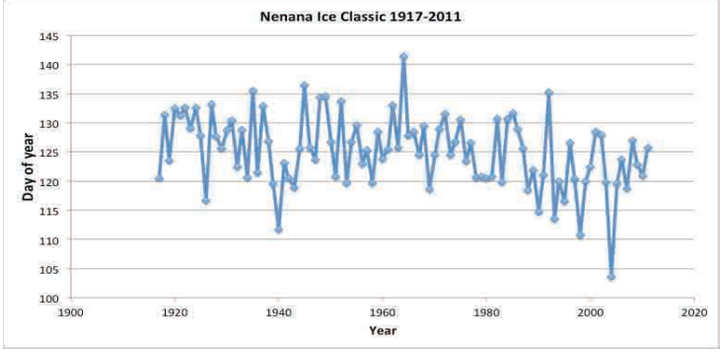
Denali National Park and Preserve Visitor Center also monitoring ground surface temperature and frost depth (frost tube). Combvined temperature profiles indicated several Chinook event during cold months.

Denali National Park and Preserve Visitor Center ground surface temperature



Nenana

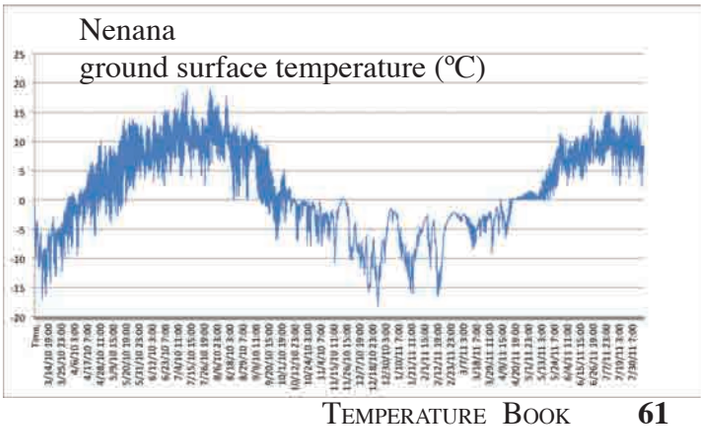
Nenana City Schools



The Nenana river in the Interior of Alaska usually freezes over during October and November. The ice continues to grow throughout the winter accumulating an average maximum thickness of about 110 cm, depending upon winter weather conditions.

The Nenana River Ice Classic competition began in 1917 when railroad engineers bet a total of 800 dollars, winner takes all, guessing the exact time (month, day, hour, minute) ice on the Nenana River would break up. Each year since then, Alaska residents have guessed at the timing of the river breakup. A tripod, connected to an on-shore clock with a string, is planted in two feet of river ice during river freeze-up in October or November. The following spring, the clock automatically stops when the tripod moves as the ice breaks up. The time on the clock is used as the river ice breakup time.

National Snow and Ice Data Center. 1998. Nenana Ice Classic: Tanana River ice annual breakup dates. Boulder, CO: National Snow and Ice Data Center. Digital media.

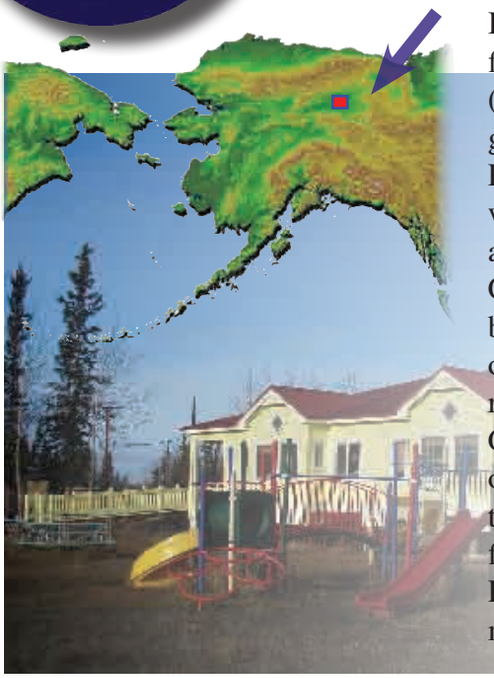


Key Facts:
Annual mean ground temperature: 0.1°C
Freezing days: 197 days
Freezing degree-days: 1012°C days
Thawing degree-days: 1047°C days

www.uaf.edu/permafrost

Beaver

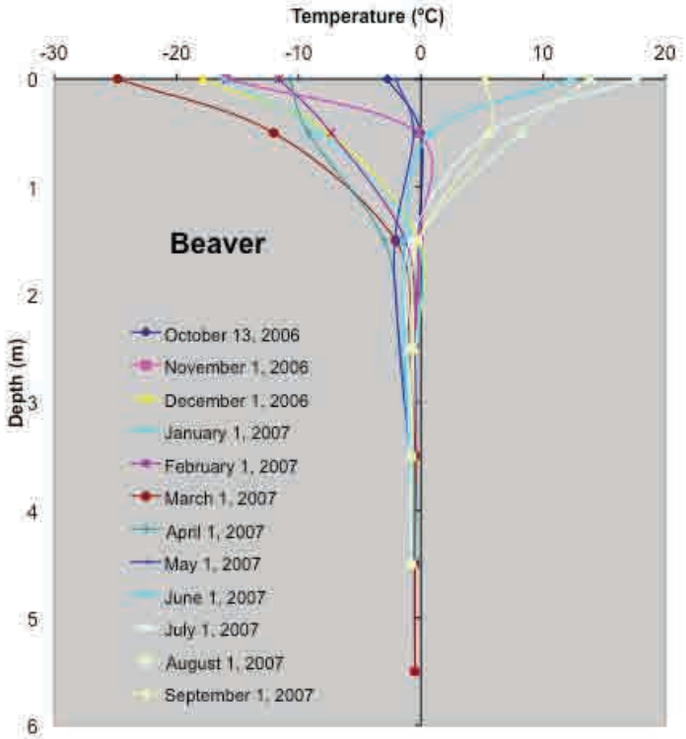
Yukon Flats School District



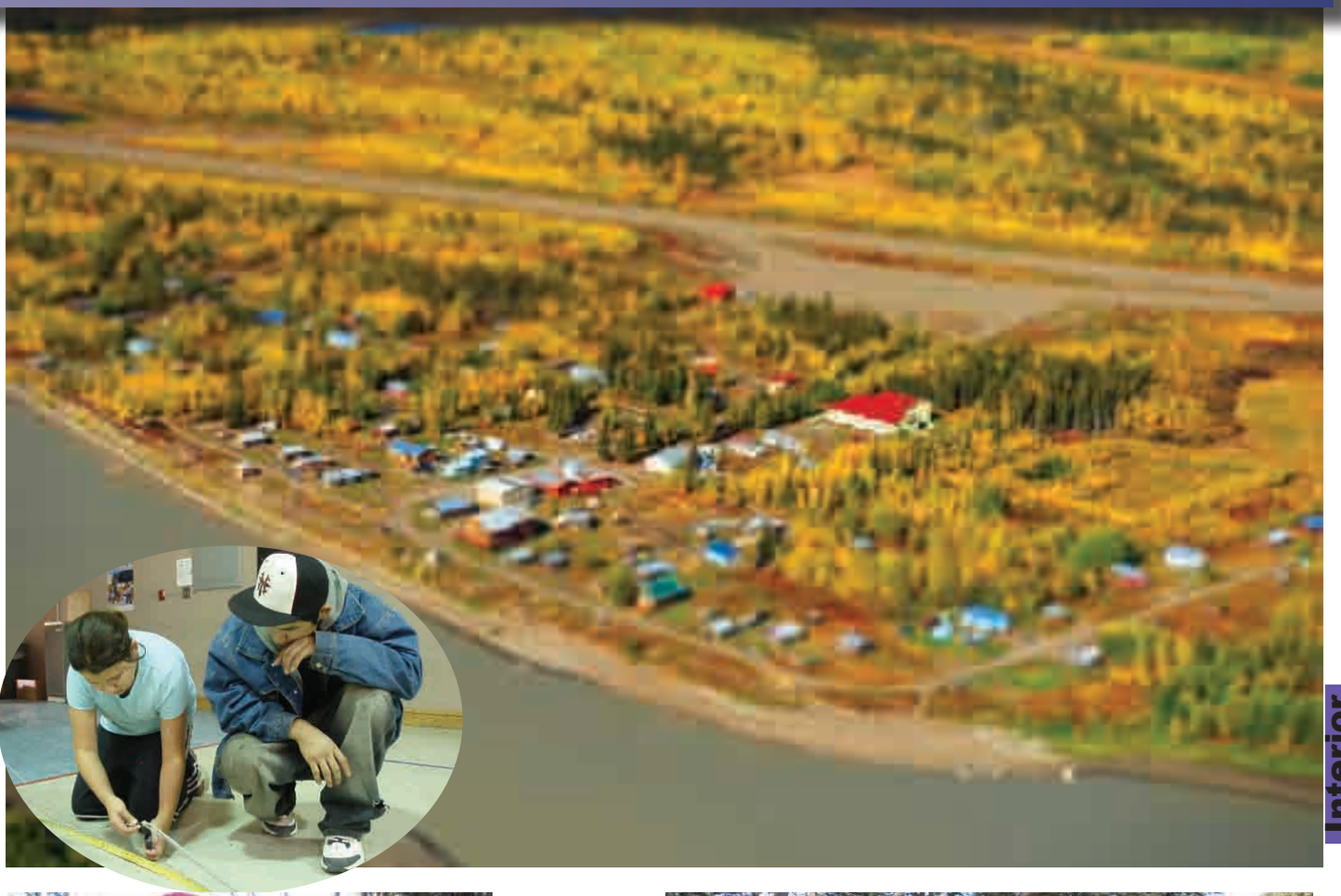
Student population: 10

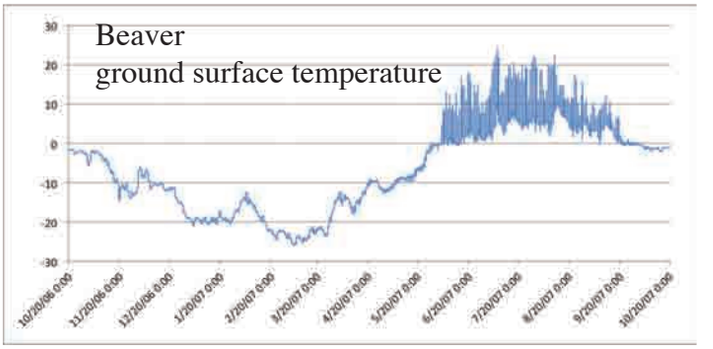
Beaver, a village with 65 residents (2008 Estimated Population, not Certified), is located on the north bank of the Yukon River, about 97 kilometers (60 miles) by air southwest of Fort Yukon. Beaver developed because of gold discoveries in the Chandalar region; it was the point along the Yukon River at which miners headed north to the gold fields. By 1910, a store was operating in Beaver, and three freight companies hauled supplies on a trail built by the Alaska Road Commission that led north to Caro on the Chandalar River. Mining continued after the gold rush, which provided business for the store and for riverboats that brought supplies. A post office was established by 1913, and a school was opened by 1928. Most residents in Beaver today are Alaska Native or part Native, mainly mixed Gwich'in/Koyukuk Athabascan and Inupiat. A traditional subsistence way of life is predominant in the community. Employment includes work in the school, post office, clinic, and village council, and construction and firefighting. Beaver is not on the road system, but has regular air service. Fuel and supplies are flown to Beaver as air cargo or barged there. From mid-June to mid-October, the Yukon River is ice-free.

Key Facts (2007):
Annual mean ground temperature: -6.3°C
Freezing days: 252 days
Freezing degree-days: 3089°C days
Thawing degree-days: 790°C days



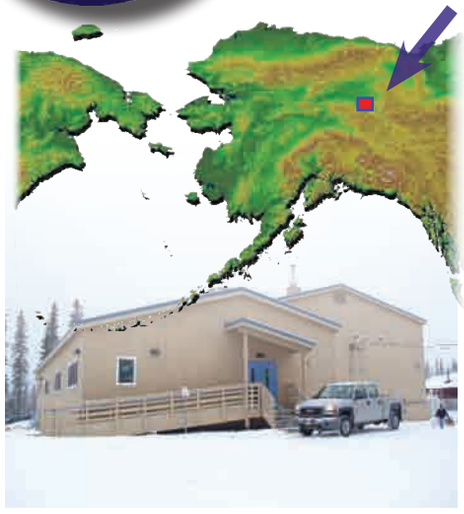
Permafrost is discontinuously present at Beaver, most of the inland forest surface overlays permafrost. However, along the Yukon River and its active floodplain, permafrost is absent. The Yukon River controls groundwater adjacent of the village. The south side of the village (left side of Yukon River) has several lakes that drained in the last several dacades (see below satellite picture).




Beaver
ground surface temperature
30
20
10
0
-10
-20
-30
10/20/06 0:00
11/20/06 0:00
12/20/06 0:00
1/20/07 0:00
2/20/07 0:00
3/20/07 0:00
4/20/07 0:00
5/20/07 0:00
6/20/07 0:00
7/20/07 0:00
8/20/07 0:00
9/20/07 0:00
10/20/07 0:00

Circle / Central

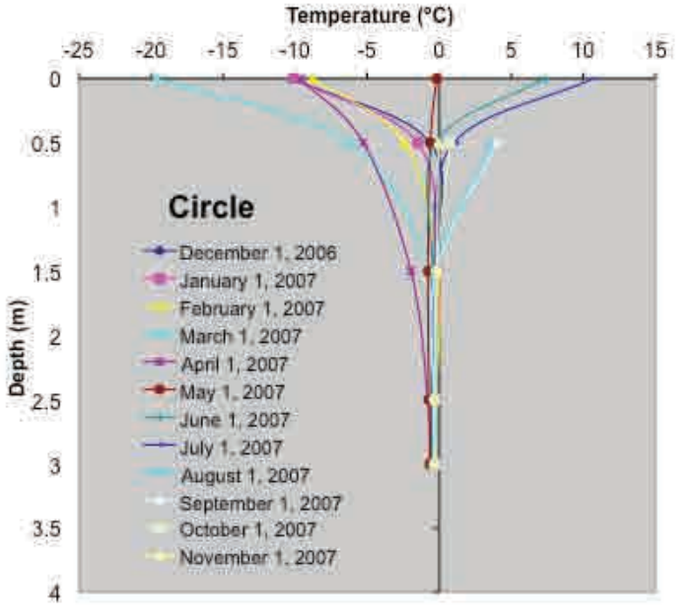
Yukon Flats School District



Student population: 23

Circle, also known as Circle City, is a community with 94 residents (2008 Estimated Population, no Certified) located on the south bank of the Yukon River, 258 kilometers (160 miles) northeast of Fairbanks. The community is accessible by road, being situated at the eastern end of the Steese Highway. Historically, this area has been home to Athabascans. In the 1890s, this Yukon River location was a drop-off point for supplies headed overland to gold mining camps. This activity led to establishment and quick growth of this settlement. Early miners thought that Circle City was on the Arctic Circle; thus its name. Circle was the largest mining town on the Yukon River by 1896, with a population of 700. The community had a store, dance halls, church, library, school, hospital, newspaper, and resident government officials, but following gold discoveries in the Klondike and at Nome, the population decreased dramatically. Some miners remained in the area, and Circle settled into a small supply community for nearby miners. Mining continues to the present. Most residents in Circle are Alaska Native or part Native, mainly Athabascan. Employment includes work at the school, clinic, store, and post office, and in the village corporation. Circle's location at the end of the Steese Highway and on the Yukon River attracts recreationists. Barges travel the Yukon River to deliver supplies while the river is ice-free from mid-June through mid-October. Aircraft can land on a lighted gravel airstrip.

Key Facts (2007):
Annual mean ground temperature: -1.1°C
Freezing days: 200 days
Freezing degree-days: 2118°C days
Thawing degree-days: 1722°C days

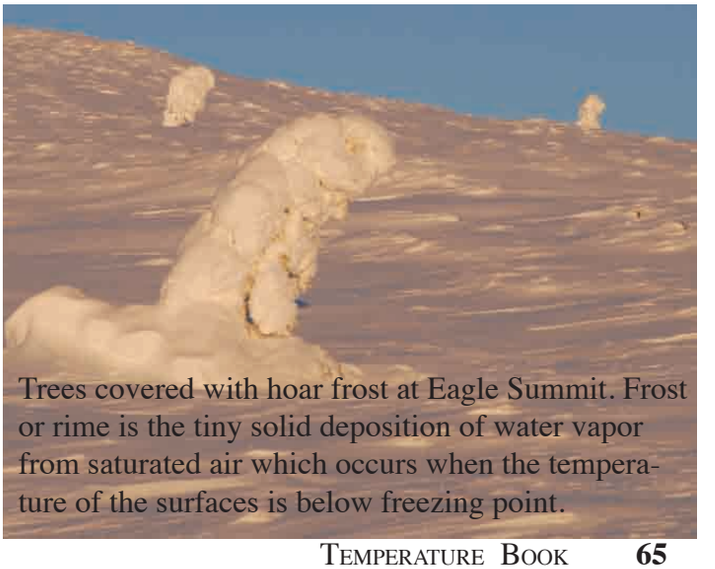


Permafrost is discontinuously present at Circle City and Central; for most of the inland forest surface, permafrost is present. However, along the Yukon River and historical mining activity sites, permafrost is absent.

Many solifluction lobes are seen around Eagle Summit

Fireweed is a popular flower in Alaska; after the wild fire (right side of the Steese Highway), fireweed growth was widespread.

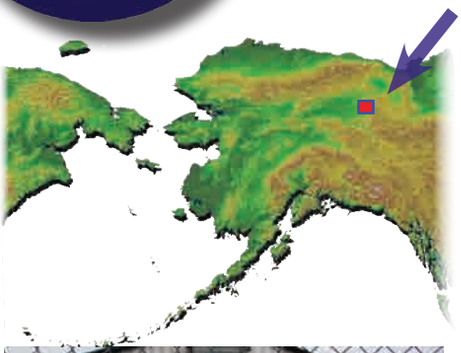
Open system pingos are commonly seen in interior Alaska. A mature pingo with its associated crater located near Birch Creek bridge.

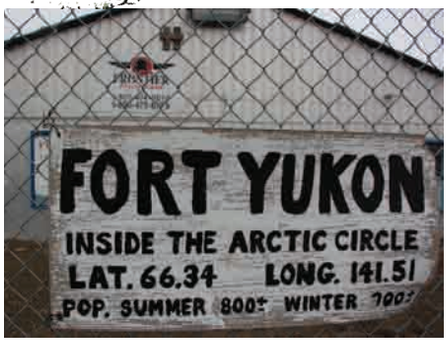


Trees covered with hoar frost at Eagle Summit. Frost or rime is the tiny solid deposition of water vapor from saturated air which occurs when the temperature of the surfaces is below freezing point.

Fort Yukon

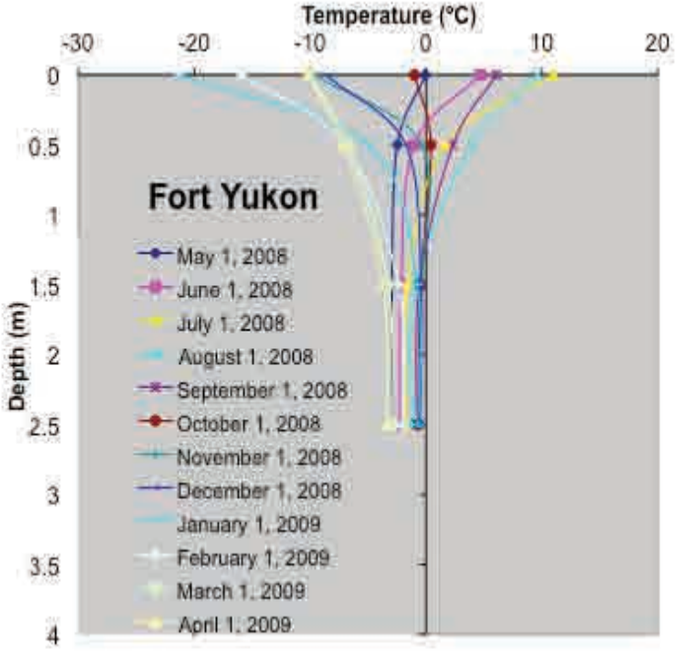
Yukon Flats School District





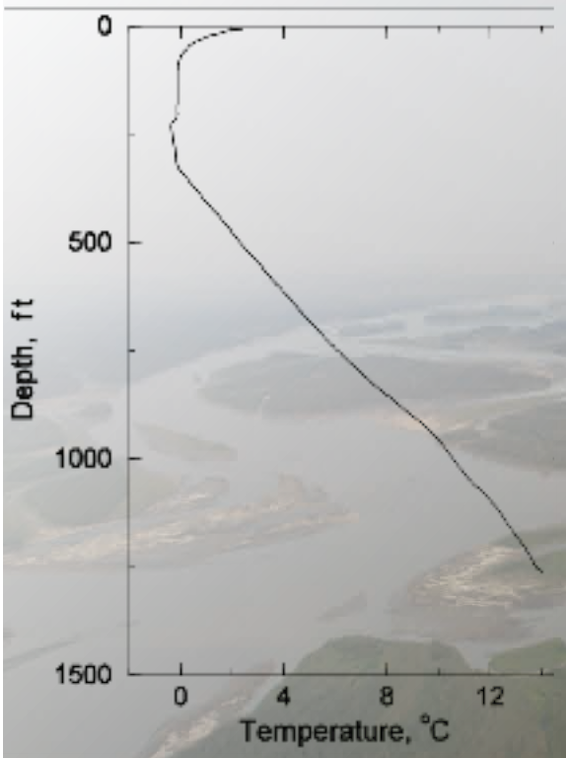
Student population: 116

Fort Yukon, a village with 587 residents (2008 DCCED Certified Population), is located on the north bank of the Yukon River, near its confluence with the Porcupine River, about 233 kilometers (145 miles) northeast of Fairbanks by air. In 1847, while Alaska was still Russian territory, the Hudson's Bay Company of Canada established a trading outpost at this location on the Yukon River. The trading post operated for over 20 years, becoming an important trade center for Gwich'in Athabascans who lived throughout the area. A mission school was built in 1862. After the U.S. purchased Alaska from Russia in 1867 and Fort Yukon was determined to be on American soil, an American company (the Alaska Commercial Company) took over operation of the trading post. The Klondike gold rush brought gold seekers and others down the Yukon River and into the area. By 1898, the Fort Yukon had a post office. Between the 1860s and the 1920s, Gwich'in Athabascans living in and around Fort Yukon suffered major epidemics caused by diseases brought into the country by newcomers. Most residents of Fort Yukon today are Alaska Native or part Native, mostly Gwich'in Athabascan descendants of people from Yukon Flats, Birch Creek, Chandalar River, Porcupine River, and Black River. Traditional subsistence practices are important to the culture of Fort Yukon. The primary employers here are local, state, and federal agencies, the Native corporation, and school. An emergency BLM firefighting base is located here, as well as a U.S. Air Force White Alice radar station, here since the 1950s. Fort Yukon is not on the road system, but the community has 17 miles of local roads. A gravel airstrip allows year-round air transportation, and travel by boat or barge is possible between the end of May and mid-September, when the Yukon River is ice-free. During winter, after freeze-up, the Yukon becomes an ice road between area villages.



Permafrost is present in most of the Fort Yukon area. The highest temperature ever recorded in Alaska occurred in Fort Yukon on June 27, 1915, when it reached 100 °F (38 °C). Until 1971, Ft. Yukon also held the all-time lowest temperature record at -78°F. (-79.8°F (-62°C) at Prospect Creek on January 23, 1971). It has the most annual temperature amplitudal area 100 °C different!!

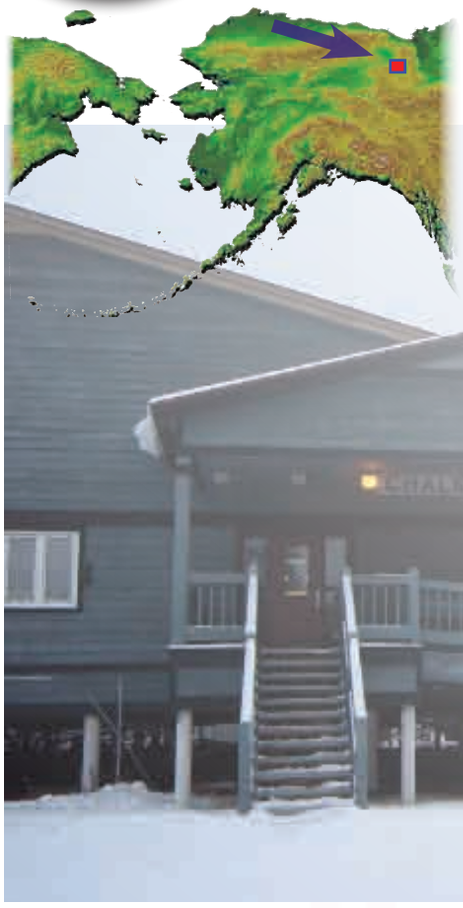
Key Facts (2008):
Annual mean ground temperature: -2.1°C
Freezing days: 258 days
Freezing degree-days: 983°C days
Thawing degree-days: 234°C days



About 350m of permafrst was observed by test well (Clark et al, 2009, Drilling and Testing the DOI-04-1A Coalbed Methane Well, Fort Yukon, Alaska, USGS open file report 2009-1064).

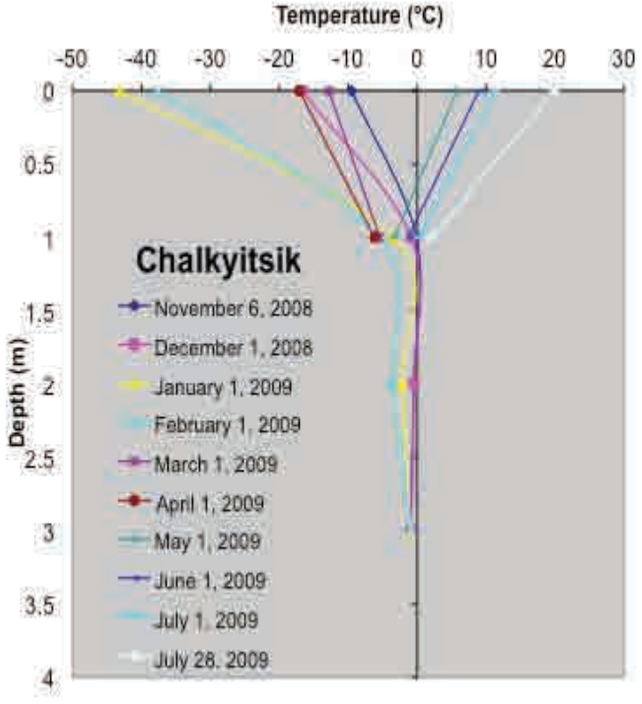
Chalkyitsik

Yukon Flats School District



Student population: 20

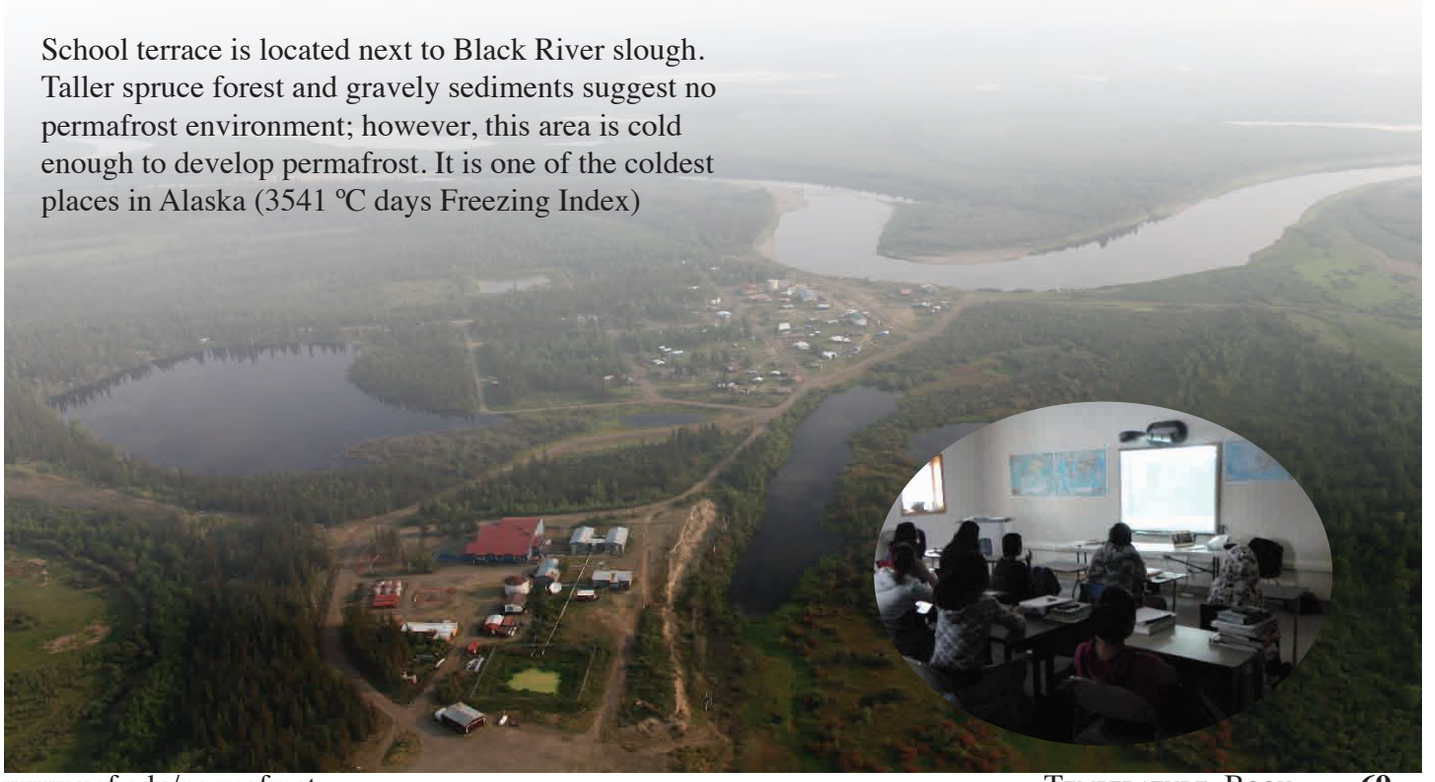
Chalkyitsik, a village with 71 residents (2008 Estimated Population, not Certified), is located on the Black River, 81 kilometers (50 miles) east of Fort Yukon. Archaeological excavations indicate that the area around Chalkyitsik has been inhabited for over 12,000 years. The village name means "fish hooking place," and its location is an important traditional fishing site for Gwich'in Athabascan. Settlement of Chalkyitsik began after a school was built there in the 1930s. The construction materials were actually intended for Salmon Village, many kilometers upriver, but low water forced the boat carrying the supplies to stop at Chalkyitsik and unload. At the time, there were four cabins at this seasonal fishing camp. It was decided that the school should be built at Chalkyitsik, rather than hauling the building materials to Salmon Village. After the school was built, people began to settle in the area. The majority of residents in Chalkyitsik are Alaska Native or part Native, mainly Gwich'in Athabascan. Traditional subsistence practices are important to the way of life here. There is limited employment with the school, village council, health clinic, and government. Sometimes there is seasonal work fire-fighting for BLM. Chalkyitsik is not on the road system, but residents can travel a winter trail to Fort Yukon. The community has a gravel runway for air transportation. The Black River, which is ice-free from mid-June to mid-October, is an important transportation route.

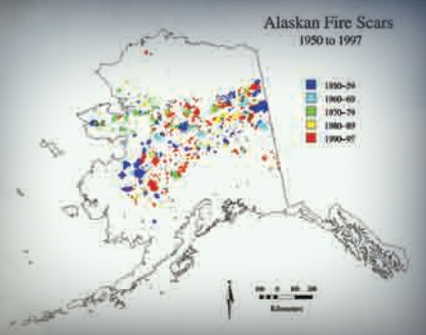


Permafrost conditions in Chalkyitsik are considered similar to Fort Yukon. The area had no glaciated during the ice age and thicker sediment between Black River and Porcupine River. Wild fire is also important permafrost disturbance in here.

Key Facts:
Annual mean ground temperature: nd °C
Freezing days:: 167 days
Freezing degree-days: 3541 °C days
Thawing degree-days: nd °C days

School terrace is located next to Black River slough. Taller spruce forest and gravely sediments suggest no permafrost environment; however, this area is cold enough to develop permafrost. It is one of the coldest places in Alaska (3541 ºC days Freezing Index)





Wild fire!! and how it affects permafrost

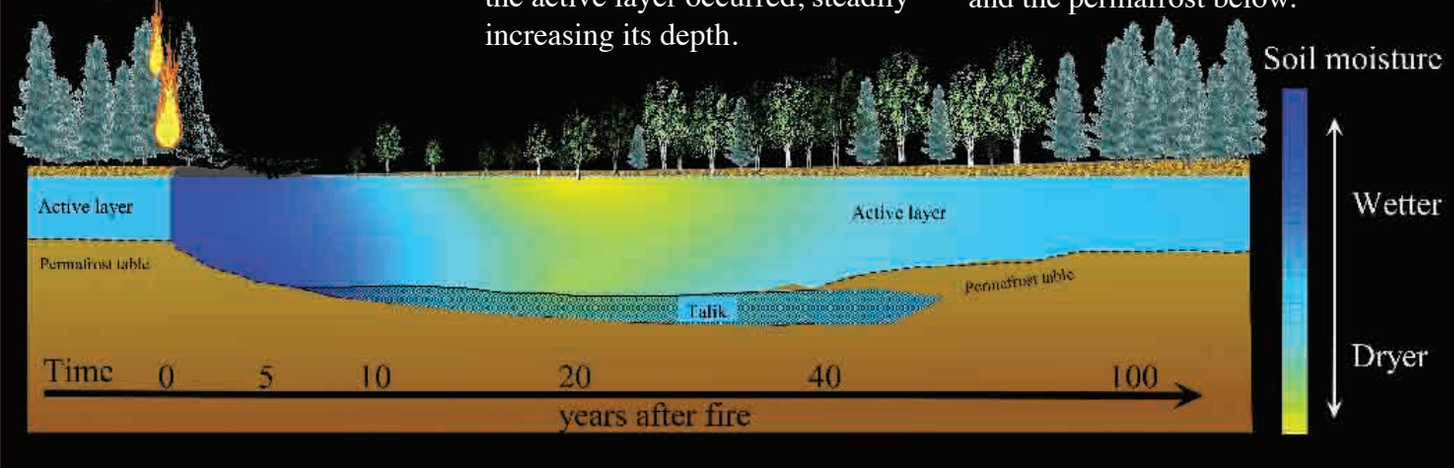
Wildfire impact

Wickersham fire in 1971, 50 km (31 mi) northwest of Fairbanks.
Vegetation at time of fire: black spruce/moss/lichen.

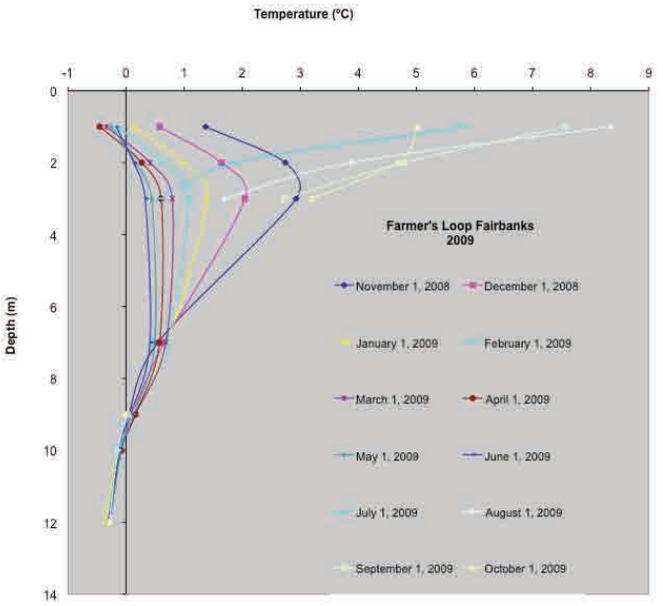
After 17 years: An upper layer of seasonal frost had formed, with an unfrozen layer (talik) between it and the permafrost beneath.

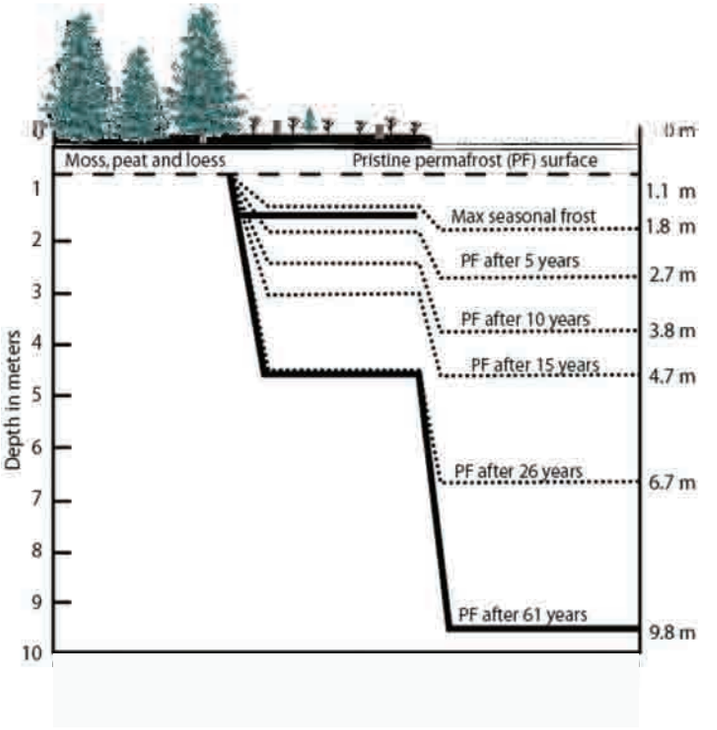
For the first 25 years: Thawing in the active layer occurred, steadily increasing its depth.

Within 32 years: A frozen layer of soil approximately 50 cm (20 in.) thick has formed 1.4 –1.9 m deep within the active layer, with a layer of unfrozen soil (talik) between it and the permafrost below.



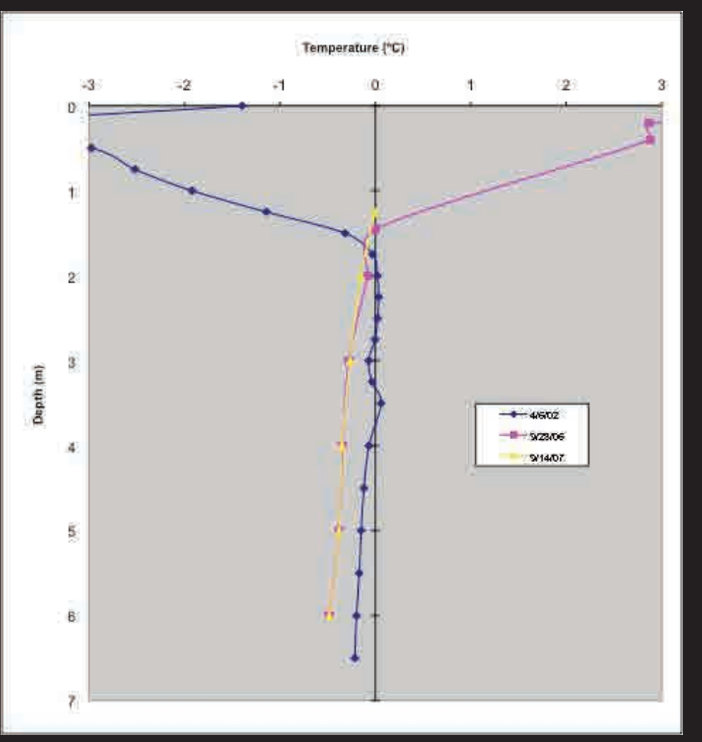
Fairbanks Permafrost Experimental Station:
In 1946, two permafrost study plots were established (called Linell plots).
One plot had vegetation, roots, and organic material completely removed.
The other plot had only trees cut down, leaving smaller plants, roots, and organic material intact.





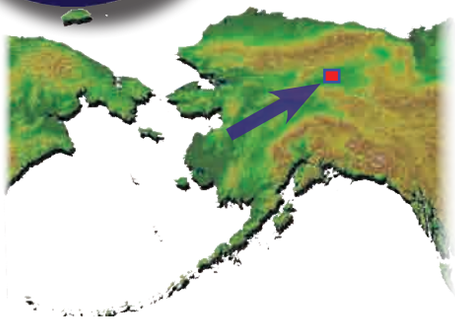
This graph of borehole temperature measurements shows that, 61 years after the Linell plot was completely stripped of vegetation, roots, and organic material, permafrost had stopped thawing at 9.8 m (33 ft) depth.

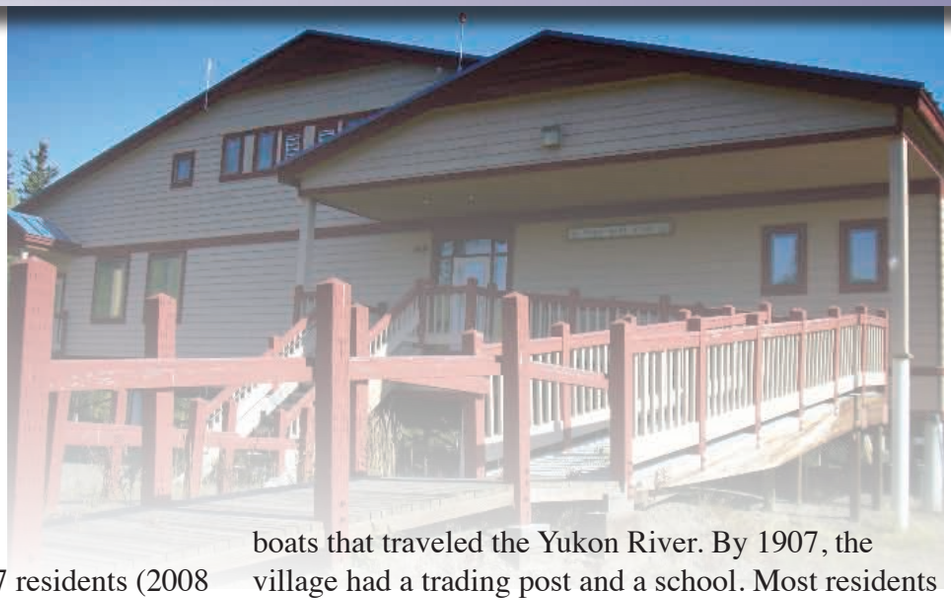
Within 35 years; The talik has disappeared, and the new frozen layer has deepened and joined the permafrost (right graph).
Original permafrost conditions had returned.
Not so at the fireline: Active layer thawing and development of an upper layer seasonal frost zone occurred, but 35 years after the fire, the upper layer of frost was still underwent seasonal freezing and thawing.



Stevens Village

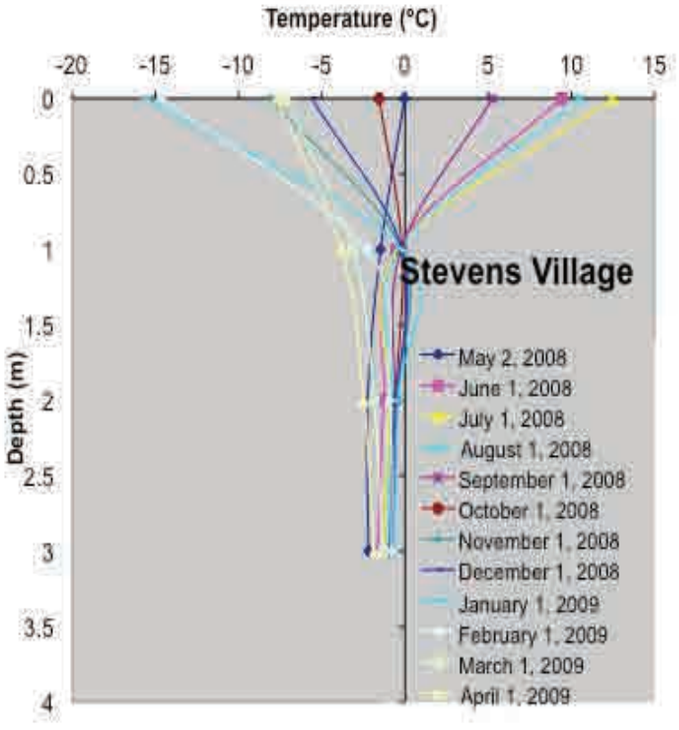
Yukon Flats School District



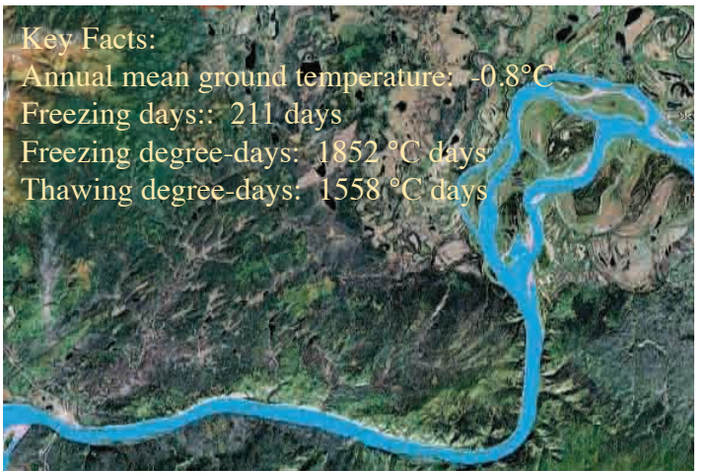


Student population: 13

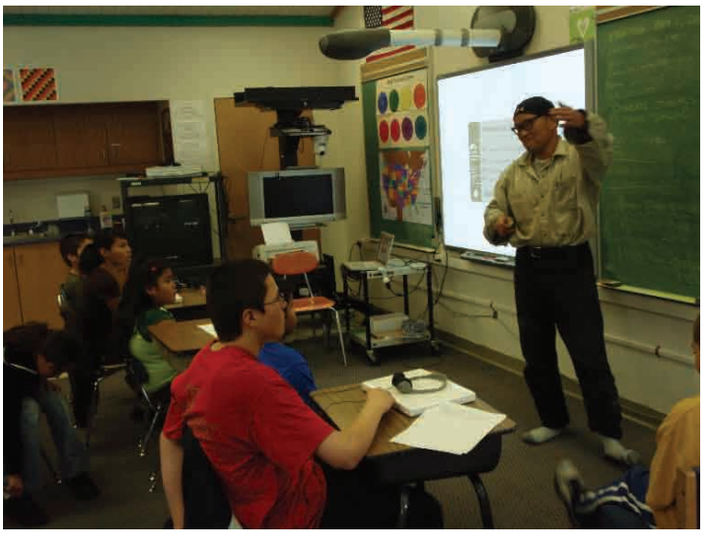
Stevens Village, a community with 57 residents (2008 Estimated Population, not Certified), is located on the north bank of the Yukon River, 27 kilometers (17 miles) upstream of the Dalton Highway bridge. Founded by three Athabascan brothers from the Koyukon region, this settlement was first called Dinyea, which means "mouth of the canyon." In 1902, when the brother named Old Steven was elected Chief, the settlement's name was changed to Stevens Village. During the gold rush, residents of Stevens Village supplied wood to mining operations and to the steamboats that traveled the Yukon River. By 1907, the village had a trading post and a school. Most residents in Stevens Village are Alaska Native or part Native, mainly Kutchin Athabascan. Subsistence activities are important in providing food. Seasonal and part-time employment includes work with the school, clinic, village council, and stores, and firefighting and construction work. Stevens Village is not on the road system, but it has a lighted gravel runway for air transportation. Fuel and supplies arrive by barge between the end of May and mid-September, when the Yukon River is ice-free.



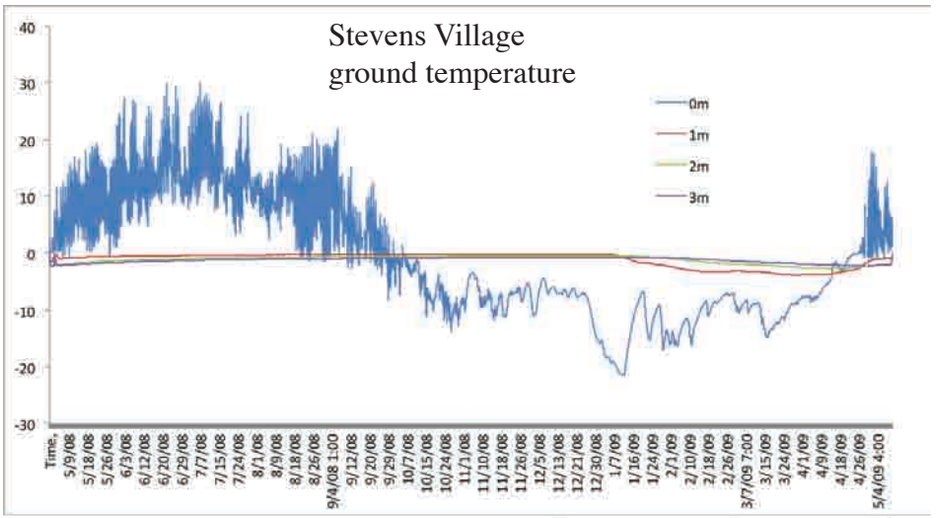
Stevens Village is located near the lowest temperature record holding place in Alaska,where the mercury fell to -79.8° F (-62° C) at Prospect Creek in 1971. Permafrost is present, there are also several hot springs near Kanuti Flat, Rampart, whitch possibly causes higher ground heat flow.



Stevens Village is located west end of Yukon Flat near Eliot Highway along the Yukon River. Yukon Flat is one of the largest fluvial deposits area in Alaska, approximately 23,000 sq. km in extent.



Multiage students discuss and install the frost tube and the temperature monitoring station next to the school yard.



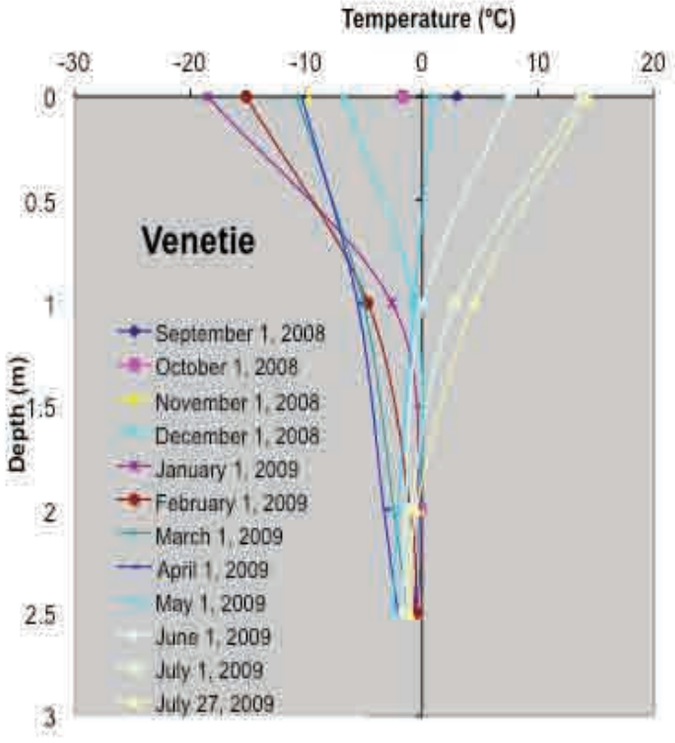
Venetie

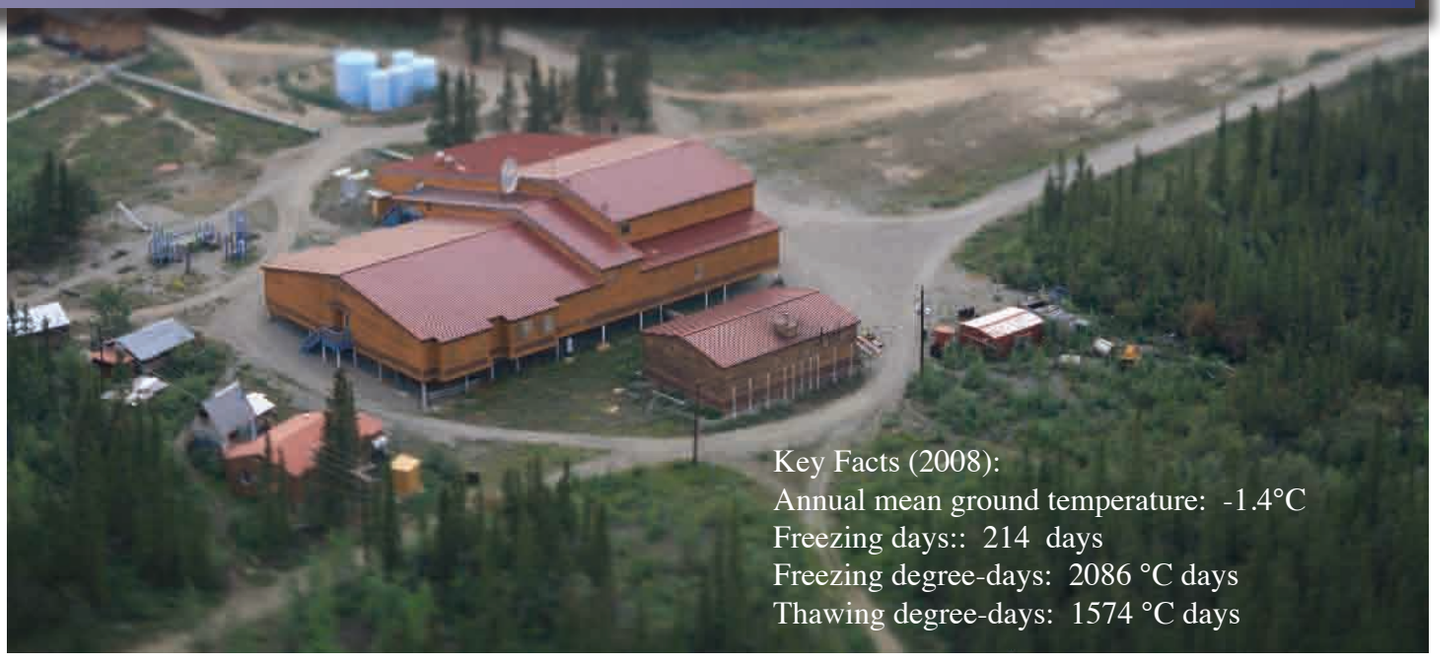
Yukon Flats School District

Student population: 48

Venetie, a village with 177 residents (2008 Estimated Population, not Certified), is located on the north side of the Chandalar River, northwest of Fort Yukon. Athabascans lived along the river and throughout the area, traveling for various food sources. In 1895, a man named Old Robert founded Venetie, settling because the area was rich with fish and game. By 1905, Venetie had a population of nearly 30 residents. After gold was discovered in the Chandalar region in 1906–07, many miners moved into the area upriver from Venetie, at the Caro mine. The mine, which played out within about four years, was nearly abandoned afterward. The Venetie Indian Reservation was established in 1943. At about the same time, a school was opened, which led more families to settle in Venetie. The community gained title to its land after the Alaska Native Claims Settlement Act. Most residents of Venetie are Alaska Native or part Native, mainly descendants of the Neets'ai Gwich'in, and the Gwichyaa and Dihaii Gwich'in. Traditional subsistence activities are an important source of food for people living here. Employment includes work with the school, clinic, post office, store, and village council. Some residents are BLM firefighters during the summer. Venetie, which is not on the road system, is accessed mainly by plane. The community has a dirt/gravel airstrip. Boats travel the Chandalar River from May to October, while it is ice-free. The river is too shallow for barge travel.

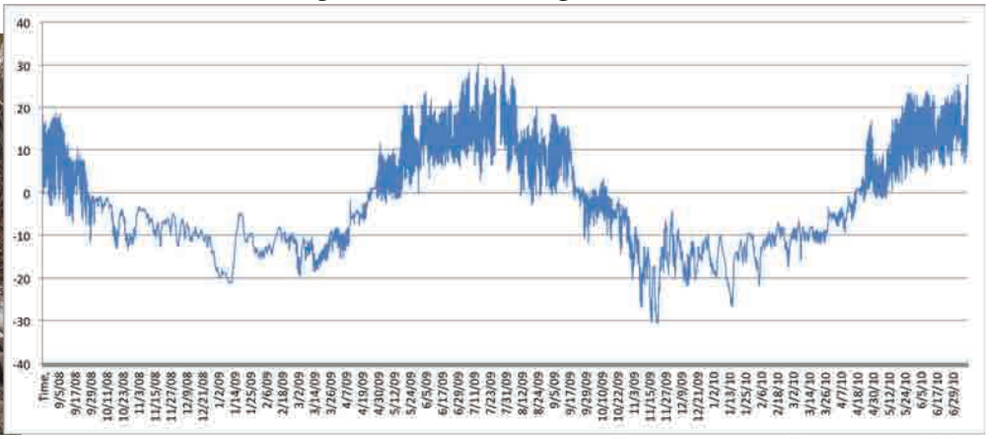
Venetie village located over permafrost; however, low ice content and gravel sediments cause thicker annual temperature amplitude depth. Even at 2.5m depth, the temperature still fluctuated 2-3 ºC.





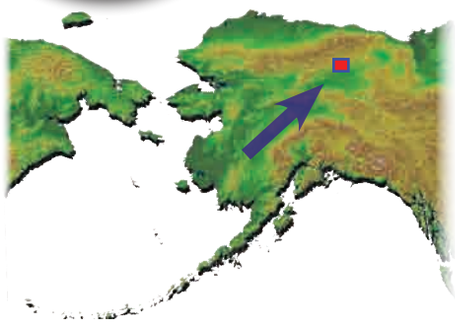
The school is located on the old runway. Most of the land was disturbed before the new airport build. A nice, small, black spruce forest was used for the temperature station and frost tube.

Venetie (2 years)
ground surface temperature



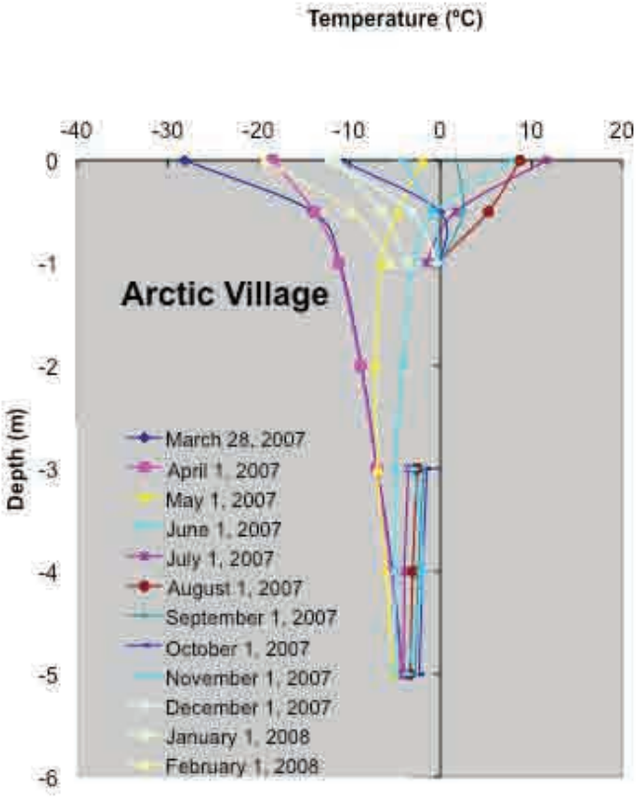
Arctic Village

Yukon Flats School District



Student population: 32

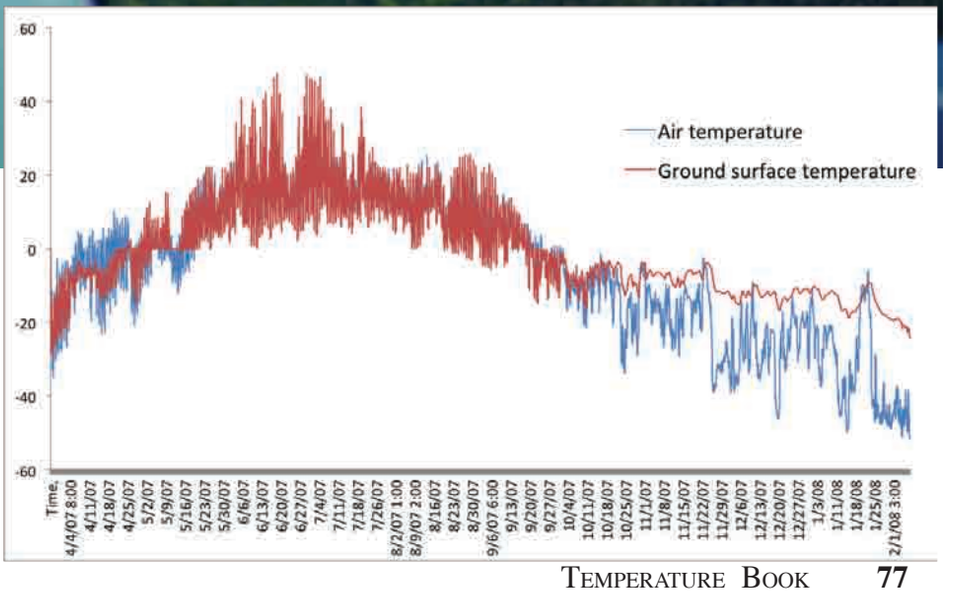
Arctic Village, a village with 158 residents (2008 Estimated Population, not Certified), is located on the east fork of the Chandalar River, 161 kilometers (100 miles) north of Fort Yukon and about 467 kilometers (290 miles) north of Fairbanks. Archaeological evidence indicates that people have lived in the surrounding area for over 6,500 years. Historically, this is home to the Neets'aii Gwich'in ("residents of the north side"). The people led a highly nomadic way of life, using seasonal camps and semi-permanent settlements as they hunted and fished for food. The Neets'aii Gwich'in traded with the coastal Inupiat to the north. Permanent settlement at Arctic Village began around 1909. The village had a school by 1959. Most residents of Arctic Village are Alaska Native or part Native, mainly Neets'aii Gwich'in. A traditional subsistence way of life is predominant in the community. There is some seasonal employment in construction and firefighting. Arctic Village is not connected to the road system, but has a gravel airstrip that permits year-round air transportation.



Arctic village has colder permafrost (-3 ºC) on the southern side of Brooks range. But permafrost may be more shallower than in the Fort Yukon Area (>300m) because the area was glaciated during the last ice age.

Typical glaciated area still have much buried glacier ice in the permafrost. Once exposed and eroded, big amount of suspended solids run to the river system. In the summer of 2011, village residents observed high levels of suspended sediments in the Chandalar River.
What caused an Arctic river to run red?
(by Craig Medred, Jul 13, 2011 @ Alaska Dispatch)
Chandalar River runs red, alarms villagers
(by By Dorothy Chomicz/dchomicz, Jul 12, 2011
@Fairbanks Daily News-Miner)

Key Facts :contact Kenji Yoshikawa
Annual mean ground temperature: nd°C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days



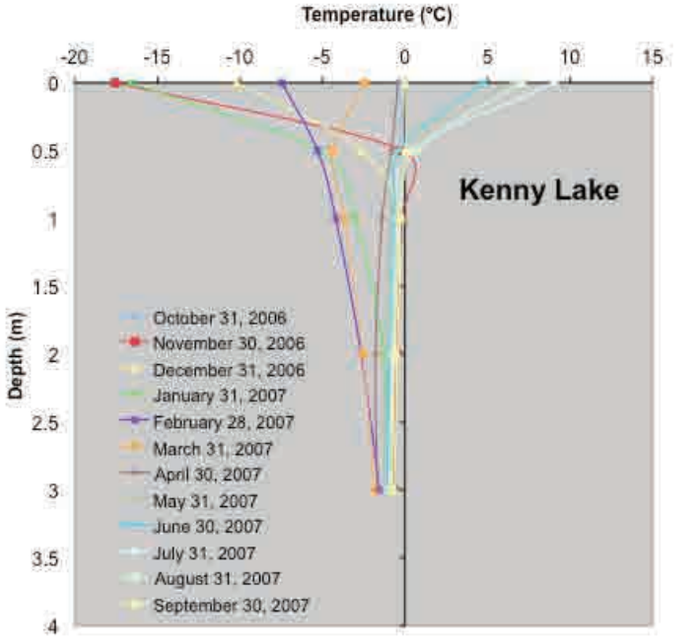
Kenny Lake

Copper River School District

Southern limit of permafrost along the Copper River

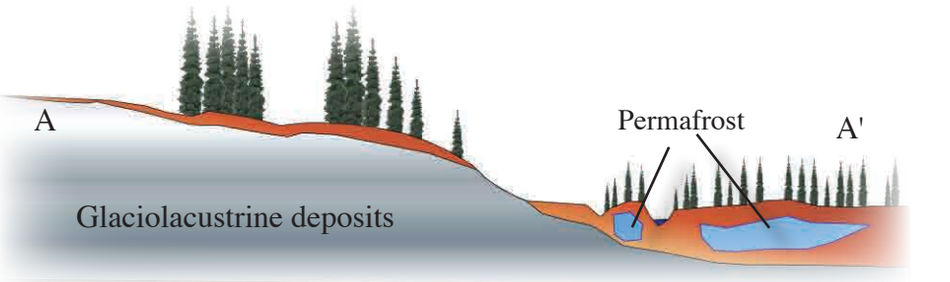
Student population: 107

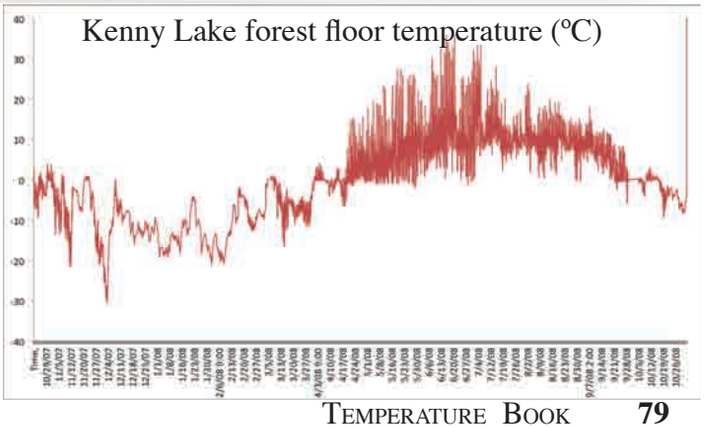
Kenny Lake, a village with 355 residents (2010 U.S. Census), is located between Mile 1 and 22 on the Edgerton Highway, a road that intersects with the Richardson Highway south of Copper Center. Historically the home of Ahtna Athabascans, a number of homesteaders moved here in the 1960s because of the land's agricultural potential. Some homesteaders stayed to farm their land, while others, after fulfilling the requirements to obtain land ownership, subdivided their homesteads and sold the property. Presently, the community is considered agricultural, with hay, vegetable, and cattle farms. Residents find work at the school and in local businesses. When the Edgerton Highway was upgraded in the 1970s, part of the route changed, so some of Kenny Lake settlement is located off the Old Edgerton Highway, which before had been the only road into the community. In addition to highway access, landing strips nearby allow air access.



Kenny Lake is located at the southern limit of both the boreal forest and the discontinuous-permafrost zone. In general, permafrost is present in thicker silty materials, as seen along Willow Creek. Several patches of permafrost are observed in the valley south of Pump Station 12 along the oil pipeline. Mountain permafrost and rock glaciers are commonly seen in the Chugach Mountains.

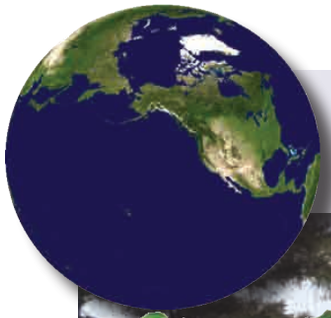
Kenny Lake is located on thick deposits of glaciolacustrine sand and gravel. Permafrost is present only in the silty valley bottom.





Key Facts:
Annual mean ground temperature: 0.8°C
Freezing days:: 198 days
Freezing degree-days: 1128 °C days
Thawing degree-days: 1409 °C days

www.uaf.edu/permafrost

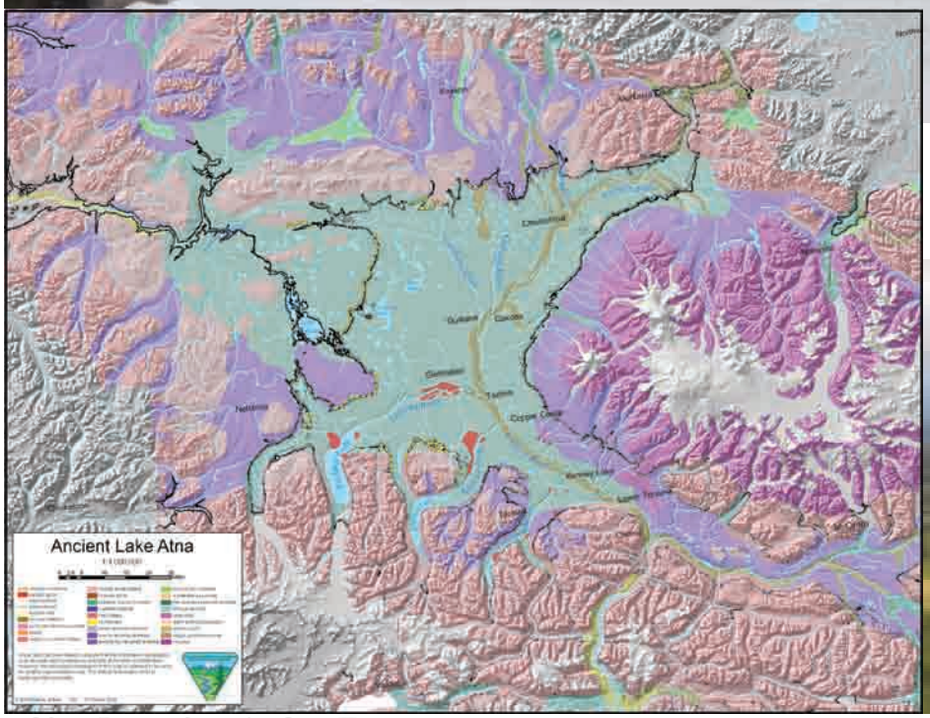


Slana

Copper River School District

Student population: 15

Slana, a village with 147 residents (2010 U.S. Census), is located along Nabesna Road, which heads southeast from the Tok Cutoff Highway at mile 63. The village is near where the Slana River meets the Copper River. In 1923, the Nabesna Mine opened, operating irregularly for about twenty years. Though mostly gold was mined there, other minerals were extracted as well. When the federal government opened the area for homesteading in the 1980s, Slana grew quickly. The community has an auto repair shop and a roadside lodge, general store, gas station, liquor store, and canoe rental business. The Tok Cutoff Highway connects with both the Richardson and Alaska Highways, and the nearest public airstrip is at Chistochina.



The maximum possible extent of Lake Atna's 975 m lake surface elevation is at Slana.

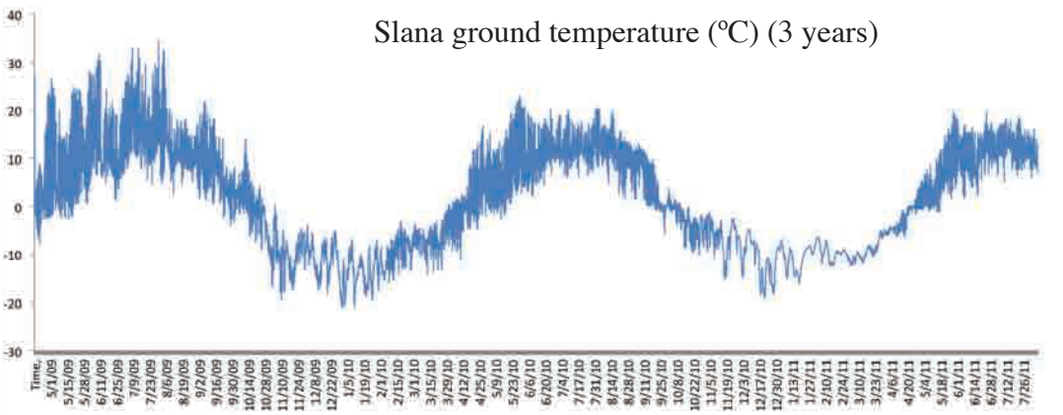
In 1898, Frank Schrader of the U.S. Geological Survey found fine sediments in the center of the Copper River Valley that suggested that an "inland lake" or an "arm of the sea" drowned the lowlands that now include the towns of Glennallen, Gulkana, Copper Center, and Tazlina. Since Schrader's exploration, geologists have found traces of old shoreline at today's 2,400-to-2,500-foot elevations.

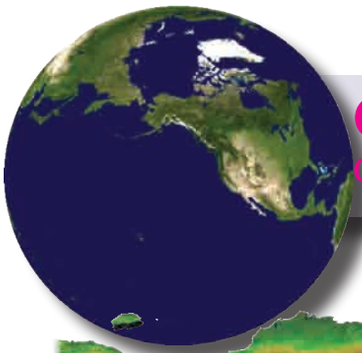
During its lifetime, about 30,000 to 10,000 years ago, Lake Atna probably covered about 2,000 square miles of the floor in the Copper River Basin, according to a USGS paper Oscar Ferrians wrote in 1989. At Atna's high-water mark, when glacial tongues stuck into it from every direction, the lake was larger than Delaware.

Lake Atna lived and died at the whims of great icefields. When the climate was cold enough for glaciers to dominate the landscape, ice provided an effective dam for Lake Atna. When ice receded, especially glaciers that acted as gates for the Copper River—such as the Allen, Miles and Childs —the lake drained to the Gulf of Alaska. Records of ancient peat moss suggest this last happened about 10,000 years ago.

Key Facts:
Annual mean ground temperature: -0.2°C
Freezing days:: 183 days
Freezing degree-days: 1660 °C days
Thawing degree-days: 1591 °C days

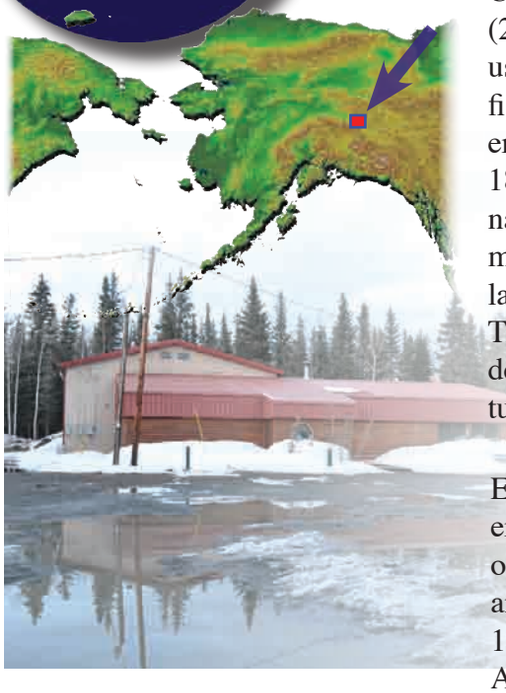
Slana ground temperature (ºC) (3 years)





Chistochina/ Gakona

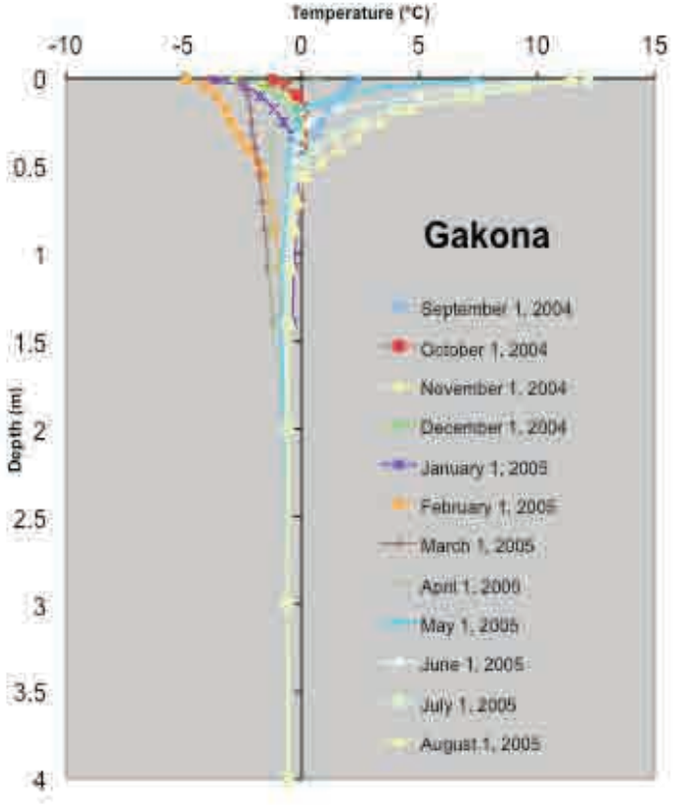
Copper River School District



Student population: 11

Chistochina, a Copper River Athabascan Indian village with 93 residents (2010 U.S. Census), is located off the Tok Cutoff Highway. Athabascans used this site, located near two other rivers and two creeks, as a seasonal fish camp. The location was also a convenient stopover place for traders and trappers. The Valdez–Eagle Trail, built by gold miners in the late 1800s, passes near the village. The trail was used by the U.S. Army Signal Corps in the early 1900s to establish a telegraph line to Eagle. Gold miners worked the upper Chistochina River and nearby waterways, and land was later opened to homesteading. Most employment is seasonal. Traditional subsistence activities are vital to the local culture and to residents' livelihood. The village is accessible year-round by road, and has a turf/gravel airstrip for small aircraft.

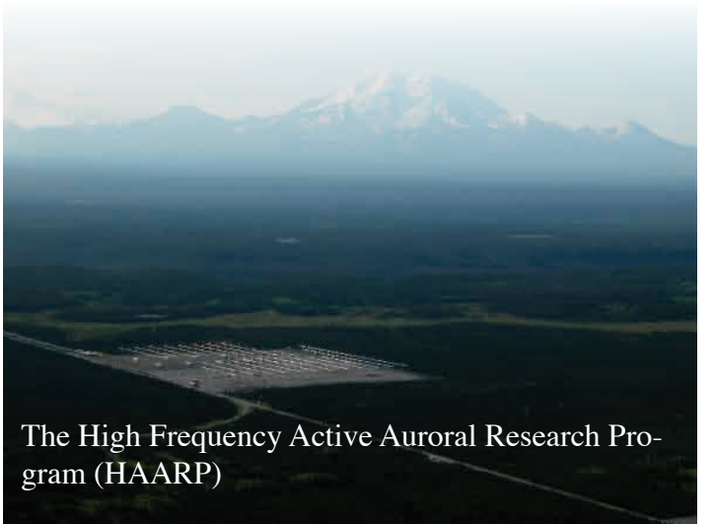
Gakona, a community with 224 residents (2011 Alaska Dept. of Labor Estimate), is located at the confluence of the Copper and Gakona Rivers. By road, it is northeast of Glennallen, about 3 kilometers (2 miles) on the Tok Cutoff Highway. Ahtna Athabascans used this site as a wood and fish camp before settling here permanently. A roadhouse was built in 1904 to serve travelers on their way from Valdez to Eagle and Fairbanks. A stagecoach station and blacksmith shop served the travelers as well. Residents work at local businesses, some of which benefit from seasonal tourist activity.



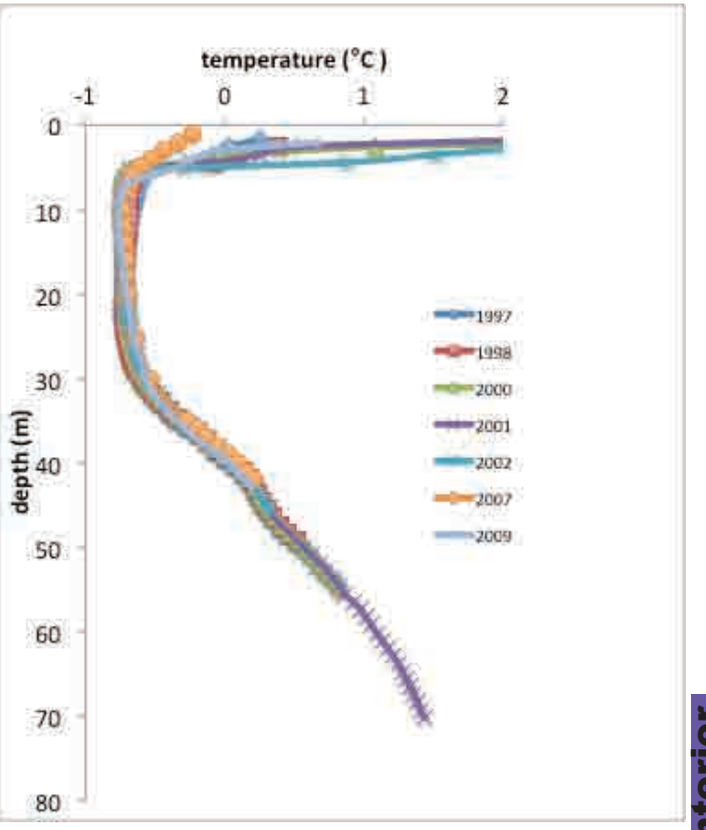
The High Frequency Active Auroral Research Program (HAARP) temperature site, located near Gakona, is a scientific endeavor to study the properties and behavior of the ionosphere, with particular emphasis on understanding and using it to enhance communications and surveillance systems for civilian and defense purposes.

The school in Gakona was closed in 2007. Since then the school building has been used for the community.

Key Facts (2009):
Annual mean ground temperature: 0.6°C
Freezing days:: 180 days
Freezing degree-days: 1422 °C days
Thawing degree-days: 1637 °C days



The High Frequency Active Auroral Research Program (HAARP)

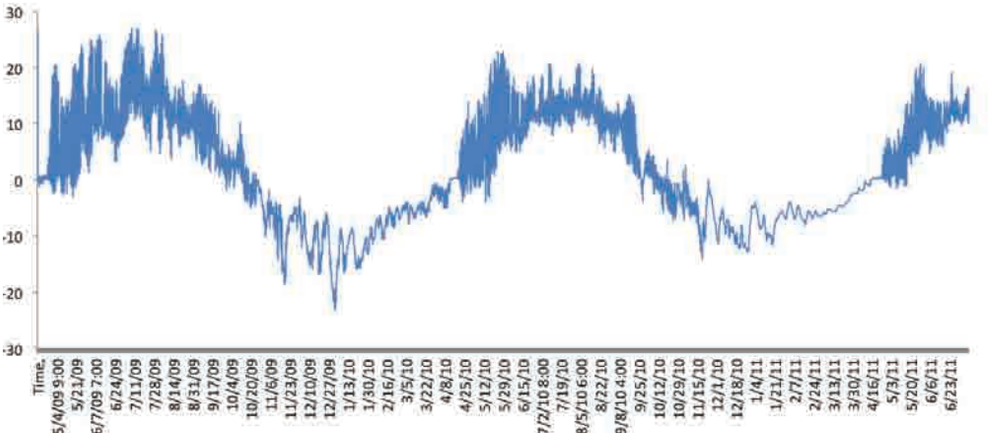


The Alaska Department of Transportation and Public Facilities drilled a deep permafrost temperature-monitoring site near the Gulkana Airport in 1985. Since then, UAF researchers have monitored the temperatures here. The thickness of permafrost is 39 m. The temperature gradient, which changes sharply at around 35 m below ground surface, reflects different thermal conductivity.

http://permafrost.gi.alaska.edu/

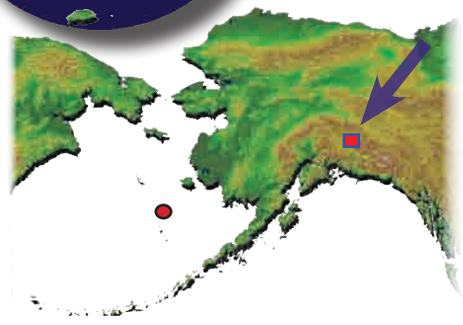
Gakona roadhouse

Chistochina ground temperature (ºC) (3 years)



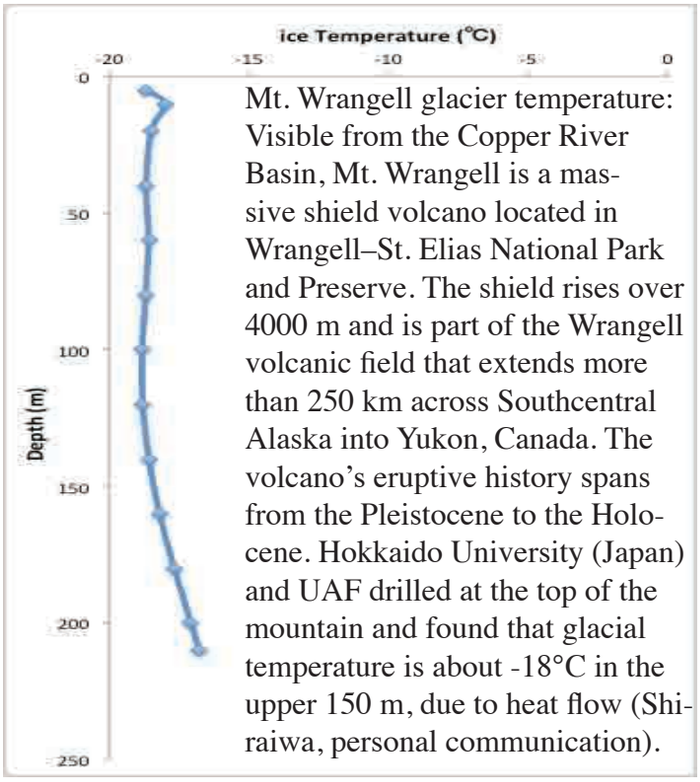
Copper Center

Copper River School District



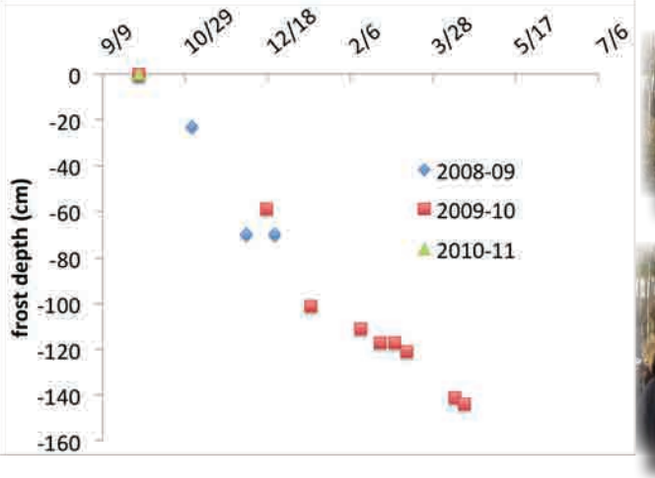
Student population: 39

Copper Center, a community with 328 residents (2010 U.S. Census) situated on the west bank of the Copper River, is about 163 kilometers (101 miles) north of Valdez along the Richardson Highway. Ahtna Athabascans have lived throughout this area and the Copper River Basin for thousands of years. The Trail of '98, a route into Interior Alaska used by gold prospectors, passed nearby. In 1896, a roadhouse built by Ringwald Blix developed into a supply point for miners working the Nelchina–Susitna region. By 1905, the community had a post office, telegraph station, and school. With its location along the river and highway and its proximity to the Wrangell–St. Elias National Park, Copper Center's economy is related to travel, fishing, and tourism.



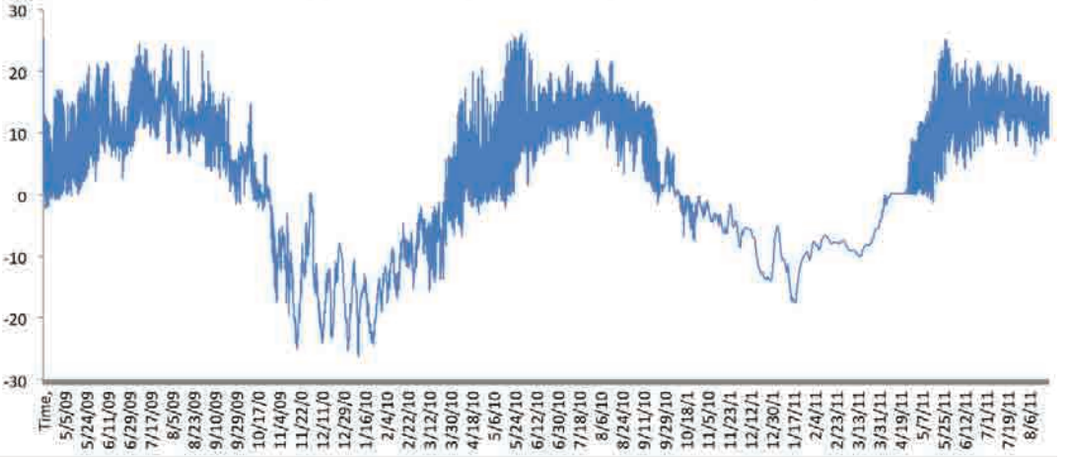
Mt. Wrangell glacier temperature: Visible from the Copper River Basin, Mt. Wrangell is a massive shield volcano located in Wrangell–St. Elias National Park and Preserve. The shield rises over 4000 m and is part of the Wrangell volcanic field that extends more than 250 km across Southcentral Alaska into Yukon, Canada. The volcano's eruptive history spans from the Pleistocene to the Holocene. Hokkaido University (Japan) and UAF drilled at the top of the mountain and found that glacial temperature is about -18°C in the upper 150 m, due to heat flow (Shiraiwa, personal communication).

Key Facts (2009):
Annual mean ground temperature: -0.1°C
Freezing days:: 200 days
Freezing degree-days: 1924 °C days
Thawing degree-days: 1905 °C days



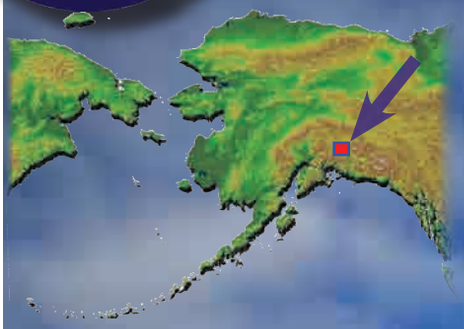
An intense frost tube study was carried on at the Copper Center School to better understand the seasonal frost layer thickness. Maximum frost depth was 120 cm in April 2008 and April 2009.

Copper Center ground temperature (ºC) (3 years)



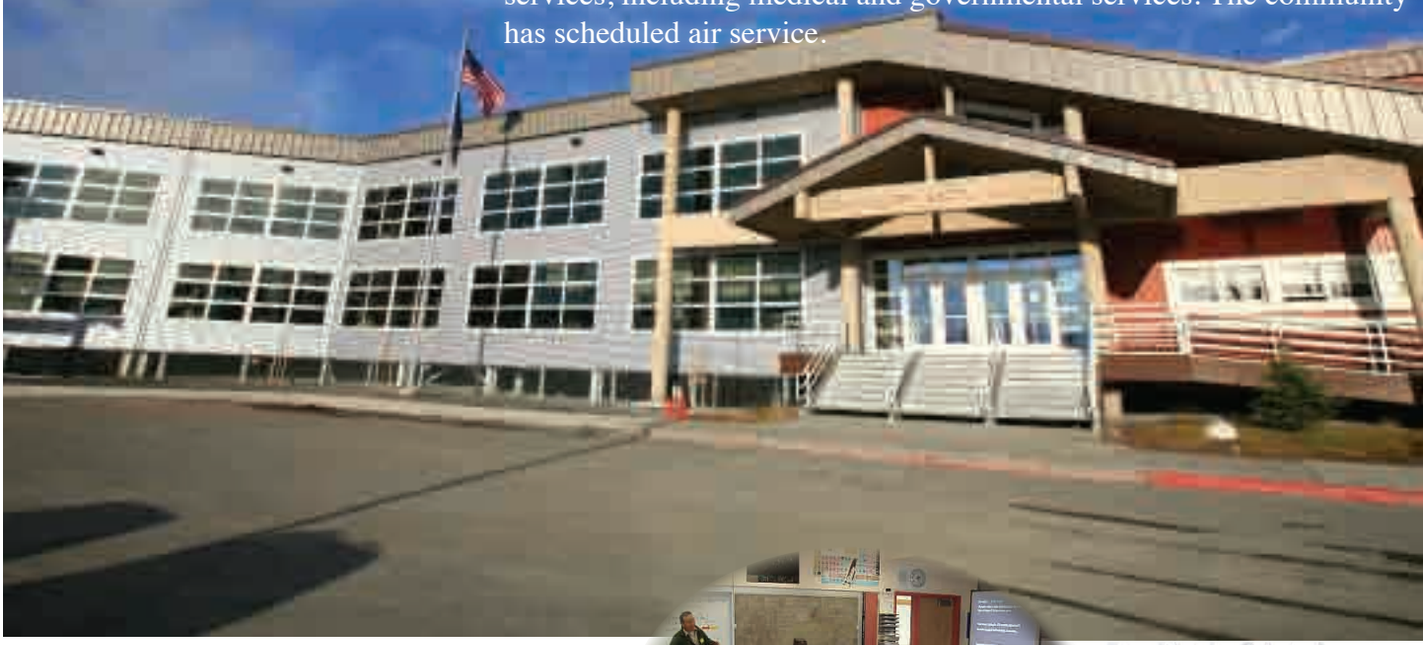
Glennallen

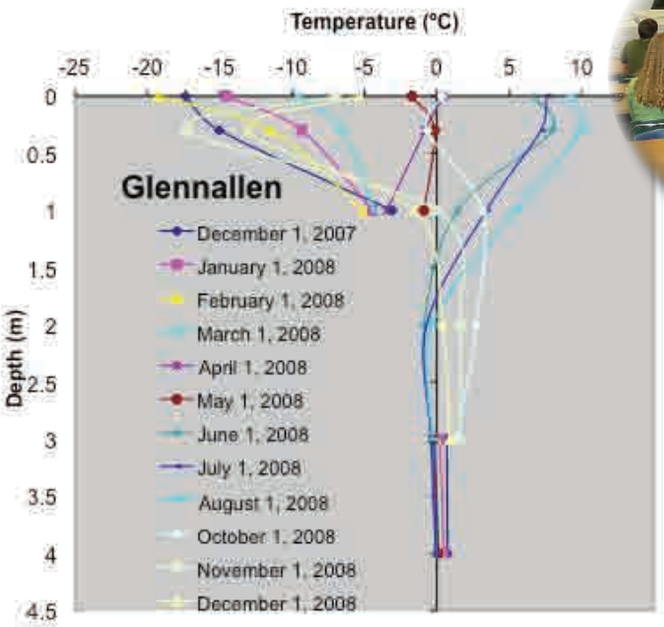
Copper River School District



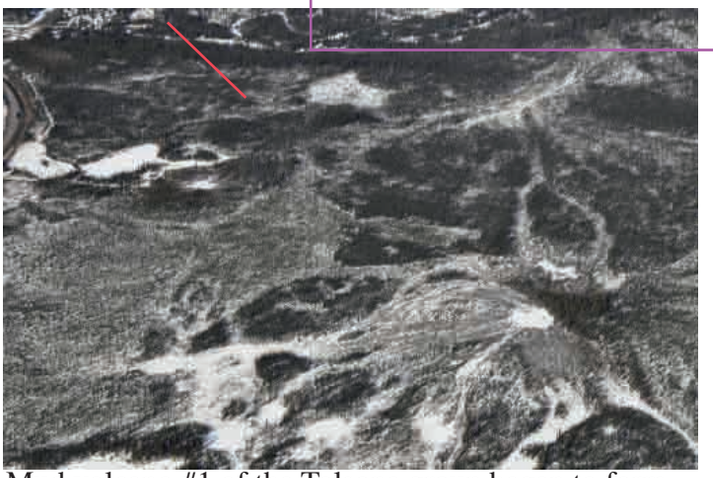
Student population: 307

Glennallen, a community with 483 residents (2010 U.S. Census), is located along the Glenn Highway, near its intersection with the Richardson Highway. The town developed around a campsite of the same name, used in the early 1940s during construction of the Glenn Highway. The campsite was named for Major Edwin Glenn and Lieutenant Henry Allen, members of the U.S. Army who led explorations into the Copper River Basin in the late 1800s. Because of Glennallen's location along major road-transportation routes, many services and businesses have developed to assist highway travelers. Glennallen is a central point in the Copper River region for supplies and services, including medical and governmental services. The community has scheduled air service.





Country of two different mud volcanoes

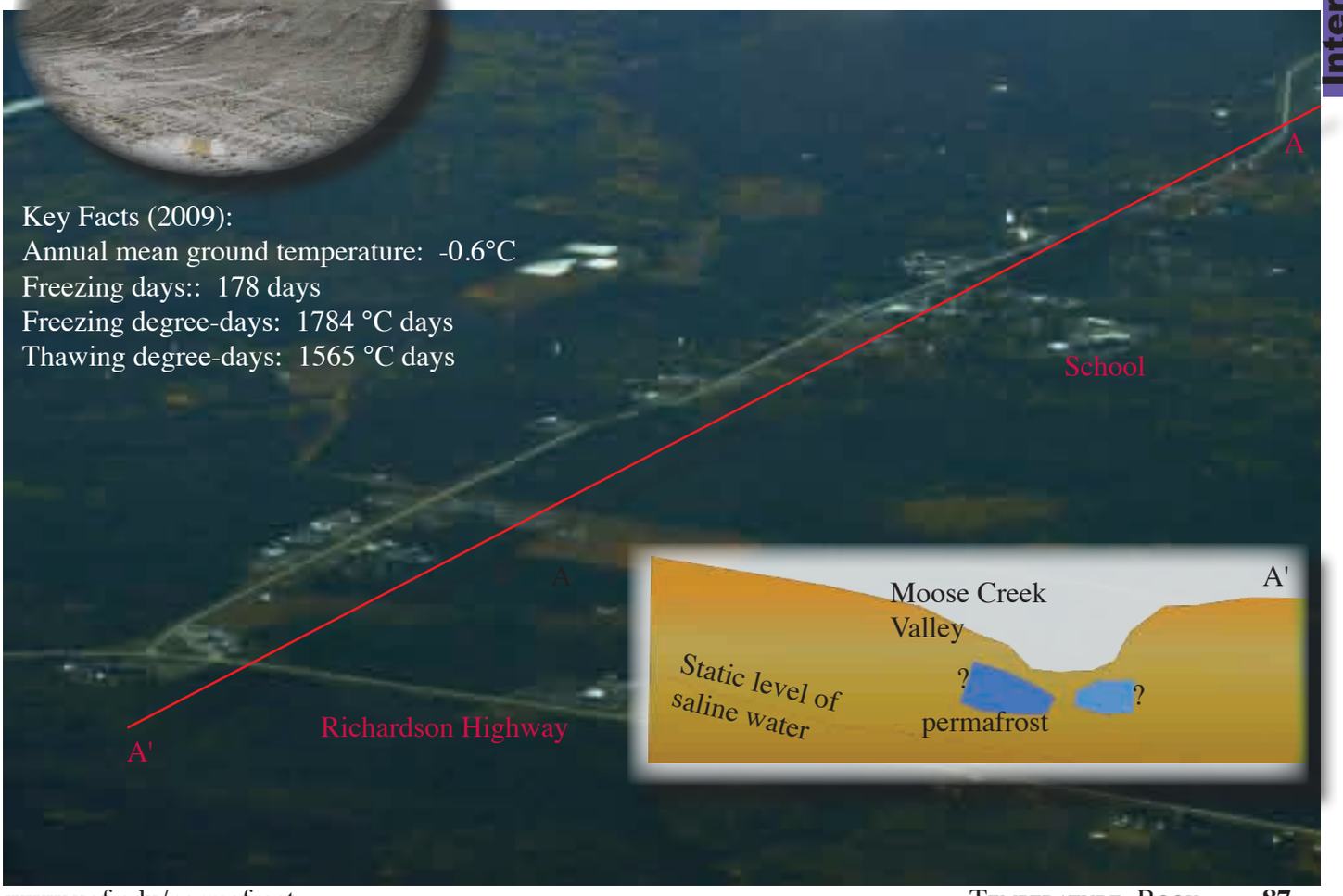


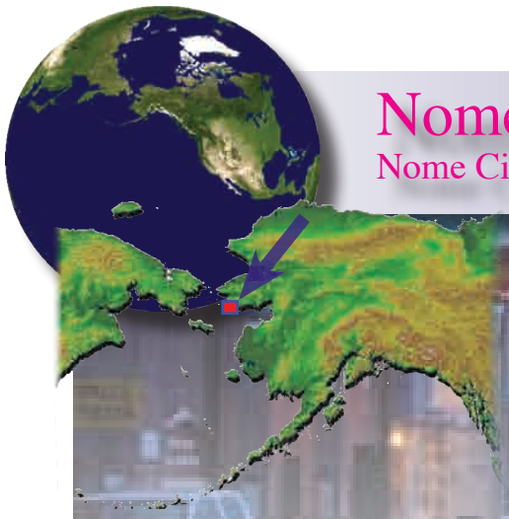
Mud volcano #1 of the Tolsona group began to form 6500 years ago.

Mud volcanoes and saline (mineral) springs are found throughout the Glennallen area. Mud volcanoes form small crater ponds at their low, broad cone-shaped tops.

Buried glacier ice was found at Lake Louise in 2010.

Key Facts (2009):
Annual mean ground temperature: -0.6°C
Freezing days:: 178 days
Freezing degree-days: 1784 °C days
Thawing degree-days: 1565 °C days



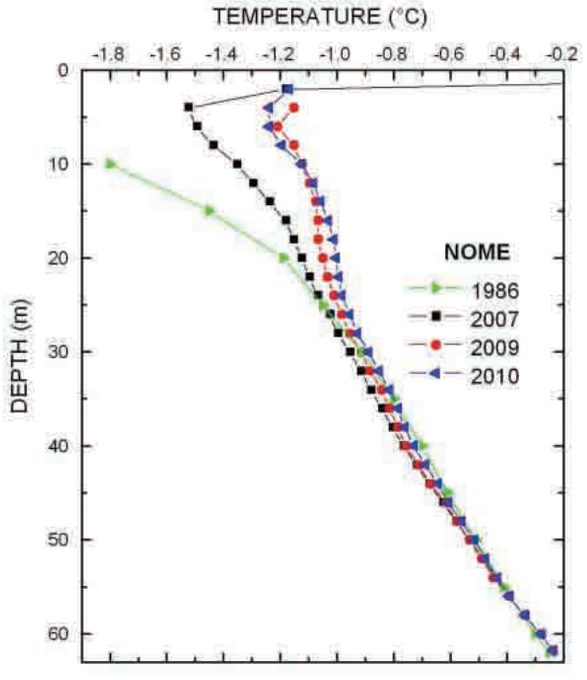


Nome

Nome City Schools District

Student population: 683

Nome, a town with 3,570 residents (2008 DCCED Certified Population), is located on the south coast of the Seward Peninsula, along the shore of Norton Sound, an inlet of the Bering Sea. Historically, the Seward Peninsula has been home to the Malemiut, Kauweramiut, and Unalikmiut. Though gold discoveries were reported as early as 1865 by surveyors for a telegraph route through Alaska to the Bering Sea, it was 1898 before a gold strike on nearby Anvil Creek brought gold prospectors into the area. Gold was found in creeks and in sand along the beach. The area's population swelled to 20,000 individuals. By 1901, the community had rail access and a telephone line to Anvil Creek, and the City of Nome had been formed. As the more easily worked claims were depleted, large mining companies with efficient equipment moved into the area. Several events in the first half of the twentieth century reduced Nome's population, including depletion of gold, the 1918 influenza epidemic, the Great Depression, and World War II. Most of the town was destroyed by fire in 1934. Gold mining continues today. Over the years, Nome has developed into the Bering Strait regional center for supplies, services, and transportation. The community has scheduled jet flights and a port facility. Though not on the state road system, Nome has local roads that connect it to Teller, Council, and the Kougarok River. The finish line for the annual Iditarod Sled Dog Race is in Nome. The town's population is a mix of Alaska Natives or part Native, mainly Inupiat, and non-Natives. There are five schools in Nome.



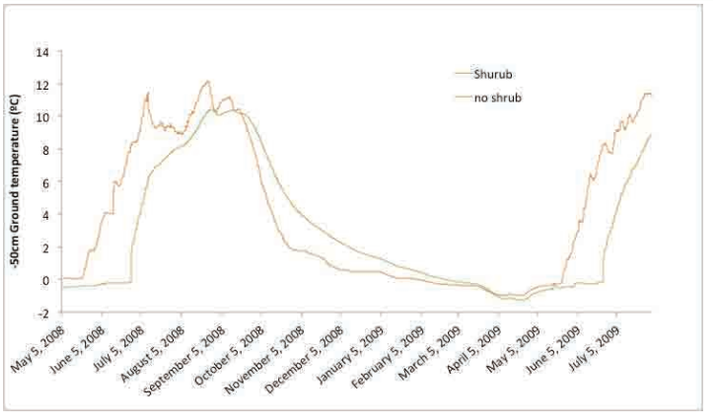
http://permafrost.gi.alaska.edu/

Many closed system pingos are seen along the Kougaruk Road

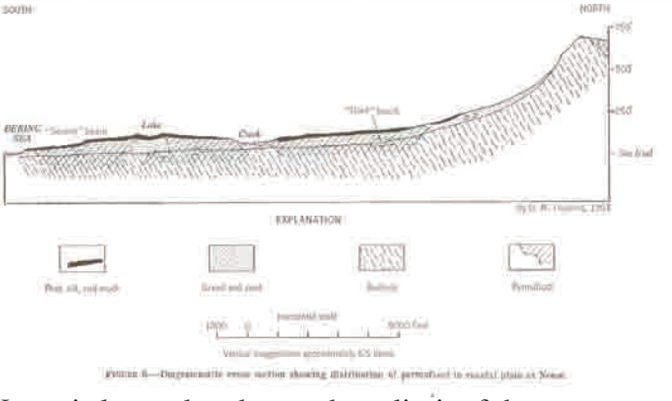
Port of Nome is located at the mouth of Snake River

Key Facts:
Annual mean ground temperature: -2.8°C
Freezing days: 206 days
Freezing degree-days: 2321°C days
Thawing degree-days: 1300°C days

Beautiful Soliflaction lobes are seen along the Council Road



Ground temperature of our Nome site (next to Charter School) is strongly affected by the shrub distribution, because shrubs accumulate wind-blown snow. Thicker snow banks next to the shrubs keep the ground surface warmer.



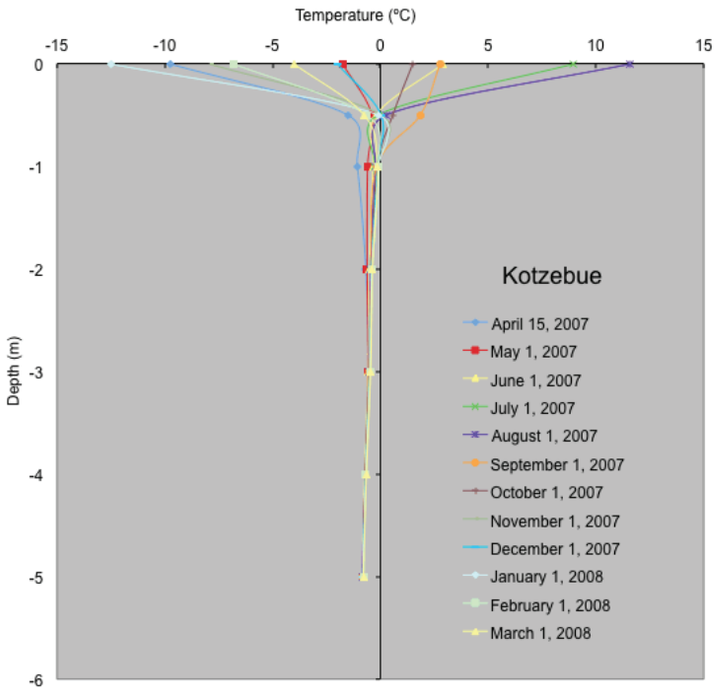
Nome is located at the southern limit of the continuous permafrost zone. In general, permafrost is present in thicker organic (muck) or silty materials, but, absent on southern facing slopes and also places where intensively disturbed ground surface was by the gold mining activity at “Second” and “Third Beaches”.

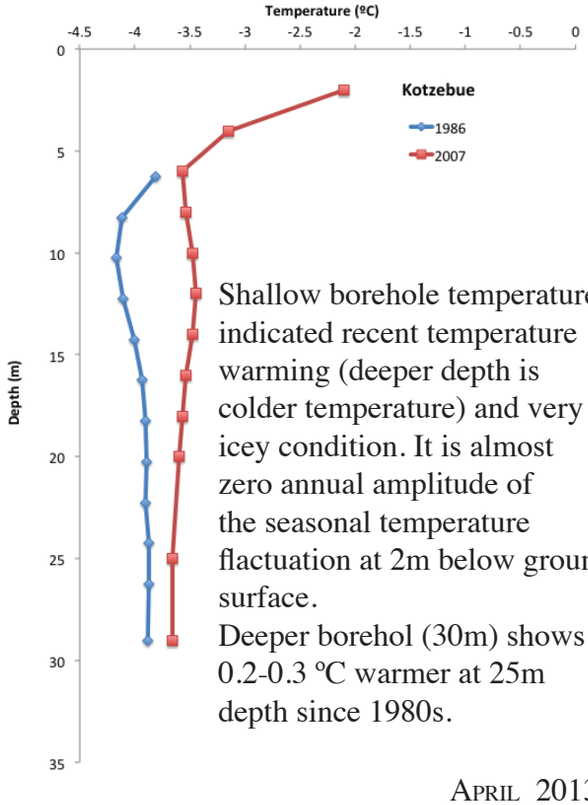
Kotzebue

Northwest Arctic Borough School District

Student population: 771

Kotzebue, a town with 3,126 residents (2008 DCCED Certified Population), is located on the northwest shore of the Baldwin Peninsula in Kotzebue Sound. The community lies north of the Arctic Circle, about 884 kilometers (549 miles) by air northwest of Anchorage. For at least 600 years, Inupiat have occupied the site on which Kotzebue is built. The site's name is Kikiktagruk, and it served as a central point for trading because of its location on the coast and near the mouth of rivers that lead to inland villages. The name Kotzebue comes from that of Lt. Otto Von Kotzebue, who in 1818 sailed into the sound while exploring for Russia. When a post office was established in the village 81 years later, the name Kotzebue identified its location. More than three-quarters of the population in Kotzebue is Alaska Native or part Native, mostly Inupiat. Over the years, Kotzebue has developed into a center for service and transportation for villages in Alaska's northwest region. The community has two schools, as well as a hospital. An airport with a paved runway accommodates jet service between Kotzebue and Anchorage as well as air taxis for transportation to villages in the region. From early July to early October, Kotzebue Sound is ice-free for shipping, though the harbor is shallow due to river sediment deposits from the Noatak River. There are 42 kilometers (26 miles) of gravel road in the area. Total annual snowfall averages just over 1 meter (40 inches), and total annual precipitation averages 23 centimeters (9inches).

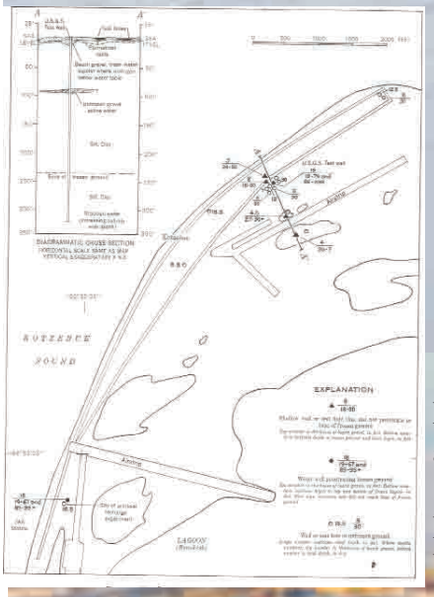




Shallow borehole temperature indicated recent temperature warming (deeper depth is colder temperature) and very icey condition. It is almost zero annual amplitude of the seasonal temperature flactuation at 2m below ground surface.

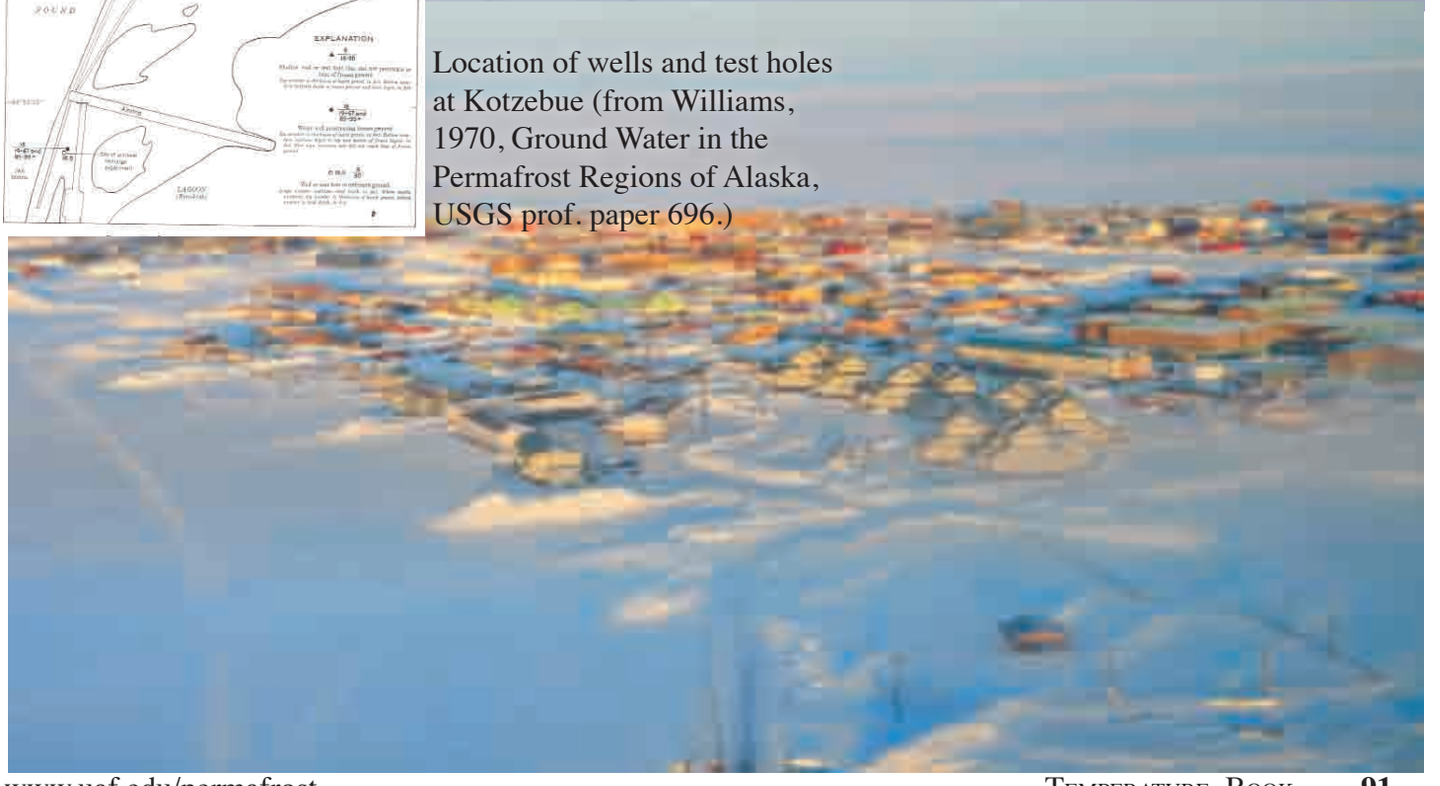
Deeper borehol (30m) shows 0.2-0.3 ºC warmer at 25m depth since 1980s.

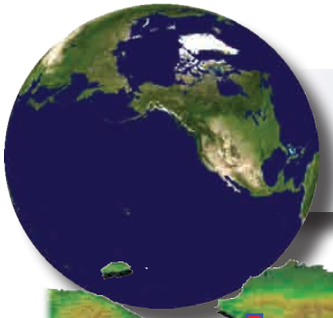
The city of Kotzebue developed at sand bar. Permafrost is about 70 m thick.



Location of wells and test holes at Kotzebue (from Williams, 1970, Ground Water in the Permafrost Regions of Alaska, USGS prof. paper 696.)

Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: -3.5°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days





Location: 67.58° N, 162.97° W

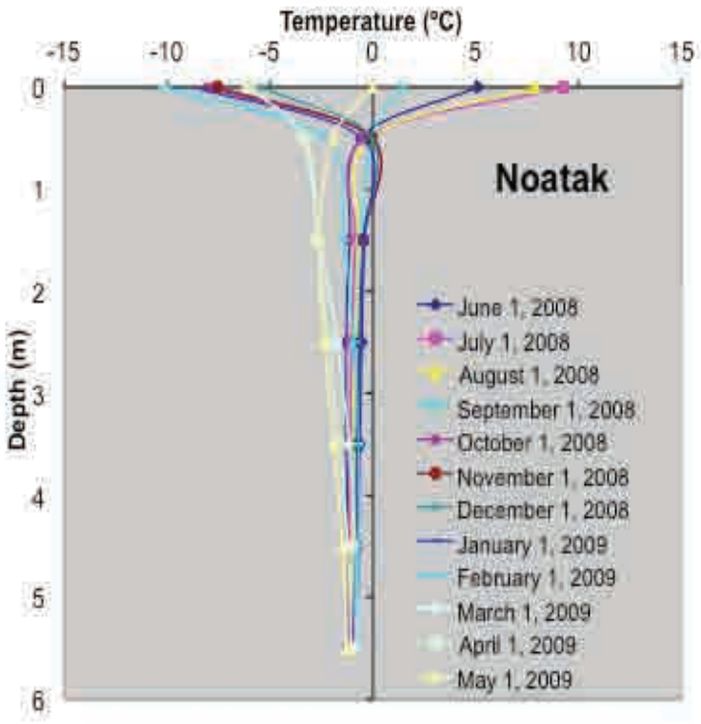
Noatak

Northwest Arctic Borough School District

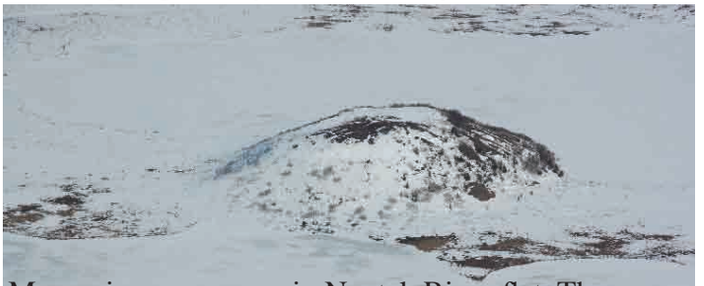
Student population: 154

Noatak, a village with 512 residents (2008 Estimated Population, not Certified), is located on the west bank of the Noatak River. This community lies north of the Arctic Circle, 89 air kilometers (55 air miles) north of Kotzebue. The Noatak River empties into Kotzebue Sound. Noatak was a fishing and hunting camp that developed into a permanent settlement because of the area's abundant resources. The 1880 census recorded this settlement as Noatagamut, meaning "inland river people." Most residents in Noatak are Alaska Native or part Native, mainly Inupiat. Subsistence activities are an important way of life for the people here. There is a state-owned gravel runway in Noatak, and it is used by regional air services that carry cargo, mail, and passengers to and from the community. There is no barge service to Noatak, though small boats travel the nearby river. Noatak is not on the road system, but many historic trails provide transportation routes for ATVs and snowmachines. Total annual snowfall in Noatak averages just over 1 meter (48 inches), and total annual precipitation averages 29 centimeters (11 inches).

Noatak is located very unique place where spruce forest at Noatak River flood plane, but adjacent terrace is tundra vegetation. Permafrost temperature is warm about -1 ºC. Active layer is typically less than 1m. Most of the silty sediments at the terrace are at eolian origin, left by a glacier during the ice age.



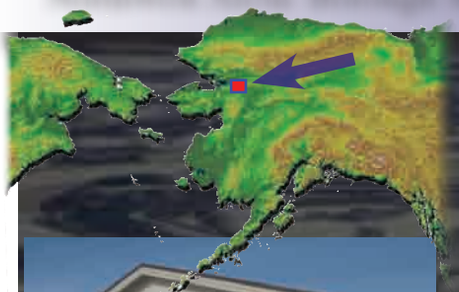
Key Facts:
Annual mean ground temperature: -1.4°C
Freezing days: 241 days
Freezing degree-days: 1551°C days
Thawing degree-days: 1050°C days



Many pingos are seen in Noatak River flat. These are considered closed system pingos and developed from aggradating permafrost in the former lake basin.

Noorvik

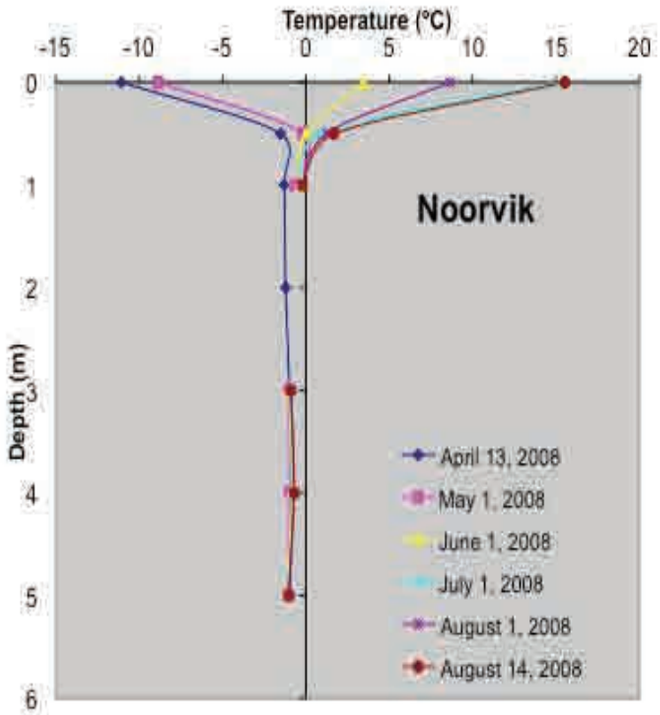
Northwest Arctic Borough School District

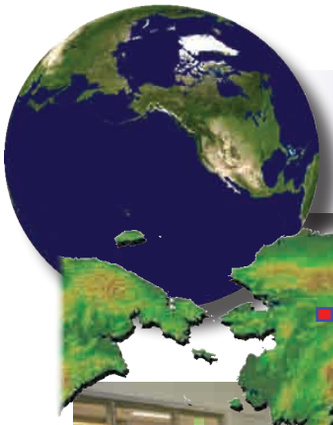


Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days

Student population: 207

Noorvik, a village with 642 residents (2008 DCCED Certified Population), is located on the east bank of the Nazuruk Channel of the Kobuk River, 72 kilometers (45 miles) east of Kotzebue. The meaning of Noorvik is "a place that is moved to." In the early 1900s, Kowagmuit Inupiat from Deering established this village. People from Oksik, upriver from Noorvik, settled here also. The community had a post office by 1937. Most residents are Alaska Native or part Native, mainly Inupiat. Subsistence practices are important to the way of life here. Employment includes work with the school, city, and health clinic, and in two local stores. Some residents work at seasonal jobs, such as mining, firefighting, and commercial fishing. Noorvik is not on the road system, but has an airport with a lighted gravel runway, used by several regional air taxis. Barges bring fuel and supplies to the village while the Kobuk River is navigable, from early June to mid-October.





Location: 66.89° N, 157.136° W

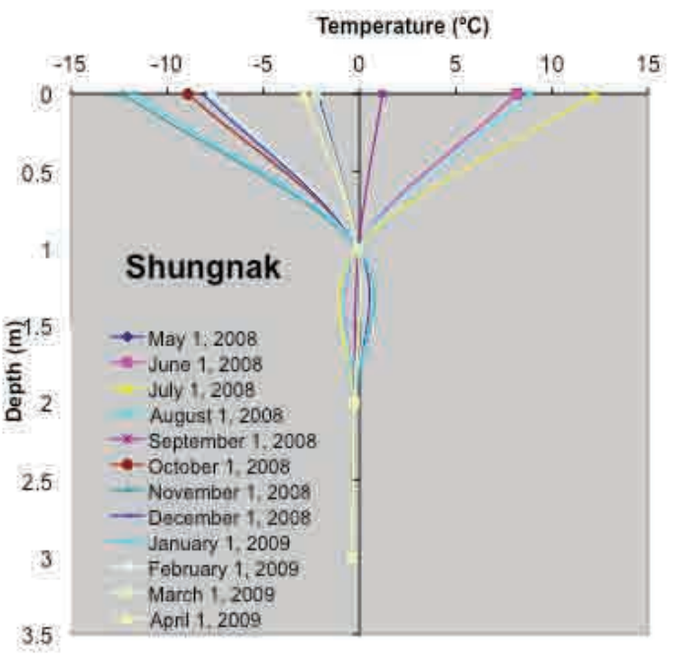
Shungnak

Northwest Arctic Borough School District

Student population: 75

Shungnak, a village with 272 residents (2008 DCCED Certified Population), is located on the west bank of the Kobuk River, 241 kilometers (150 miles) east of Kotzebue. This settlement was originally located 16 kilometers (10 miles) upstream of its present location, but river erosion and ice damage forced relocation in the 1920s. At the time of its establishment in 1899, Shungnak served as a supply station for miners working in the Cosmos Hills. The word shungnak is derived from issingnak, the Inupiat word for jade, a stone that is found throughout the surrounding hills. The majority of the population in Shungnak is Alaska Native or part Native, mainly Inupiat. A traditional subsistence way of life is important to the people here. Though Shungnak is not on the road system, it is accessible by plane, small boat, and barge. The state-owned gravel runway allows scheduled air service, and a barge service transports fuel and supplies on the Kobuk River while it is navigable, from the end of May to mid-October. Numerous trails are used for inter-village travel, using ATVs, snowmachines, and dog sleds. Total annual snowfall averages 2 meters (80 inches), and total annual precipitation is 41 centimeters (16 inches).

Key Facts:
Annual mean ground temperature: -0.1°C
Freezing days: 216 days
Freezing degree-days: 1527°C days
Thawing degree-days: 1492°C days

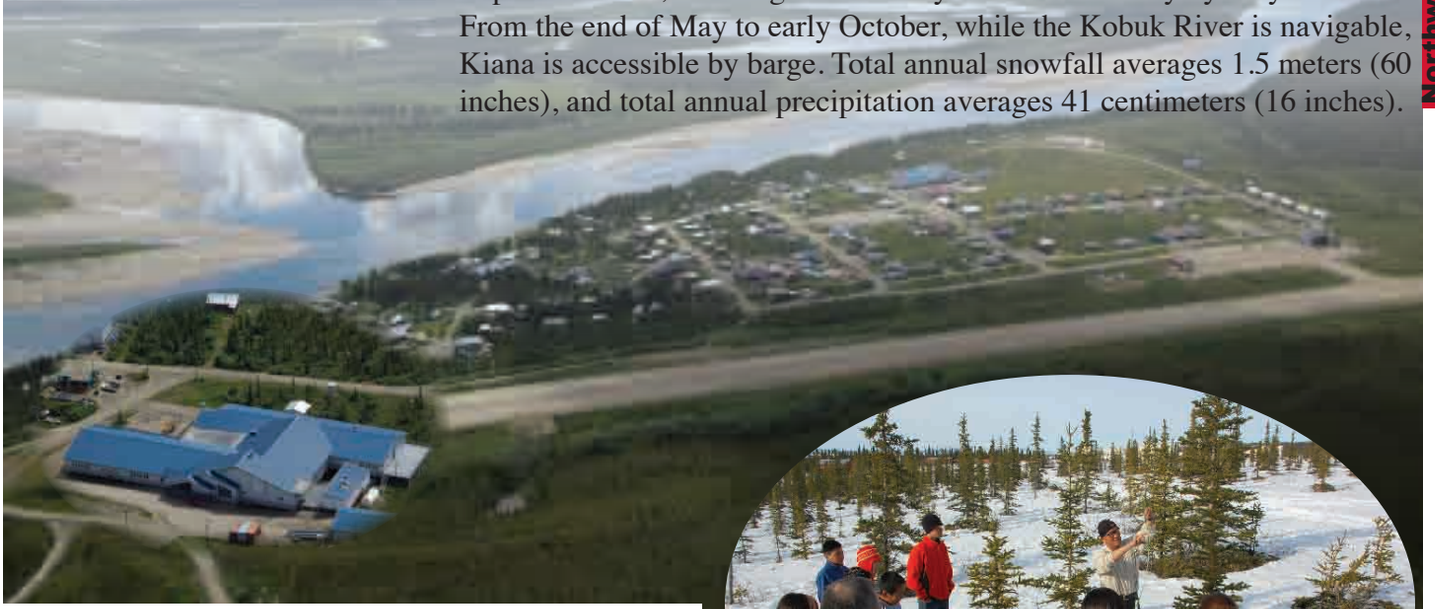


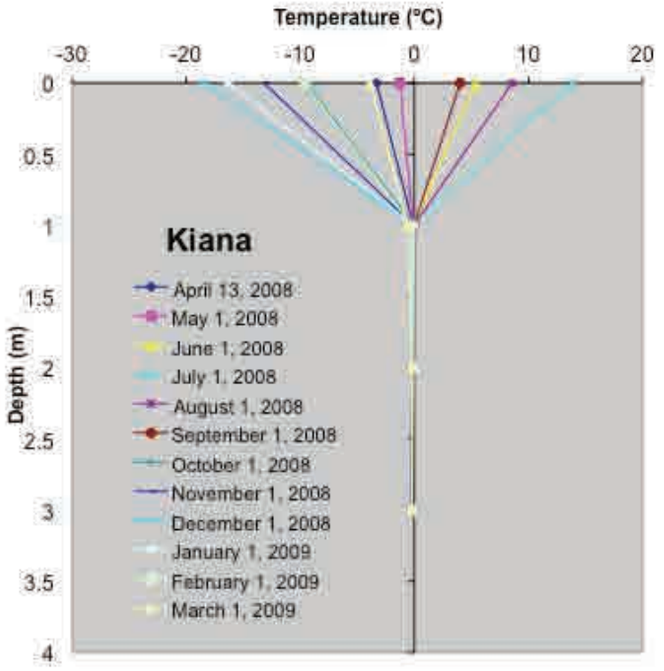
Kiana

Northwest Arctic Borough School District

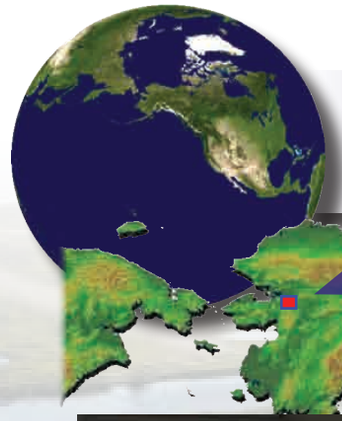
Student population: 110

Kiana, a village with 383 residents (2008 DCCED Certified Population), is located on the north bank of the Kobuk River, 92 kilometers (57 miles) by air east of Kotzebue. Kiana has long been the central village of the Kobuk River Kowagmiut Inupiat; the meaning of its name is "a place where three rivers meet." In 1909, when supplies were needed by placer miners working along the Squirrel River nearby, Kiana became a supply center in support of those activities. The majority of the population in this community is Alaska Native or part Native, mainly Inupiat. A subsistence way of life is important here. Though Kiana is not located on the road system, there are local roads and a network of old trading trails in the area. There is a state-owned airport in Kiana, allowing accessibility to the community by air year-round. From the end of May to early October, while the Kobuk River is navigable, Kiana is accessible by barge. Total annual snowfall averages 1.5 meters (60 inches), and total annual precipitation averages 41 centimeters (16 inches).





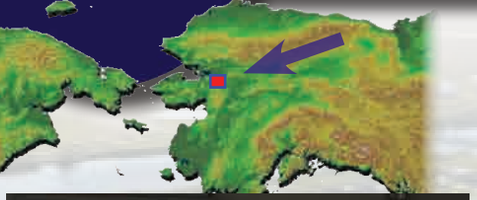
Key Facts:
Annual mean ground temperature: -1.3°C
Freezing days: 213 days
Freezing degree-days: 1906°C days
Thawing degree-days: 1428°C days



Location: 66.61° N, 160.01° W

Selawik

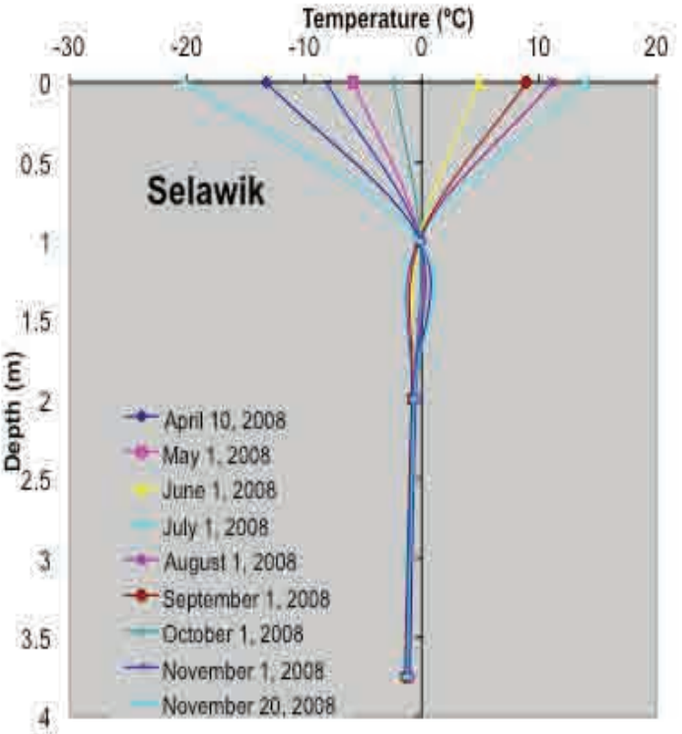
Northwest Arctic Borough School District



Student population: 274

Selawik, a village with 846 residents (2008 DCCED Certified Population), is located on the Selawik River, 145 kilometers (90 miles) east of Kotzebue. In the Inupiat language, selawik is the name for a species of fish. The village was noted in the 1840s by Lt. L.A. Zagoskin, an explorer with the Imperial Russian Navy. By 1908, a schoolhouse and a church had been built in Selawik. Over the years, the community has grown, such that it now occupies space on three riverbanks of the Selawik River, interconnected by two bridges. The majority of the population in Selawik is Alaska Native or part Native, mainly Inupiat. A traditional subsistence way of life is important with the people here. Though Selawik is not on the road system, it is accessible by plane and by barge. Gravel airstrips allow scheduled flights to and from the village. A barge service transports supplies upriver from Kotzebue each summer, since there is a water route that leads from Kotzebue to Selawik Lake to the Selawik River. Where the river meets the lake is about 16 kilometers (10 miles) west of Selawik, and the river is navigable from early June to mid-October. Total annual snowfall is nearly 1 meter (37 inches), and total annual precipitation is 25 centimeters (10 inches).

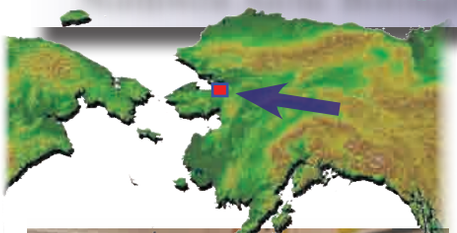
Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days



Retrogressive thaw slump that occurred on the upper Selawik River possiblly affected the aquatic ecosystem due to high levels of suspended solids.

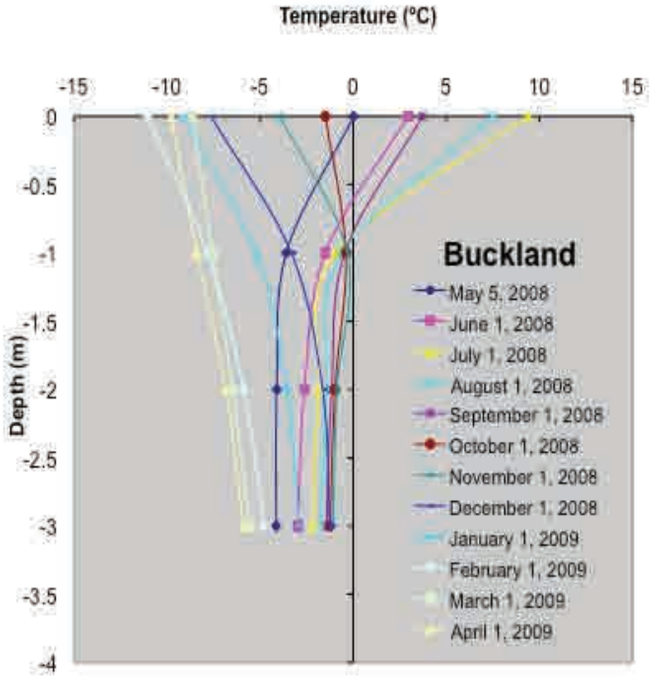
Buckland

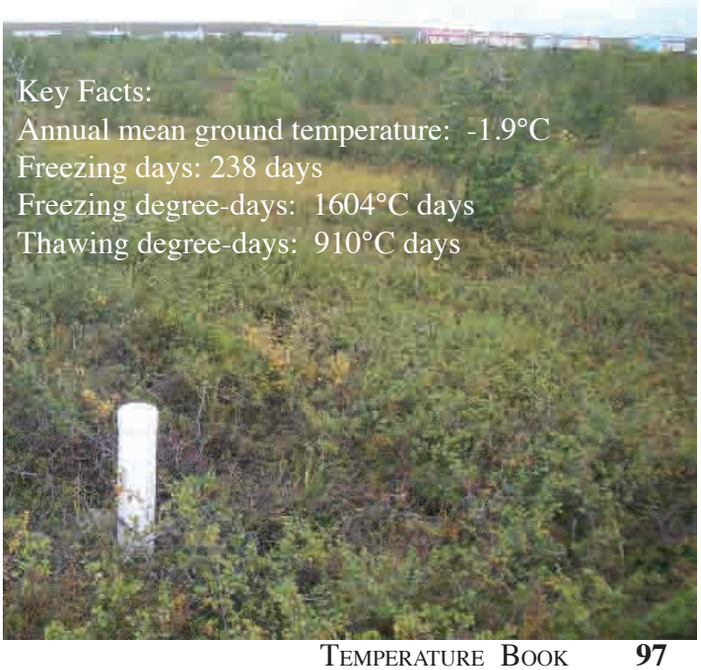
Northwest Arctic Borough School District

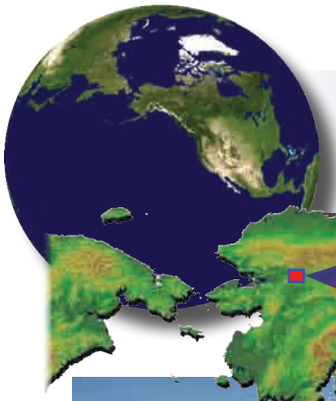


Student population: 166

Buckland, a village with 458 residents (2008 DCCED Certified Population), is located inland on the west bank of the Buckland River, about 121 kilometers (75 miles) southeast of Kotzebue. The people of Buckland have lived in various sites along the river, including places called Elephant Point, Old Buckland, and New Site. There is evidence of prehistoric use at Elephant Point and in the area, as indicated by fossil finds. Buckland is an Inupiat community, and most residents are Alaska Native or part Native. Residents depend on a subsistence way of life for most food sources. Buckland is not on the road system; its main means of transportation are plane, small boat, barge, and snowmachine. The annual mean air temperature in Buckland is -11°C (13°F). The average annual precipitation is 23 centimeters (9 inches), and the average annual snowfall is just over 1 meter (40 inches).







Location: 66.91° N, 156.88° W

Kobuk

Northwest Arctic Borough School District

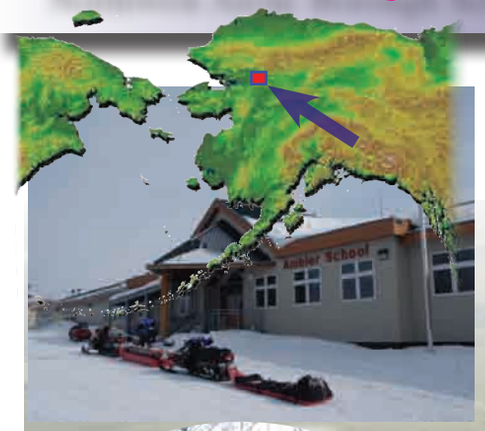
Student population: 37

Kobuk, a village with 109 residents (2008 DCCED Certified Population), is located on the east bank of the Kobuk River, 11 kilometers (7 miles) upriver from Shungnak and about 206 kilometers (128 miles) northeast of Kotzebue by air. Mining activity in the nearby Cosmos Hills in 1899 led to the establishment of a miners' supply station at this point along the Kobuk River. At the time, the location was called Shungnak. A school, a trading post, and the Friends mission attracted settlement to this area. In the 1920s, river erosion and flooding forced the relocation of this settlement several kilometers downstream, to a place then called Kochuk, but later renamed Shungnak. Not all villagers relocated, and those who remained behind named their location Kobuk. The majority of people living in Kobuk are Alaska Native or part Native, most Inupiat. A subsistence way of life is important in this community. Transportation needs are met by plane, barge, small boat, and snowmachine. Air carriers into Kobuk use the state-owned airstrip, and a barge brings supplies and fuel when there is high water, the Kobuk River being navigable from the end of May through October. There are numerous inter-village trails for year-round travel and a road between Kobuk and Shungnak. Total annual snowfall averages 1.4 meters (56 inches), and total annual precipitation averages 43 centimeters (17 inches).

Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days

Ambler

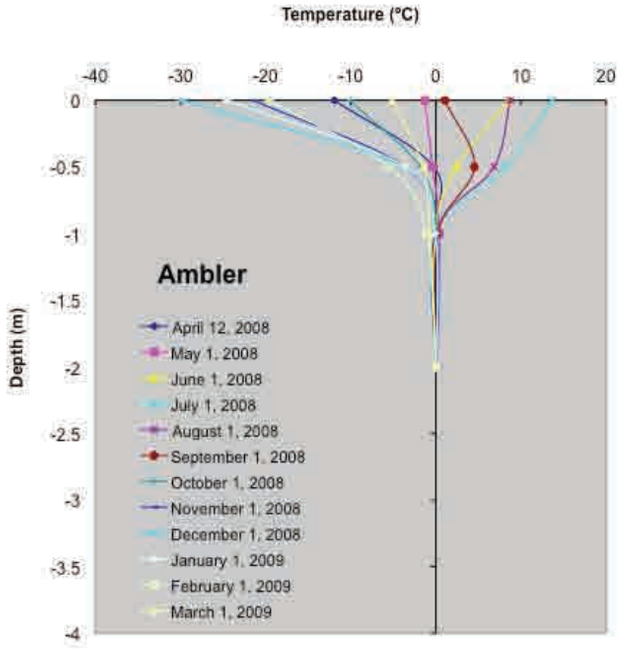
Northwest Arctic Borough School District

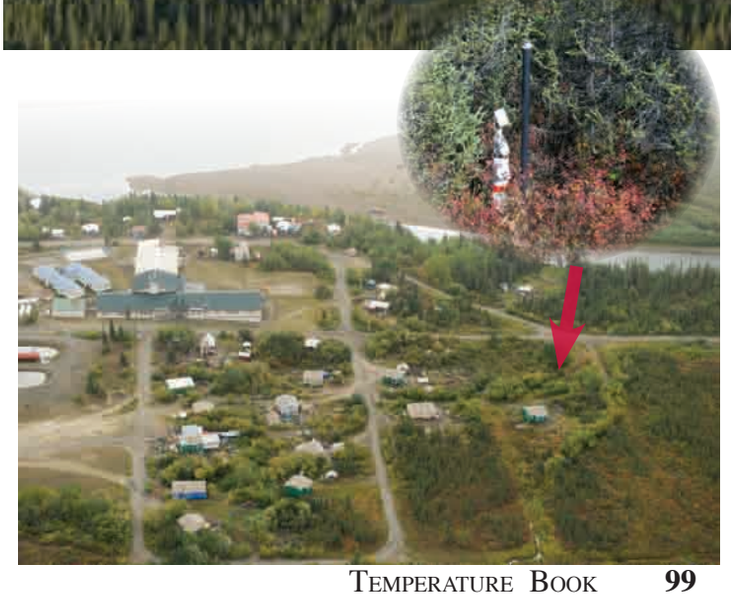


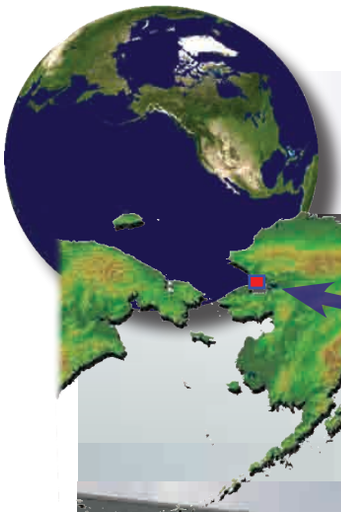
Student population: 66

Ambler, a village with 259 residents (2008 DCCED Certified Population), is located on the north bank of the Kobuk River, near where the Ambler and Kobuk Rivers meet. It is 72 kilometers (45 miles) north of the Arctic Circle, and 222 kilometers (138 miles) northeast of Kotzebue. People from Shungnak and Kobuk settled in this area in 1958 because of the variety of fish and wild game. The village is named after Dr. James M. Ambler, a U.S. Navy surgeon who died in 1881 while on an arctic expedition. Most residents in Ambler are Kowagniut Inupiat. A traditional subsistence way of life is predominant in this community, with chum salmon and caribou important food sources, as well as moose, bear, and berries. Ambler is not on the road system; transportation is by barge, plane, small boat, and snowmachine. The annual mean air temperature in Ambler is -2°C (28°F). Snowfall averages 2 meters (80 inches) per year, and precipitation averages 41 centimeters (16 inches) per year.

Key Facts:
Annual mean ground temperature: -3.2°C
Freezing days: 218 days
Freezing degree-days: 2654°C days
Thawing degree-days: 1492°C days







Location: 66.07° N, 162.71° W

Deering

Northwest Arctic Borough School District

Student population: 32

Deering, a village with 133 residents (2008 DCCED Certified Population), is located at the mouth of the Inmachuk River on Kotzebue Sound, 92 kilometers (57 miles) southwest of the town of Kotzebue. With its location accessible by sea, Deering began as a supply station in 1901, in support of gold mining activities further inland. This newer village, Deering, is situated not far from the historic Malemiut village of Inmachukmiut. It is thought that Deering is named after a 90-ton schooner that operated in nearby waters around 1900—the Abbey Deering. The majority of the population in Deering is Alaska Native or part Native, primarily Inupiat. A traditional subsistence way of life is important in this community. Winter trails connect Deering to the villages of Candle and Buckland. There is a state-owned airstrip in Deering, allowing accessibility by air year-round; and from early July until mid-October, the period when Kotzebue Sound is ice-free, the community is accessible by barge. Total annual snowfall in Deering is about 1 meter (36 inches), and total annual precipitation is about 23 centimeters (9 inches).

Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days

Kivalina

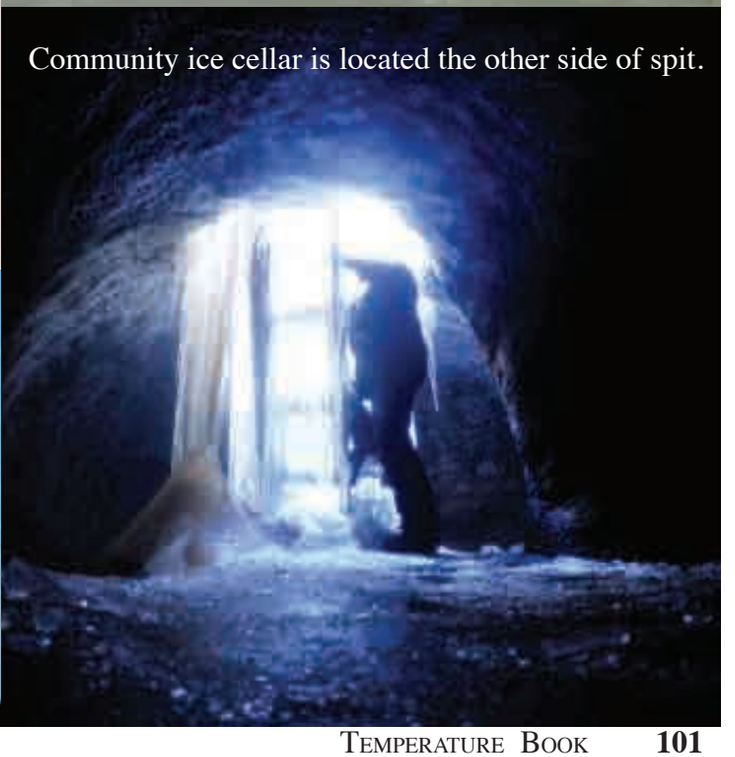
Northwest Arctic Borough School District

Student population: 119

Kivalina, a village of 406 residents (2008 DCCED Certified Population), is located on the southern end of a 13 kilometer long (8 mile long) barrier reef. The Chukchi Sea is to the west of this barrier reef, and Kivalina Lagoon is to the east. The village is northwest of Kotzebue, separated 129 kilometers (80 miles) by air. In times past, Kivalina was located at the north end of the lagoon. The community is now in the process of planning a relocation from the present site. A relocation is necessary because of severe erosion and wind-driven ice damage occurring too close to the community. Kivalina was visited by members of the Russian Navy as early as 1847. Lt. Zagoskin, who was among those Russians, reported the village name as Kivualinagmut. The majority of residents in Kivalina is Alaska Native or part Native, mostly Inupiat. Subsistence is an important way of life for the people of Kivalina. The community relies on a subsistence living, which includes whaling, to provide most of their food. Kivalina is accessible by air and sea. There is a state-owned gravel airstrip in Kivalina for air service, and a barge from Kotzebue brings supplies during the summer, when the Chukchi Sea is ice-free mid-June to early November. Total annual snowfall averages 1.5 meters (57 inches), and total annual precipitation averages 22 centimeters (8.6 inches).

Key Facts:
Annual mean ground temperature: nd°C
Permafrost/ground temperature: -1.49°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days

Community ice cellar is located the other side of spit.

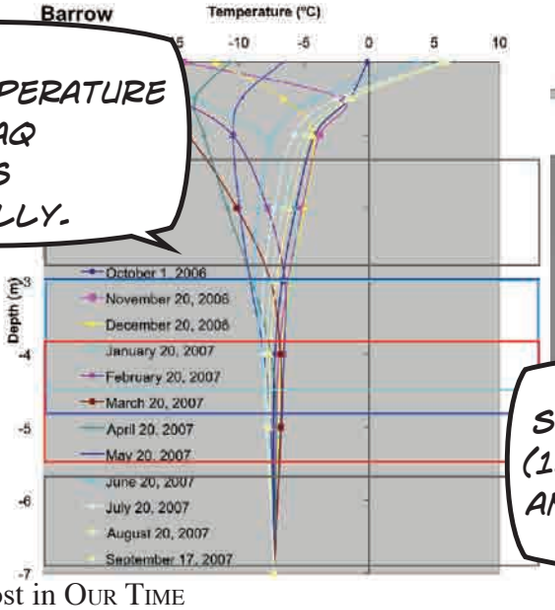


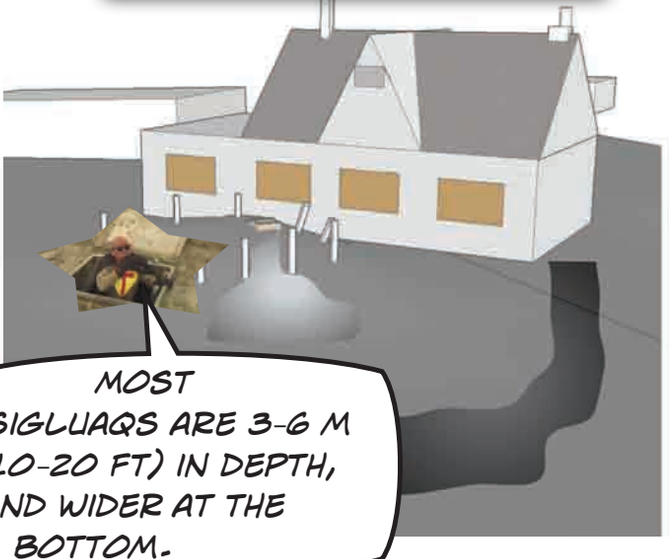
SIGLUAQS (ICE CELLARS)

A SIGLUAQ (ICE CELLAR) WAS ONE OF THE SMARTEST IDEAS OF ANCIENT NORTHERN NATIVES. EVEN MEAT STORES WELL IN THIS TRADITIONAL NATURAL FREEZER. SIGLUAQS ARE WIDELY USED IN WHALING COMMUNITIES OF ALASKA, NORTHERN CANADA, AND EASTERN SIBERIA. WHALING CAPTAINS OFTEN HAVE THEIR OWN SIGLUAQS.

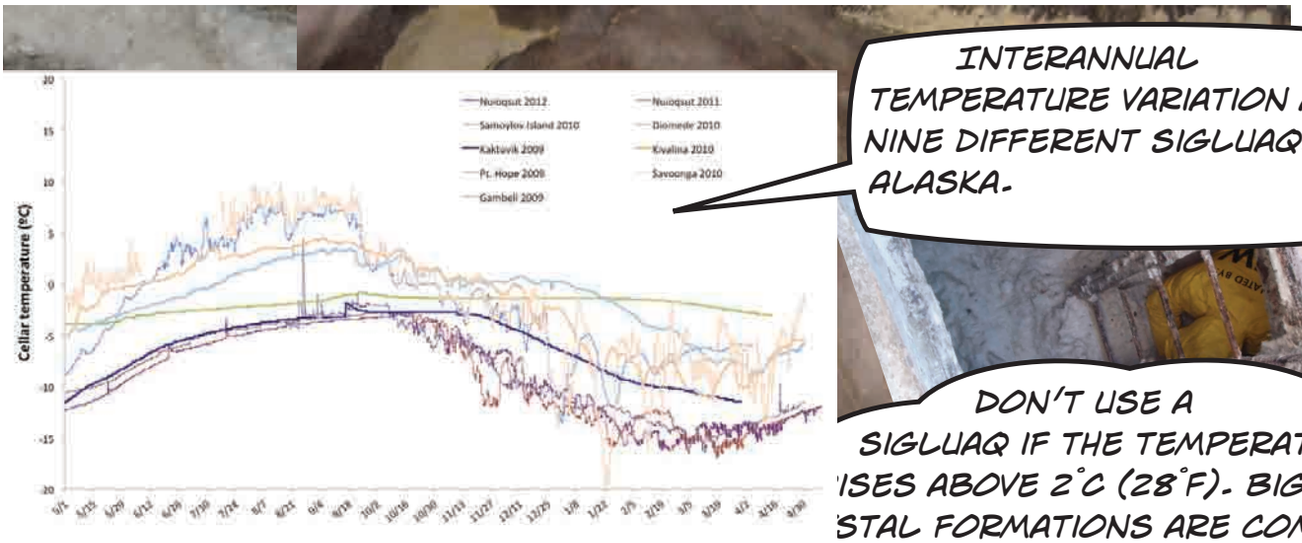
SIGLUAQS COMMUNITIES

THE INSIDE TEMPERATURE OF A SIGLUAQ FLUCTUATES SEASONALLY.





MOST SIGLUAQS ARE 3-6 M (10-20 FT) IN DEPTH, AND WIDER AT THE BOTTOM.



INTERANNUAL TEMPERATURE VARIATION AT NINE DIFFERENT SIGLUAQS IN ALASKA.

DON'T USE A SIGLUAQ IF THE TEMPERATURE 'ISES ABOVE 2°C (28°F). BIG 'STAL FORMATIONS ARE COMMON... THIS MEANS THAT BACTERIA AND FUNGUS CAN GROW. BAD NEWS FOR MEAT.

INTERNATIONAL POLAR YEAR

DURING THE FIRST INTERNATIONAL POLAR YEAR IN 1883, P.H. RAY MEASURED PERMAFROST TEMPERATURE IN A SHAFT (SIMILAR TO A SIGLUAQ) THAT HAD BEEN BUILT. THOSE MEASUREMENTS HAVE MADE IT POSSIBLE FOR US TO COMPARE TEMPERATURES FROM THE MID -1900S AND 2008.

TEMPERATURE WAS SLIGHTLY WARMER AT 10°C. NOW IT'S 7°C.

SPY FROM AIR...

REMOTE SENSING IS A GREAT TOOL FOR LOOKING AT EARTH, AND EVEN MARS.

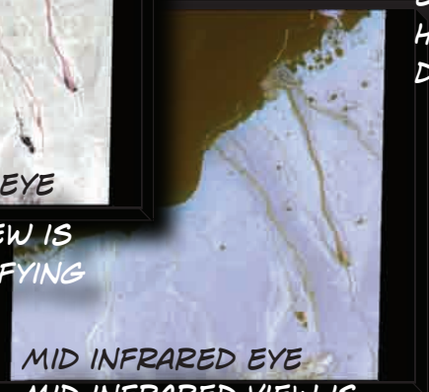
VISIBLE EYE

VISIBLE LIGHT IS GOOD FOR VIEWING LAND USES, BUILDING STRUCTURES, POLLUTION ETC.

SATELLITE USE ELECTROMAGNETIC WAVES TO HELP US VIEW OBJECTS IN A DIFFERENT WAY.

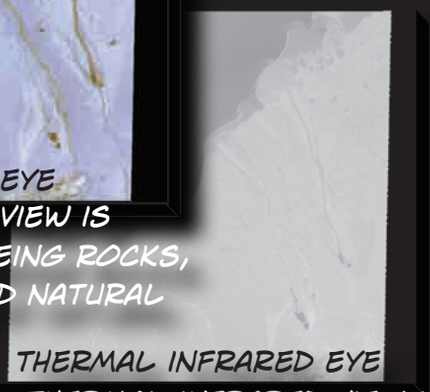
NEAR INFRARED EYE

NEAR INFRARED VIEW IS GOOD FOR CLASSIFYING VEGETATION.



MID INFRARED EYE

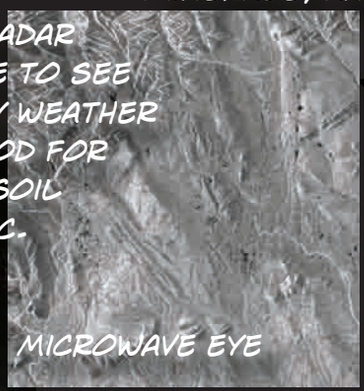
MID INFRARED VIEW IS GOOD FOR SEEING ROCKS, MINERALS, AND NATURAL



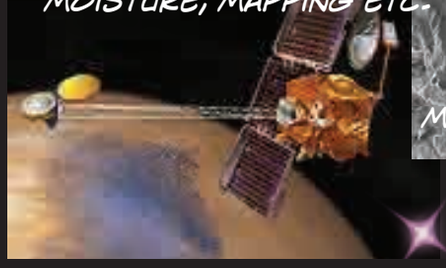
THERMAL INFRARED EYE

THERMAL INFRARED VIEW IS GOOD FOR MONITORING FOREST FIRES, DETERMINING SURFACE TEMPERATURE.

SYNTHETIC APERTURE RADAR (SAR) USES MICROWAVE TO SEE GROUND -ANYTIME, ANY WEATHER CONDITION. THIS IS GOOD FOR TRACKING MOVEMENT, SOIL MOISTURE, MAPPING ETC.



MICROWAVE EYE



PERMAFROST IS INVISIBLE FROM ABOVE, BUT REMOTE SENSING IS A USEFUL TECHNIQUE WHEN LOOKING FOR PERMAFROST. A SATELLITE PICTURE SHOWS VEGETATION, SURFACE TEMPERATURE, SOIL MOISTURE, ETC. WITH REMOTE SENSING, THESE COMPONENTS CAN BE IDENTIFIED AS PERMAFROST.

Location: 66.25° N, 166.08° W

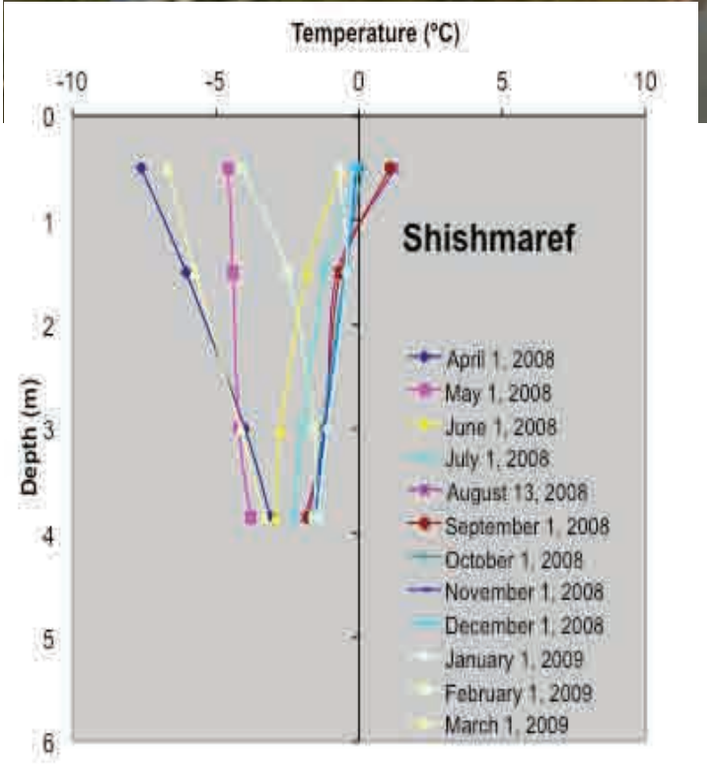
Shishmaref

Bering Straight School District

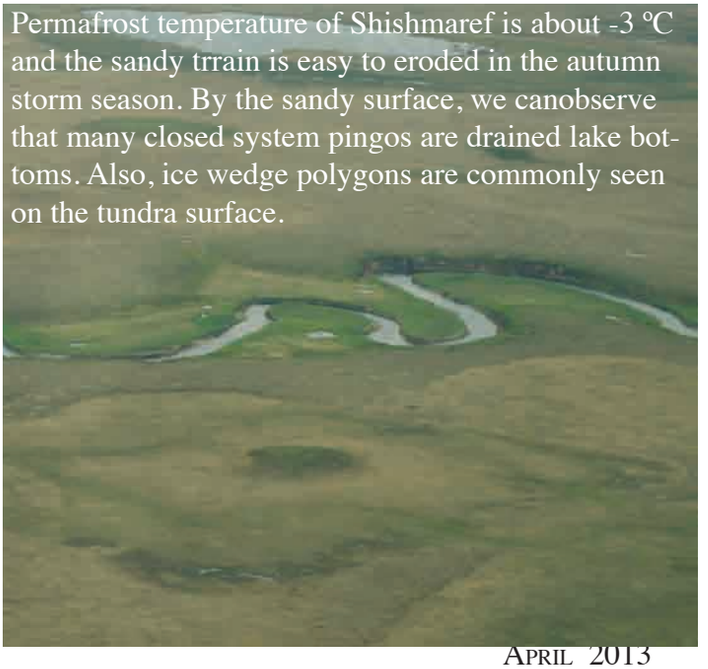
Key Facts:
Annual mean ground temperature: nd °C
Permafrost/ground temperature: nd°C
Freezing degree-days: nd°C days
Thawing degree-days: nd°C days

Student population: 173

Shishmaref, a village with 587 residents (2008 DCCED Certified Population), is located on Sarichef Island, a barrier island 8 kilometers (5 miles) from the Seward Peninsula mainland, northeast of Wales. Shishmaref is within the Bering Land Bridge National Reserve. Inupiat are the indigenous people of this area; their name for Sarichef Island was Kigiktaq. Russian explorers named the nearby inlet Shishmarev. The village was given the inlet's name. Around 1900, supplies that were needed for gold mining activities further south on the Seward Peninsula were shipped to Shishmaref because its location provided good harbor. A post office opened in 1901. Most residents of Shishmaref are Alaska Native or part Native, mainly Inupiat. Villagers rely on traditional subsistence activities to provide food. Year-round employment is limited. Storms off the Chukchi Sea have caused erosion of the north shoreline, to the extent that relocation of the village is planned. Air transportation is Shishmaref's primary connection to the rest of the state. The community has a paved runway and charter and air freight service from Nome. Many residents travel to the mainland by boat during ice-free months, usually mid-June through mid-November.

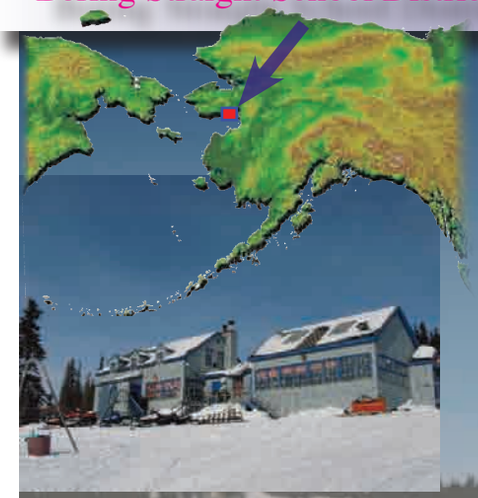


Permafrost temperature of Shishmaref is about -3 ºC and the sandy trrain is easy to eroded in the autumn storm season. By the sandy surface, we canobserve that many closed system pingos are drained lake bottoms. Also, ice wedge polygons are commonly seen on the tundra surface.



White Mountain

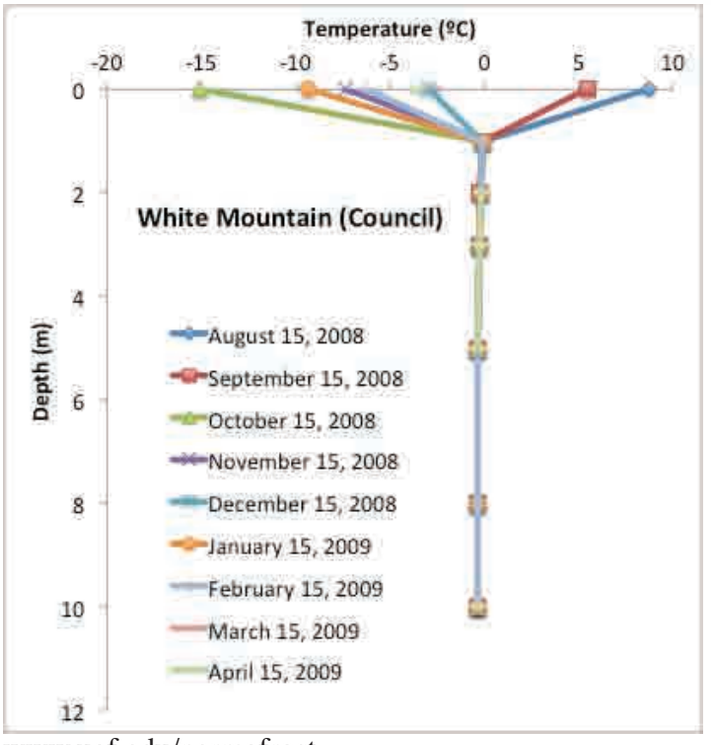
Bering Straight School District



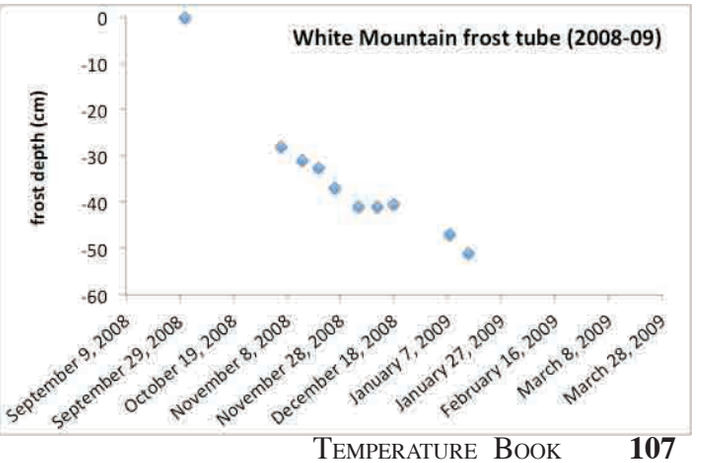
Student population: 51

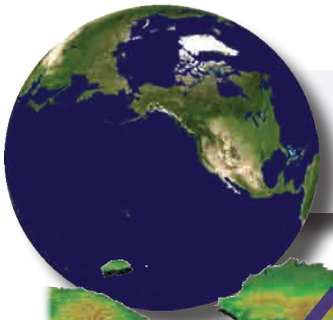
White Mountain, a village with 191 residents (2008 DCCED Certified Population), is located on the east bank of the Fish River, near the head of Golovnin Lagoon on the southern side of the Seward Peninsula. This location was an Inupiat fish camp, called Nutchirviq. Gold prospectors moved into the area with the gold rush of 1900, and development of the place began. A government-subsidized orphanage operated in White Mountain until being converted to an industrial school in 1926. Most residents are Alaska Native or part Native, mainly Kawerak. Subsistence activities are an important food source for people here. Employment in the village includes work with the school, store, post office, local government, and airport. Some residents produce and sell artwork. Though White Mountain is not on the road system, air transportation is available from Nome. Air carriers use the community's gravel runway. Supplies are lightered from Nome and off-loaded on the beach, since the community does not have a dock.

Key Facts:
Annual mean ground temperature: -0.4°C
Freezing days: 213 days
Freezing degree-days: 1634°C days
Thawing degree-days: 1488°C days



White Mountain is located on warm south-facing slopes and permafrost is absent. Seasonal frost depth reachs typically more than 60cm.





Location: 63.52° N, 162.28° W

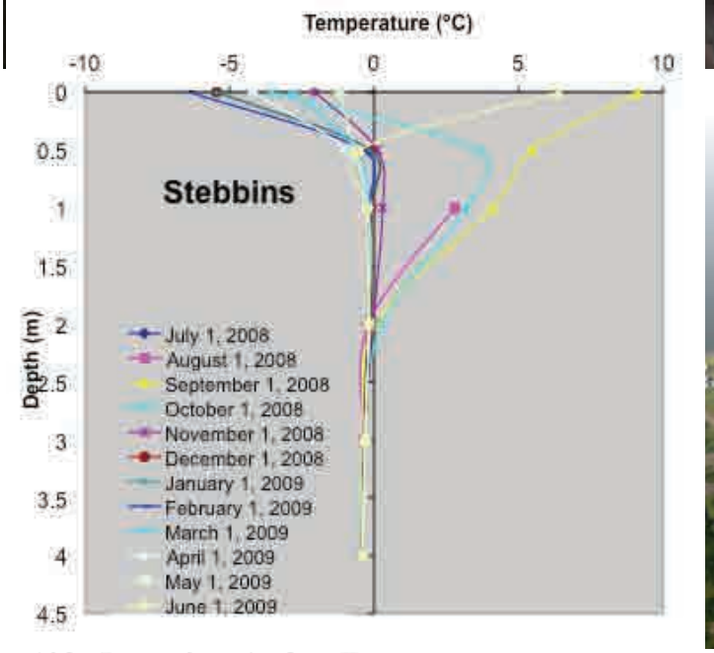
Stebbins

Bering Straight School District

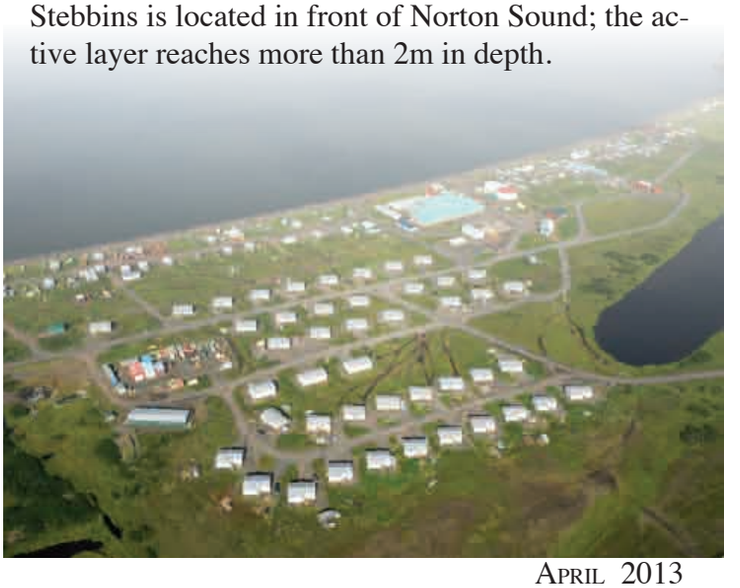
Student population: 196

Stebbins, a village with 577 residents (2008 DCCED Certified Population), is located on the northwest coast of St. Michael Island on the southern shore of Norton Sound. Stebbins is 17 kilometers (10.5 miles) west of Saint Michael, a location where the Russian-American Company built a fort in 1833. The Yup'ik name for Stebbins is Tapraq. Most residents here are Alaska Native or part Native, mainly Yup'ik. Subsistence activities are important to their livelihood. Employment includes work with the school and local government, and commercial fishing. The community has a gravel runway, with regular flights come from Bethel. Supplies arrive annually by cargo ship. Stebbins is connected to St. Michael by a trail.

Key Facts:
Annual mean ground temperature: 2.3°C
Freezing days: 122 days
Freezing degree-days: 296°C days
Thawing degree-days: 1142°C days

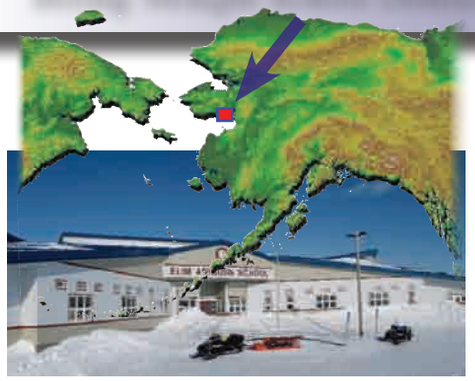


Stebbins is located in front of Norton Sound; the active layer reaches more than 2m in depth.



Elim

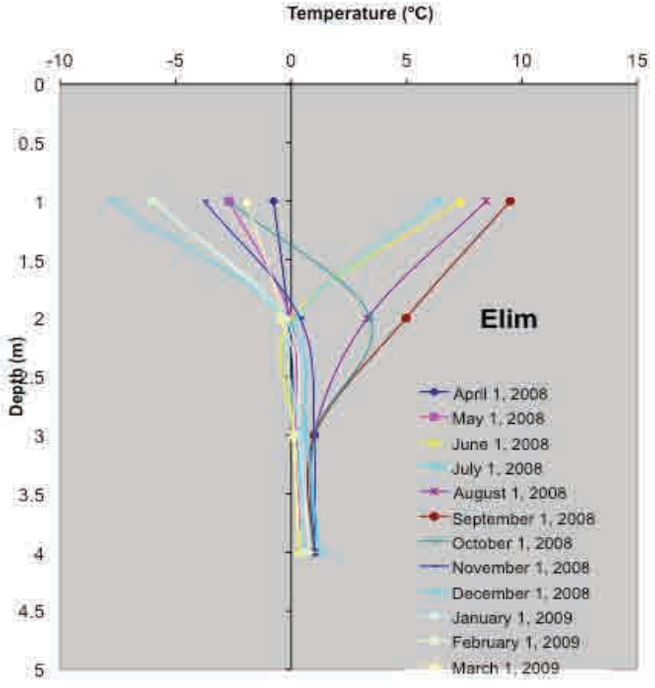
Bering Straight School District

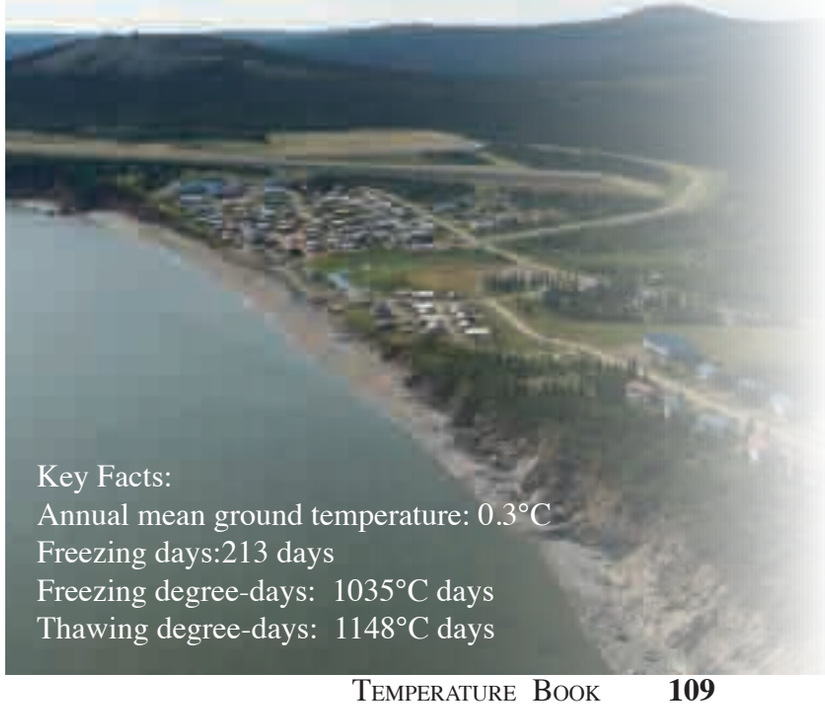


Student population: 77

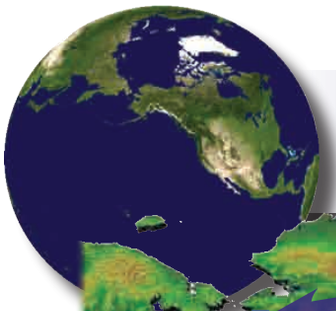
Elim, a village with 297 residents (2008 DCCED Certified Population), is located on the northwest shore of Norton Bay on the southern edge of the Seward Peninsula. The village is 155 kilometers (96 miles) east of Nome. This site was originally called Nuviakchak by the Malemiut Inupiat who lived here. A federal reindeer reserve was located in the area in 1911, and by 1914, a Covenant mission and school, called the Elim Mission Roadhouse, had been established. Most residents of Elim are Alaska Native or part Native, mainly Inupiat. Subsistence practices are important to the way of life here. Employment includes work in the school and in local government, as well as commercial fishing. Elim is not on the road system, but has an airport with a gravel runway for air transportation. Cargo is brought to Elim from Nome across Norton Sound, which remains ice-free between mid-June and mid-November. Elim is one of the communities along the route of the annual Iditarod Sled Dog Race between Anchorage and Nome.

Elim is located on the warm south-facing Norton Sound's shoreline. Hot springs are nearby and we assume there is higher heat flow at this area.





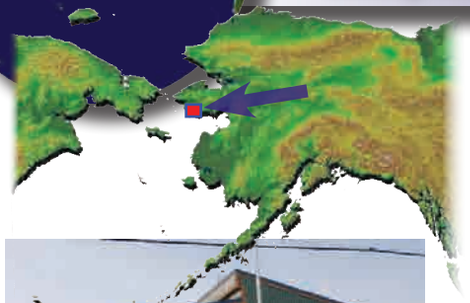
Key Facts:
Annual mean ground temperature: 0.3°C
Freezing days:213 days
Freezing degree-days: 1035°C days
Thawing degree-days: 1148°C days



Location: 65.34° N, 166.50° W

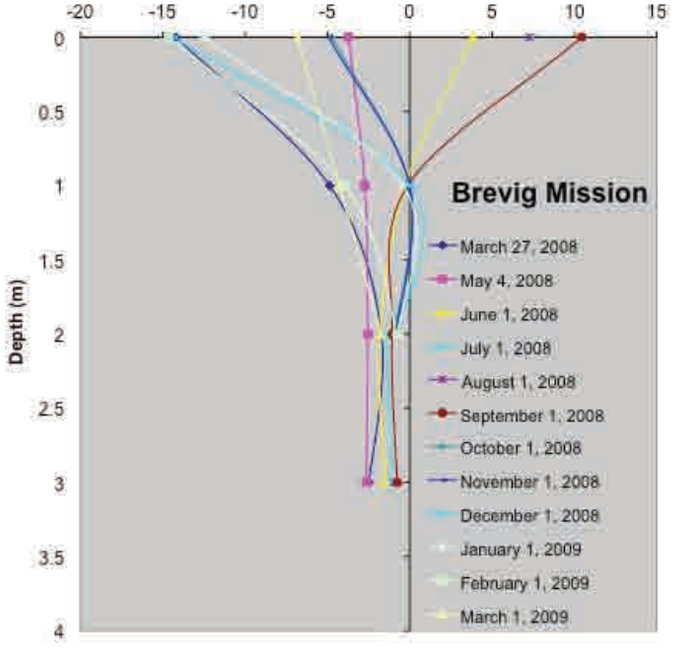
Brevig Mission

Bering Straight School District



Student population: 111

Brevig Mission, a village with 350 residents (2008 DCCED Certified Population), is located at Port Clarence, along the Seward Peninsula, about 105 kilometers (65 miles) northwest of Nome. The Kauwerak who hunted and fished in this area originally also traded furs with people in Siberia, Little Diomede, and King Island. In 1892, the U.S. government began operation of the Teller Reindeer Station. A Norwegian Lutheran missionary, Rev. Tollef L. Brevig, moved to the area in 1894 to serve as pastor and teacher to the local people and those in nearby villages. In 1900, a Lutheran mission was constructed and became known as Teller Mission. The U.S. government gave 100 reindeer to Teller Mission on a five-year loan, and by 1906, the government's role in the reindeer station had diminished, and the mission's role had become dominant. Reindeer herding formed the economic base of Brevig Mission until 1974. Most residents in Brevig Mission are Alaska Native or part Native, predominantly Inupiat who live a subsistence way of life. Brevig Mission is not on the road system, but between early June and mid-November, Port Clarence is generally ice-free, allowing access to the community by cargo ships. Additionally, there is an airstrip, which allows air transportation year-round. The annual mean air temperature at Brevig Mission is -4°C (24°F). Annual average precipitation is about 30 centimeters (12 inches), and average annual snowfall is 1.3 meters (50 inches).



Key Facts:

Annual mean ground temperature: -1.9°C

Freezing days: 215 days

Freezing degree-days: 2014°C days

Thawing degree-days: 1322°C days

Unalakleet

Bering Straight School District

Student population: 164

Unalakleet, a village with 723 residents (2008 DCCED Certified Population), is located on the east shore of Norton Sound at the mouth of the Unalakleet River. Unalakleet is an Inupiat word that means “from the southern side.” Archaeological evidence from the nearby beach ridge indicates that people have lived in this area for over 2,200 years. Situated at the end of the Kaltag Portage, a winter travel route that connects this coastal area to the Yukon River, Unalakleet was an important historic trade center for people of Alaska’s coast and Interior. In the 1830s, the Russian American Company built a post in Unalakleet. Reindeer herders from Lapland were brought to Unalakleet in 1898 to teach residents about reindeer herding. In 1901, a telegraph line built by the Army Signal Corps passed through the village on its route from St. Michael to Fort Gibbon in Tanana. Most residents in Unalakleet are Alaska Native or part Native, though culturally diverse. Traditional subsistence activities are an important source of food here. Unalakleet has an active local economy. Many residents hold commercial fishing permits. Employment includes work in fish processing, and with the school and local government. Air carriers use Unalakleet’s gravel runway or gravel airstrip. Cargo for the community is lightered from Nome.

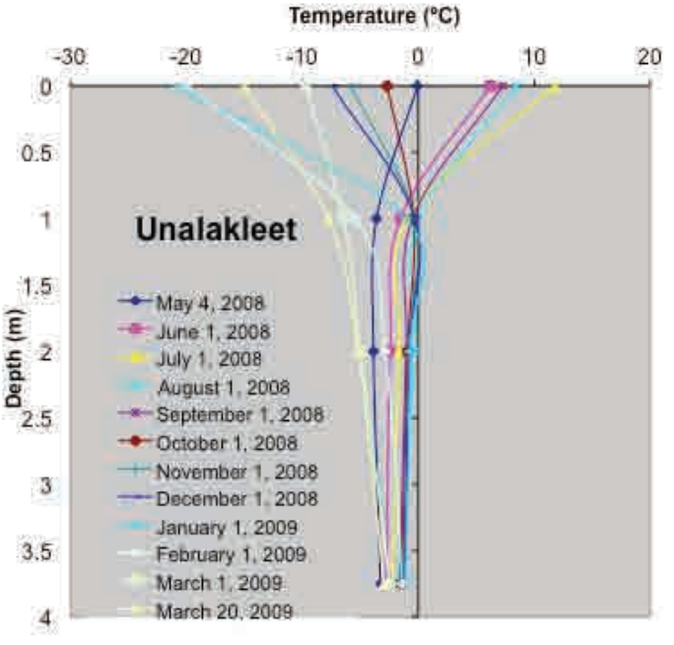
Key Facts:

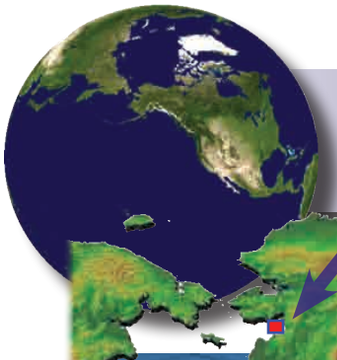
Annual mean ground temperature: -2.2°C

Permafrost/ground temperature: ND

Freezing degree-days: ND

Thawing degree-days: ND

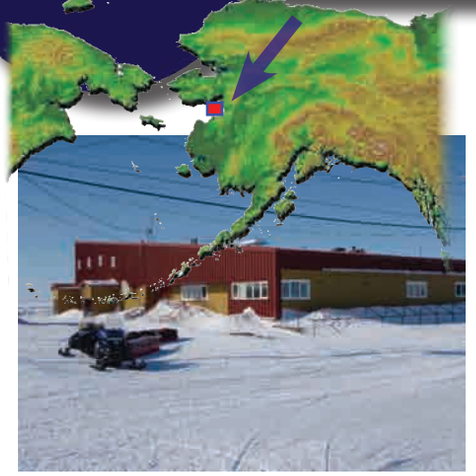




Location: 64.32° N, 161.13° W

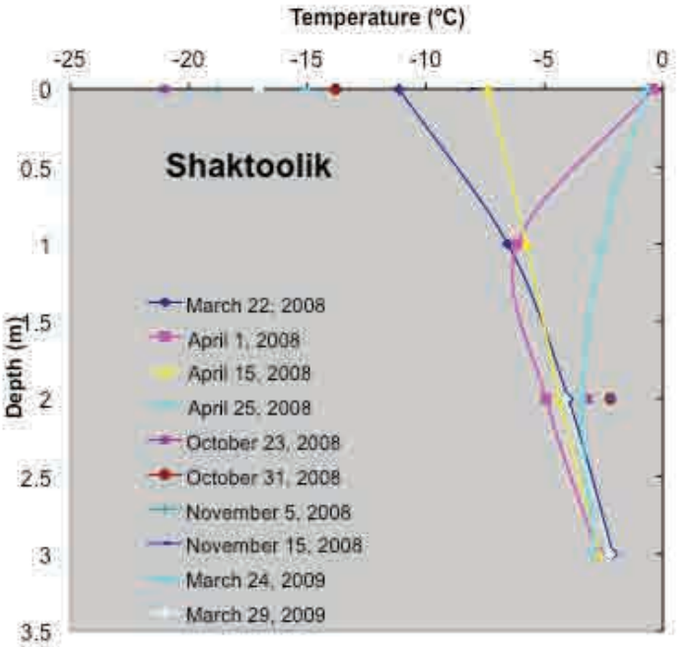
Shaktoolik

Bering Straight School District



Student population: 49

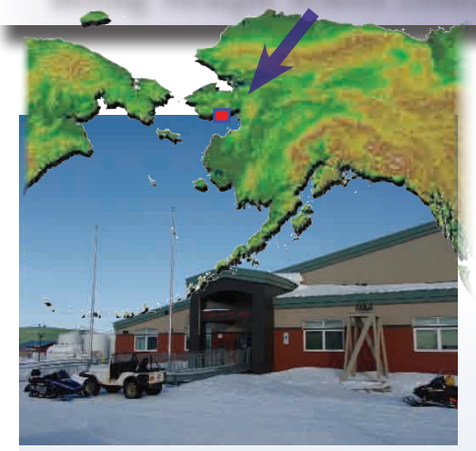
Shaktoolik, a village with 223 residents (2008 DCCED Certified Population), is located on the east shore of Norton Sound, north of Unalakleet. A Malemiut settlement, the village has had two other locations: one several kilometers up the Shaktoolik River, and the other at the mouth of the river. The present location is better sheltered from winds and storms. Just northwest of Shaktoolik, at a site near Cape Denbigh, also on the shore of Norton Sound, there is evidence of human occupation as far back as 6,000 to 8,000 years. Reindeer herding was practiced in the early 1900s. Most residents here are Alaska Native or part Native, mainly Malemiut, for whom subsistence activities are important. Employment consists of commercial fishing. Shaktoolik has a gravel airstrip and regular air service from Unalakleet. Cargo that comes from Nome is lightered to shore at Shaktoolik during summer.



Key Facts:
Annual mean ground temperature: ND
Permafrost/ground temperature: ND
Freezing degree-days: ND
Thawing degree-days: ND

Golovin

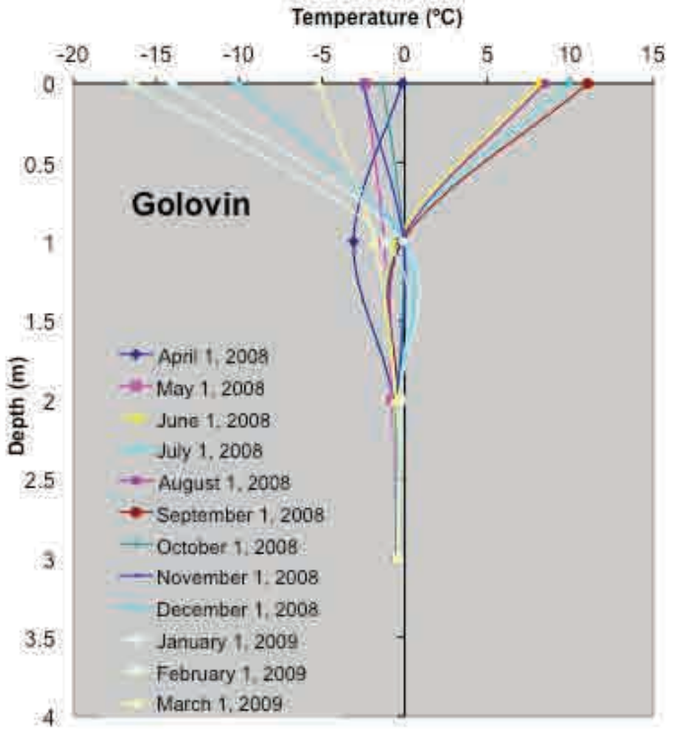
Bering Straight School District



Student population: 46

Golovin, also known as Chinik, is a village with 160 residents (2008 DCCED Certified Population) located on the southeast side of Golovnin Lagoon, on a point of land between the lagoon and Golovnin Bay. The community is east of Nome on the Seward Peninsula. Chinik was settled by Kauweramiut, who later were joined by Unaligmiut. This location was named by Russian explorers for Captain Vasili Golovnin of the Russian Navy. The Mission Covenant of Sweden established a church and school just south of Golovin in 1887. Three years later, a trading post opened and became an information center for prospectors interested in gold in the Seward Peninsula. With gold discoveries inland at Council in 1898, Golovin developed as a supply point for miners. By the early 1900s, a post office had opened, and reindeer herding had been introduced through the missions. Most residents in Golovin are Alaska Native or part Native, mainly Inupiat. Subsistence practices are important to the people here. Employment includes work with reindeer herding, fish processing, and commercial fishing. Golovin has a gravel runway used by scheduled and chartered air carriers. When Golovnin Bay is ice-free from late May to late October, barges bring supplies from Nome.

Key Facts:
Annual mean ground temperature: -0.8°C
Freezing days: 212 days
Freezing degree-days: 1680°C days
Thawing degree-days: 1386°C days



Location: 63.48° N, 162.03° W

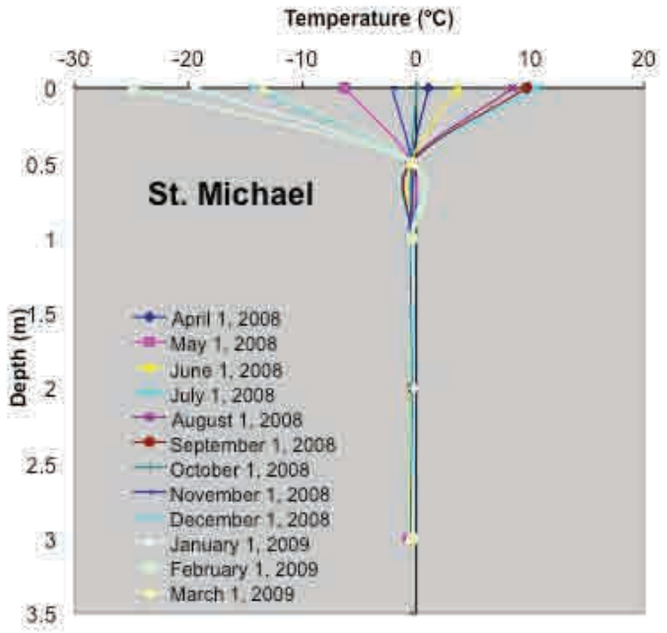
Saint Micheal

Bering Straight School District

Student population: 150

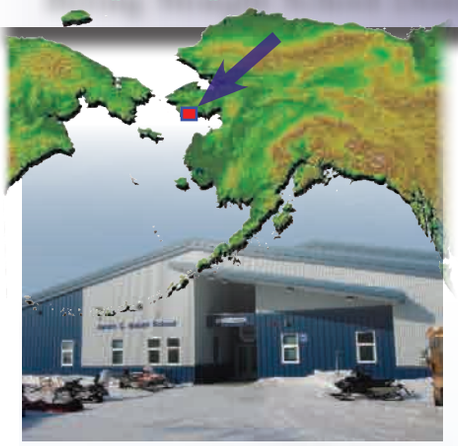
Saint Michael, a village with 434 residents (2008 DCCED Certified Population), is located on the east coast of Saint Michael Island in Norton Sound. The village is east of Stebbins, also on the island, and southwest of Unalakleet. In 1833, a fortified trading post was built at this location by the Russian-American Company, called Redoubt Saint Michael. To the northeast of this new construction was a Yup'ik village called Tachik. Though the Russians abandoned the post after 1867, some of the traders remained. In 1897, the U.S. established Fort Saint Michael, a military post. The gold rush began the same year, and thousands of people were attracted to the location, with many gold seekers finding inland access from Saint Michael on the Yukon River. Yup'iks traveled to Saint Michael to trade. Following the measles epidemic of 1900 and the influenza epidemic of 1918, many Yup'iks gathered in Saint Michael from surrounding villages. Before construction of the Alaska Railroad, Saint Michael was an important trans-shipment point. Most residents in Saint Michael are Alaska Native or part Native, mainly Yup'ik, and there are many descendants of Russian traders. Subsistence activities are important to the way of life here. Employment includes work in local government, the village council and corporation, stores, and the school. Saint Michael has a gravel airstrip and a seaplane base. Supplies and bulk cargo are lightered from Nome early June to mid-November, when Norton Sound is ice-free. A road connects Saint Michael to Stebbins.

Key Facts:
Annual mean ground temperature: 2.4°C
Freezing days: 211 days
Freezing degree-days: 111°C days
Thawing degree-days: 989°C days



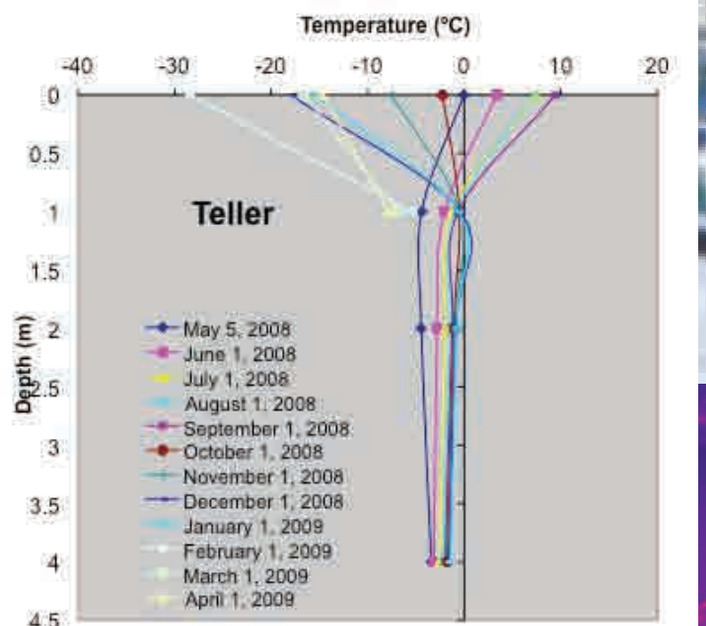
Teller

Bering Straight School District



Student population: 65

Teller, a village with 260 residents (2008 DCCED Certified Population), is located on a spit between Port Clarence and Grantley Harbor on the west coast of Seward Peninsula, just southeast of Brevig Mission. This area is home to the Kawerak Inupiat. When first reported in 1827, they had a fish camp just south of where Teller is today. An expedition for the Western Union Telegraph overwintered at Teller in 1866 and 1867; the site was called Libbyville or Libby Station, then. With the Bluestone placer mine discovery south of Teller in 1900, the village grew quickly, becoming a major regional trading center and attracting people from Diomede, Wales, Mary's Igloo, and King Island. A reindeer station nearby, managed from 1892 to 1900 by the U.S. government, was named Teller Reindeer Station, after Henry Moore Teller, a U.S. Senator and Secretary of the Interior. Teller became the village name. In 1926, on its first transpolar flight from Norway to Nome, the dirigible Norge was forced to land in Teller instead of Nome because of bad weather. Most residents in Teller are Alaska Native or part Native, mainly Kawerak Inupiat. Subsistence activities contribute importantly to their livelihood. Employment includes participating in the annual reindeer herd roundup and commercial fishing. Many residents produce and sell their artwork. Teller has a gravel runway and regular flights to Nome. A gravel road that connects Teller to Nome is open from May to September.



Key Facts:
Annual mean ground temperature: ND
Permafrost/ground temperature: ND
Freezing degree-days: ND
Thawing degree-days: ND

Thermal and visuble images of bird view Teller and spit in winter.

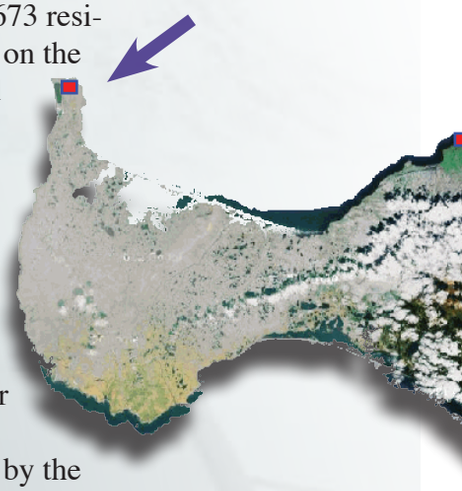
Location: 63.78° N, 171.72° W

Gambell

Bering Straight School District

Student population: 189

Gambell, also known as Sivuqaq, is a village with 673 residents (2008 DCCED Certified Population), located on the northwest shore of St. Lawrence Island. This island lies just 58 kilometers (36 miles) southeast of Chukotsk Peninsula, Siberia. The village is named after Presbyterian missionaries who lived in Gambell in the 1890s. The Yup'ik name for both the village and the island is Sivuqaq. Yup'ik have lived on St. Lawrence Island for more than 2,000 years. A famine that occurred there between 1878 and 1880 severely reduced the population. Reindeer were introduced to the island for local use in 1900, and in 1903, a reindeer reservation was established by the U.S. government. Most residents in Gambell are Alaska Native or part Native, mainly Yup'ik. Because its location is distant, Gambell has retained a strong traditional St. Lawrence Yup'ik culture, including language. Almost all residents speak both Yup'ik and English. Subsistence practices are predominant. The sale of ivory carvings by local artists generates income. Gambell does not have a seaport; it relies heavily on air transportation. Regular flights from Nome and chartered flights use the community's paved runway.



Igunaq is fermented (aged) walrus meat. A particular favourite is made by sewing up the meat inside the skin and burying it several months in a cellar.

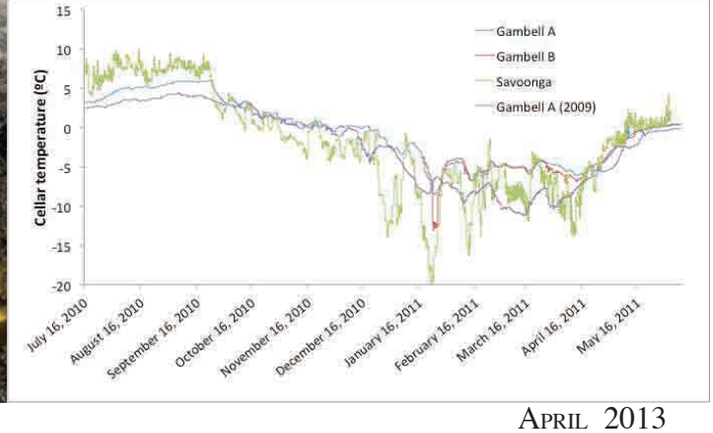
Key Facts:

Annual mean ground temperature: -1.6°C

Freezing days: 193 days

Freezing degree-days: 1061°C days

Thawing degree-days: 463°C days



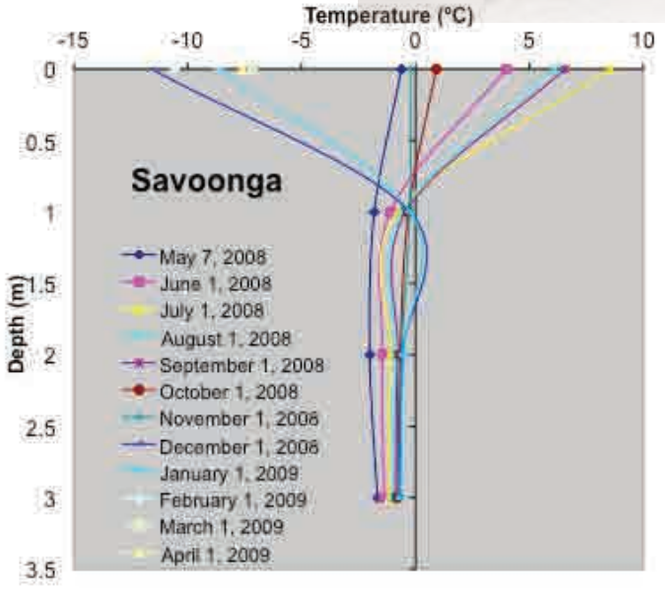
Savoonga

Bering Straight School District

Student population: 233

Savoonga, a village with 722 residents (2008 DCCED Certified Population), is located on the northern coast of St. Lawrence Island, an island in the Bering Sea, southwest of Nome. For over 2,000 years, Yup'ik have lived on the island intermittently. Reindeer were introduced to the island in 1900 and thrived. Because grazing lands were better in the area around Savoonga, the reindeer herd tended to stay there; this led to the establishment of a reindeer camp in the community in 1916. A post office opened in 1934. Most residents in Savoonga are Alaska Native or part Native, mainly Yup'ik. Residents live a subsistence way of life based on walrus, whale, fish, and seal hunting. Employment includes work related to commercial fishing and seafood processing. Because of the remote location of St. Lawrence Island, most residents in Savoonga are bilingual, Siberian Yup'ik being their first language. The Bering Sea is frozen at St. Lawrence Island from mid-November to late May. During this time, the community depends on air transportation. A gravel airstrip is used by air carriers, which offer regular air service to Nome and Unalakleet. In the summer, supplies are lightered from Nome.

Key Facts:
Annual mean ground temperature: -1.6°C
Freezing days: 213 days
Freezing degree-days: 1375°C days
Thawing degree-days: 777°C days



Monitoring site was destroyed due to new school facilities in 2011

Location: 64.93° N, 161.16° W

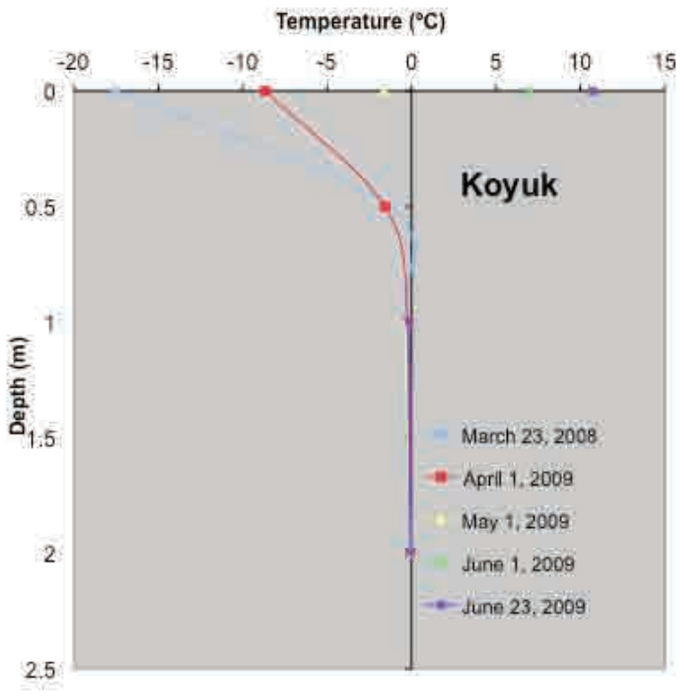
Koyuk

Bering Straight School District

Student population: 107

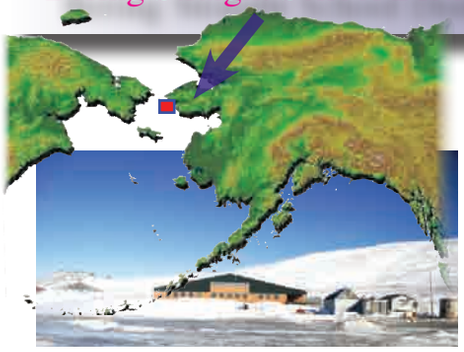
Koyuk, a village with 333 residents (2008 DCCED Certified Population), is located at the mouth of the Koyuk River, which drains into the northeast end of Norton Bay. Archaeological evidence from Cape Denbigh, located across Norton Bay, indicates that people have lived in the area for 6,000 to 8,000 years. In the early 1840s, Russian Navy explorers reported a village at the site of Koyuk. A Western Union Telegraph expedition was in the area in 1865. The population of Koyuk began to increase around 1900 because of mining. By 1914, the region around Koyuk saw the growth of Dime Landing and Haycock—two boomtowns—and a year later, Norton Bay Station, established upriver from Koyuk to supply miners and others living there. Both gold and coal were mined on the Koyuk River. A church-related school was opened in 1915, and a public school, by 1928. Most residents of Koyuk are Alaska Native or part Native, mainly Unalit and Malemiut. Subsistence activities are important to the way of life here. Employment is limited commercial fishing and reindeer herding. Koyuk is not on the road system, but it has a runway and regular flight service from Nome and Unalakleet. Cargo is barged in from Nome. Norton Bay is generally ice-free from May to October.

Key Facts:
Annual mean ground temperature: ND
Permafrost/ground temperature: ND
Freezing degree-days: ND
Thawing degree-days: ND



Wales

Bering Straight School District



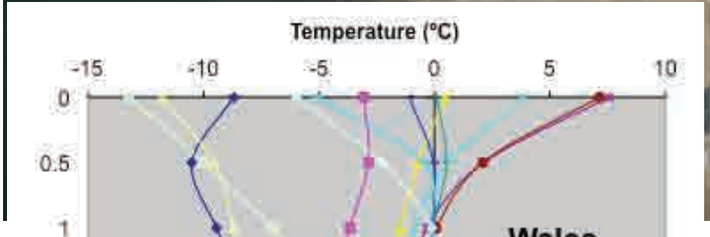
Student population: 33

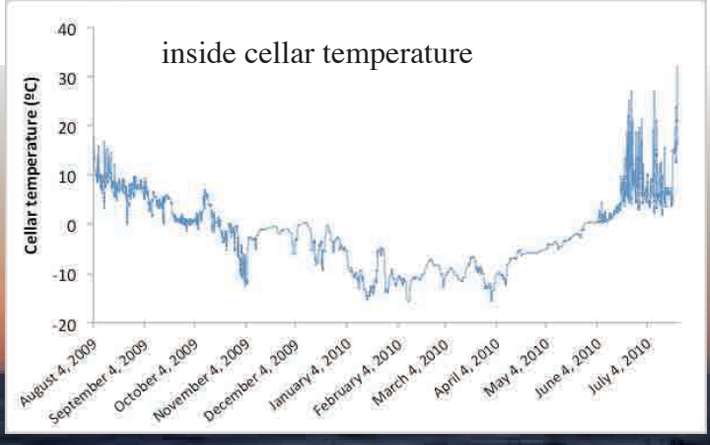
Wales, a village with 138 residents (2008 DCCED Certified Population), is located at the western tip of the Seward Peninsula on Cape Prince of Wales, across the Bering Strait from Little Diomede. There is a burial mound in Wales identified as being of the Birnirk culture; it is dated at more than 1,000 years old. The Russian Navy reported people living at this site in 1827. By 1890, a mission had been established by the American Missionary Association. Reindeer were introduced to the area four years later. Because of its location along the migratory route of whales, Wales became a major whaling center—prosperous and with a population, at one point, of more than 500.

During the 1918–19 influenza epidemic, many people in Wales died; among them were some of the community's finest whalers. Most residents here are Alaska Native or part Native. The traditional Kinugmiut whaling culture is strong in Wales, with ancient songs, dances, and customs still practiced. Subsistence activities are important to the way of life here. Employment includes work with a private reindeer herder and some mining. Some residents produce and sell their artwork. Wales is not on the road system, but is connected by road to Tin City 10 kilometers (6.5 miles) to the southeast. Air carriers use the community's gravel airstrip or, during winter, land on ice in the Bering Straits. When the Bering Straits is ice-free, cargo arrives by barge, and villagers travel by boat between Wales and Little Diomede. Large traditional skin boats are sometimes still used for this trip.

Key Facts:
Annual mean ground temperature: -2.6°C
Freezing days: 213 days
Freezing degree-days: 1703°C days
Thawing degree-days: 748°C days

kauk walrus skin

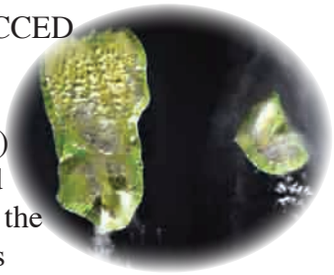




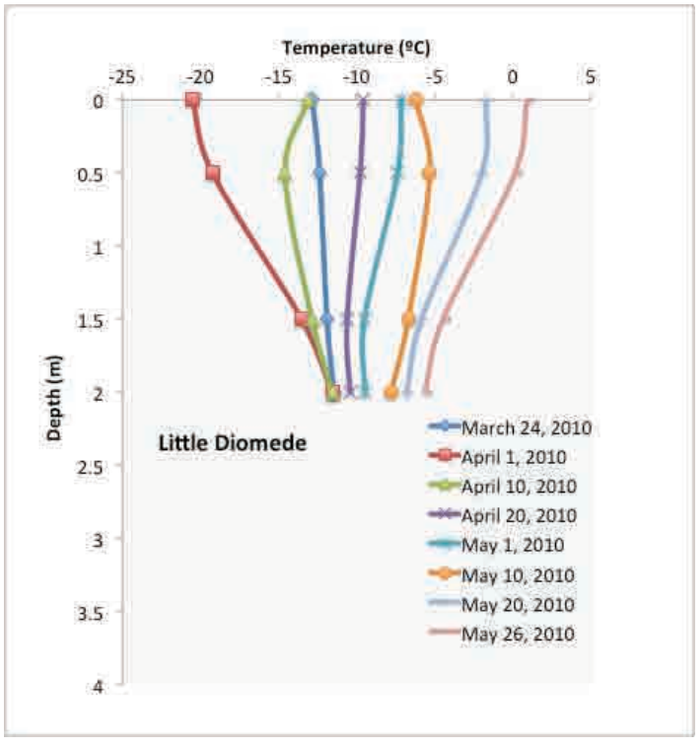
Little Diomede

Bering Straight School District

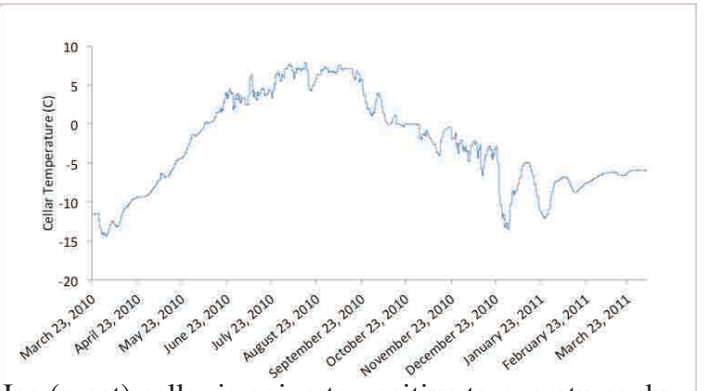
Student population: 27



Diomede, a village with 128 residents (2008 DCCED Certified Population), is located on the west coast of Little Diomede Island, a small island in the Bering Straits, 217 kilometers (135 miles) northwest of Nome. The island is characterized by steep, rocky slopes and constant winds from the north. Little Diomede Island is just 4 kilometers (2.5 miles) east of Big Diomede Island, territory belonging to Russia. The international boundary falls between the two islands. Early inhabitants of these two islands traded with each other and shared cultural and subsistence activities and traditions, until Soviet intervention during the Cold War. At that time, the people of Big Diomede Island were relocated to mainland Russia and the island became a Soviet military base. The choice of the islands' names was made in 1728 by Vitus Bering, who named them after Saint Diomede. The majority of residents at Diomede are Alaska Native or part Native, mainly Ingalikmiut. Subsistence activities are essential to the livelihood of the people living here. Work with the government and the school, or seasonal construction and commercial fishing, is what is available for employment. Many residents of Diomede are excellent ivory carvers and sell their work. Fog, wind, and rough seas limit accessibility to Little Diomede Island in the summer, and the island is surrounded by ice from mid-December to mid-June, when the Bering Straits freezes. A winter ice airstrip on the ocean offers island access to small aircraft, and flights arrive regularly from Nome if weather permits. A heliport is used for mail delivery once a week. A barge with supplies arrives at least once each year. Villagers travel across the Bering Straits to Wales, a village that lies east 45 kilometers (28 miles). In summer, this sea travel is still done by some in traditional skin boats.



Key Facts (cellar):
Annual mean ground temperature: -2.3°C
Permafrost/ground temperature: ND
Freezing degree-days: 1411°C days
Thawing degree-days: 567°C days

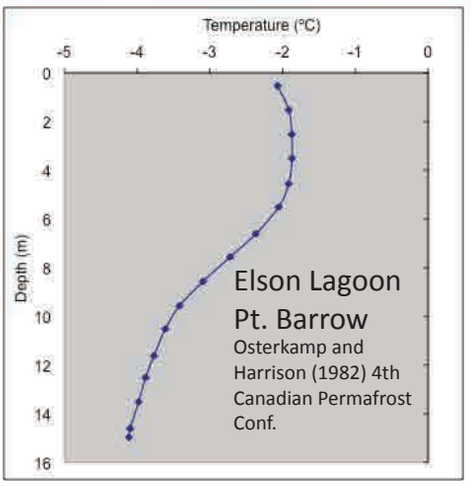


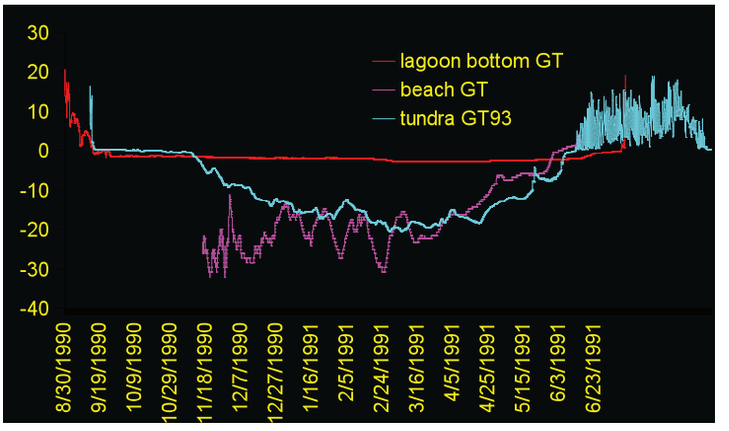
Ice (meat) cellar is going to positive temperatures during summer months. People traditionally use as temporary storage.

Frozen... even under the ocean!?

Seventy percent of Earth is covered by water, much of it the salty water of oceans. There are many mysteries still held by the ocean—many things yet to be discovered.

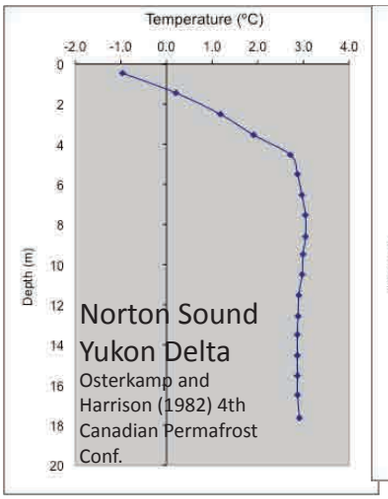
Permafrost lies under the Arctic Ocean. It formed there during the last glacial period, when the sea bottom was exposed to cold air. Ice sheets and glaciers expanded in Canada, Scandinavia, and other northern countries, and sea level was 100–200 m (328–656 ft) lower than it is today, exposing what we now call the continental terrace (the shallow undersea shelf). During this time, permafrost formed several hundred meters deep in ground that gradually became submerged once the climate grew warmer and glacier ice melted, about 18,000 years ago. Today, most of the water in the Arctic Ocean remains below 0°C (32°F) because of its salt content. A 3.5% increase in the salt content of water means that the water's freezing point drops -1.8°C, so ice age permafrost could exist in the submersed sea floor.

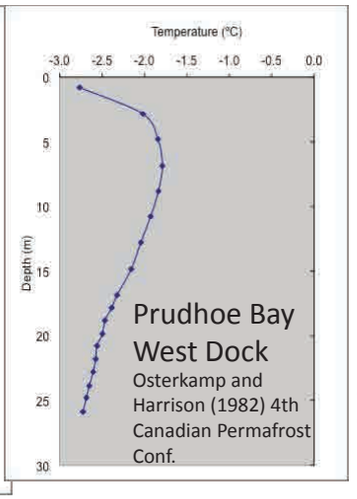




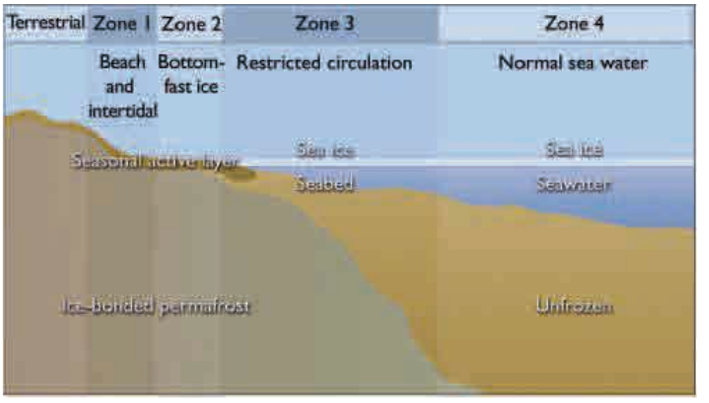
Subsea permafrost also occurs because of coastline erosion due to storms. The coastline along Alaska's North Slope is an example. Here, terrestrial permafrost 300–600 m thick has eroded into the ocean, and submersed (-1.8°C temperature). This ground temperature profile shows that the upper 6 m (20 ft) are the same temperature as the ocean, but below 8 m (26 ft), ground temperature approaches that of the original permafrost.

During springtime, a drill can operate through sea ice almost as easily as in land, and data loggers can be set up at the sea bottom. Monitoring data loggers can be done every day if you live on the boat throughout the winter, as I once did. The graph to the left shows that the winter temperature at the ocean bottom stays from about 0°C (32°F) to 2.8°C (27°F). At the beach, the temperature reaches -30°C (-22°F).





Permafrost is unknown in the Bering Sea. During the Ice Age, Eurasia and Alaska were connected by a land bridge, called Beringia. The frozen land was submerged, and today, many subsea temperatures in that area measure below zero, though less so than in the Arctic Ocean. No permafrost is found in the Yukon Delta–Norton Sound area.



There are four types of subsea permafrost:
Zone 1 – beach (on shore); temperature is warmer than land, but slightly approaches ocean temperature.
Zone 2 – sea floor covered by sea ice during winter, which has an effect on strong winter freezing; sea floor has freeze/thaw cycles (an active layer).
Zone 3 – no longer sea ice launched at floor, but still a variety of permafrost exists.
Zone 4 – normal seawater (deep ocean bed); still has old ice-bonded permafrost, but most is unfrozen.

Subsea permafrost is exciting and challenging to study. The shallow sea floor has many scratch marks due to sea ice movement. It is difficult to leave permanent scientific instruments on the sea floor. This image (below) was obtained by side scan sonar using acoustic signals.

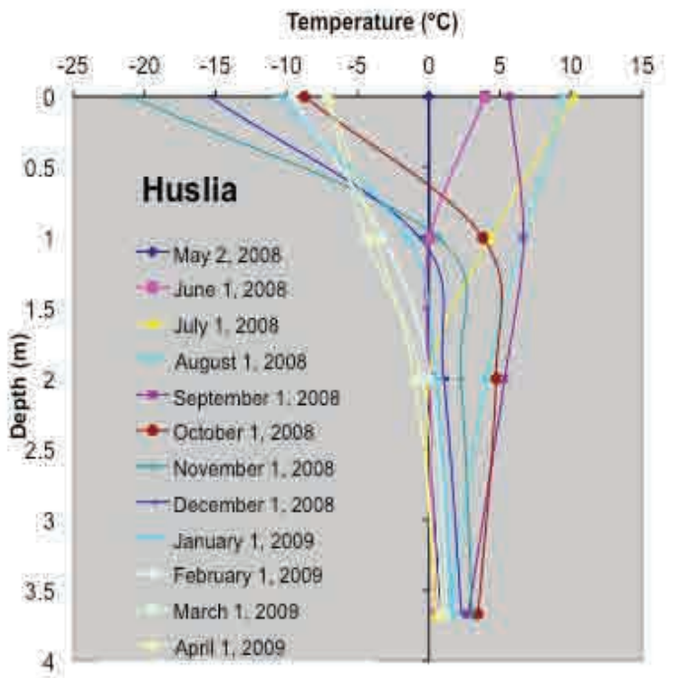
Location: 65.70° N, 156.37° W

Huslia

Yukon-Koyukuk School District

Student population: 78

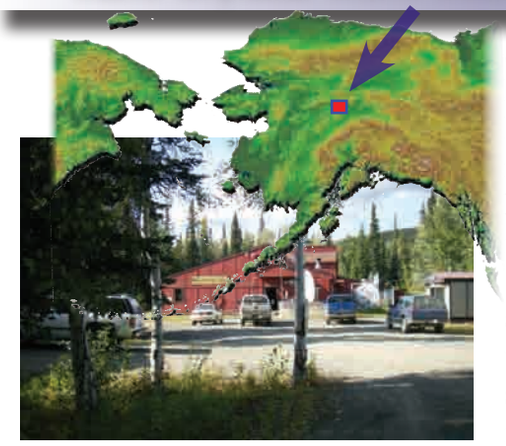
Huslia, a village with 277 residents (2008 DCCED Certified Population), is located on the north bank of the Koyukuk River, downriver from Hughes and northeast of Galena. Historically, this area is home to the Koyukon Athabascans, who had seasonal camps throughout and traded with the Inupiat of the Kobuk River. Russians explorers were on the Koyukuk River by 1843. By 1870, workers with the Western Union Telegraph Company had explored this area, and missionaries had arrived. Huslia moved to its present location in 1949, after repeated flooding at its original site. Families began to stay year-round in the 1950s, after a school, post office, airstrip, and roads had been constructed. Most residents in Huslia are Alaska Native or part Native, mainly Koyukon Athabascans. Subsistence practices are important to the livelihood of people living here. Employment includes work with local government, the school, and the clinic, and in stores. Jobs with construction and firefighting are sometimes available. Though Huslia is not on the road system, it has several winter trails. The Koyukuk River, which is traveled both summer and winter, is ice-free from May through September. Barges bring supplies to Huslia twice during this time. The community has a gravel airstrip.



Key Facts (2008):
Annual mean ground temperature: -1.0°C
Freezing days: 220 days
Freezing degree-days: 2012 °C days
Thawing degree-days: 1634 °C days

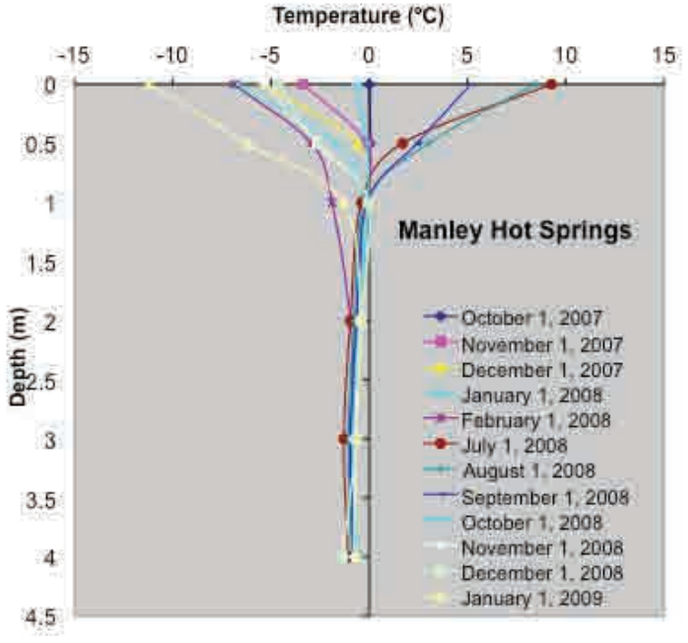
Manley Hot Springs

Yukon-Koyukuk School District



Student population: 11

Manley Hot Springs, a community with 77 residents (2008 Estimated Population, not Certified), is located at the end of the Elliott Highway, north of the Tanana River, on Hot Springs Slough. The community is 258 kilometers (160 miles) west of Fairbanks by road. Historically, this area is the home of Athabascans. A mining prospector homesteaded here in 1902, developing a vegetable farm on 278 acres. At about the same time, a trading post and U.S. Army telegraph station were built. The location was called Baker's Hot Springs then, named after a nearby creek, and soon became a service and supply point for miners in the area. Mining activities and the Hot Springs Resort Hotel, built in 1907, helped the community to thrive; soon, other businesses opened. A fire in 1913 destroyed the resort, and at about the same time, mining began to decline, causing a drastic drop in the town's population. In 1957, the town was renamed Manley Hot Springs, after Frank Manley who built the resort, and a couple of years later, the community had a school and a road that connected it to Fairbanks. This road, the Elliott Highway, passes through the community and ends just southwest of it at the Tanana River, where there is a boat landing. Employment today includes work in several small businesses, the school, a health clinic, government offices, and commercial fishing. A gravel runway at Manley Hot Springs is used year-round.

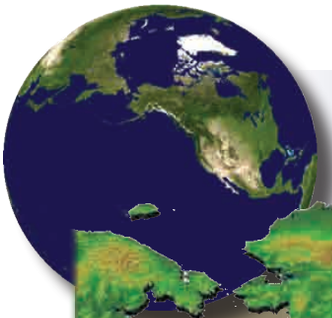


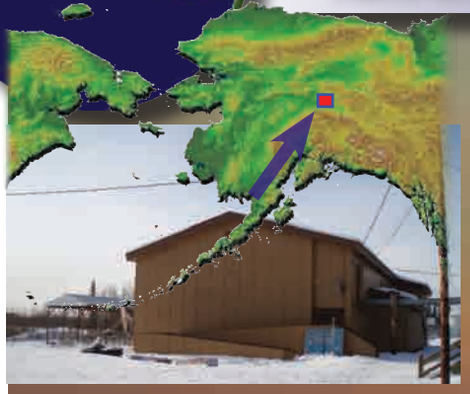
Key Facts (2008):
Annual mean ground temperature: 0.1°C
Freezing days: 215 days
Freezing degree-days: 1262°C days
Thawing degree-days: 1289°C days

Location: 65.15° N, 149.35° W

Minto

Yukon-Koyukuk School District





Student population: 52

Minto, a village with 190 residents (2008 Estimated Population, not Certified), is located on the west bank of the Tolovana River, at the end of an 18-kilometer (11-mile) spur road off the Elliott Highway. The community is west of Fairbanks and northeast of Manley Hot Springs. Historically, Minto marks the westernmost area of where Tanana Athabascans have lived. Old Minto—the first Minto settlement—was located on the bank of the Tanana River. The discovery of gold north of Fairbanks in 1902 brought steamboats up the Tanana River with supplies for miners; they also brought non-Natives, who moved into the area. A BIA school opened in 1937. Families from Nenana, Toklat, Crossjacket, and Chena moved to Old Minto. Because of repeated flooding and erosion at the Old Minto site, the village changed locations, moving 64 kilometers (40 miles) north to its present site on the Tolovana River. This new location had been used as a fall and winter camp since the early 1900s. Most residents of Minto are Alaska Native or part Native, mainly Tanana Athabascan. Subsistence activities are important to the way of life here. Employment includes work with the school, lodge, clinic, and village council, and firefighting. The community has a gravel airstrip. Boats are used on the Tolovana, but the river is too shallow for barges.

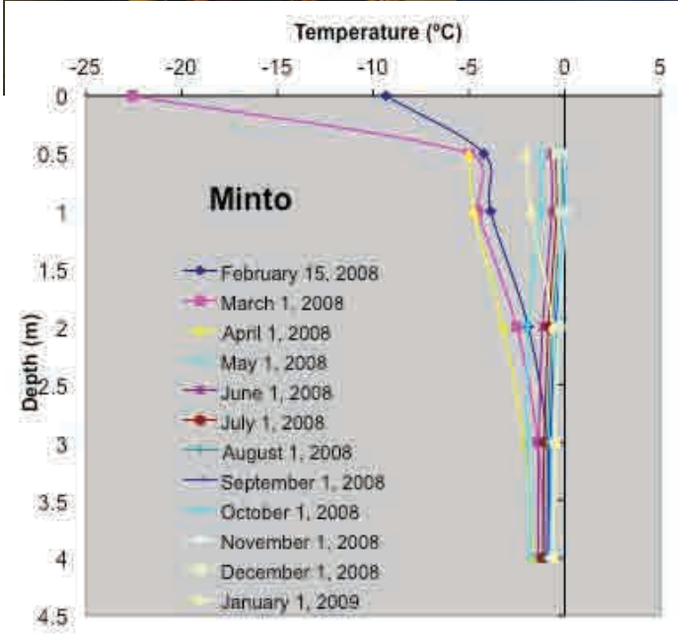
Key Facts:

Annual mean ground temperature: nd°C

Freezing days: nd days

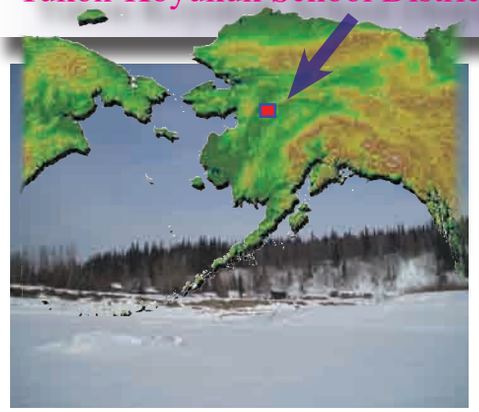
Freezing degree-days: nd °C days

Thawing degree-days: nd°C days



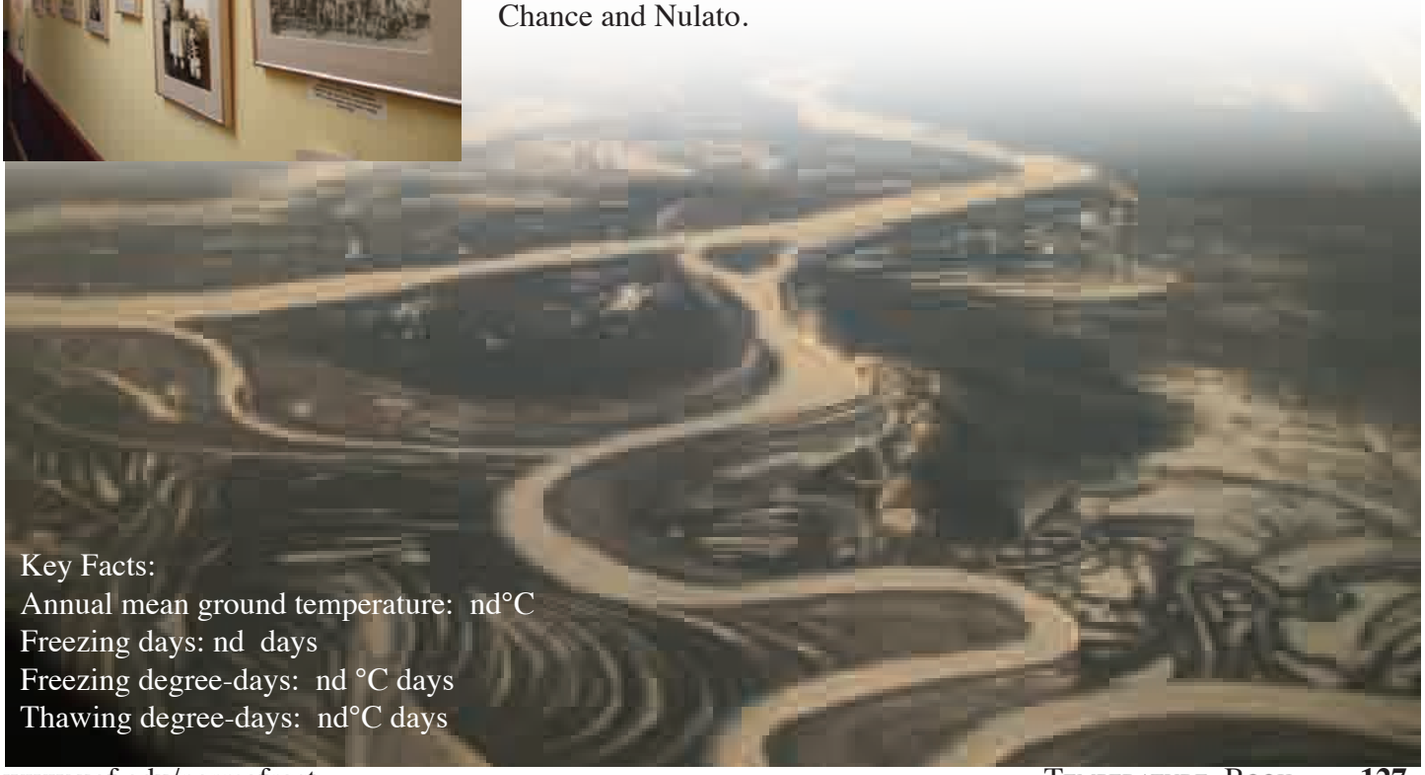
Koyukuk

Yukon-Koyukuk School District



Student population: 12

Koyukuk, a village with 88 residents (2008 DCCED Certified Population), is located where the Koyukuk River meets the Yukon River, between Nulato and Galena. Historically, Koyukon Athabascans have had seasonal hunting camps throughout this area and fish camps on the Yukon River. For generations, trading took place between the Koyukon Athabascans and Inupiat. In 1838, a Russian trading post was established in Nulato. A year later, a smallpox epidemic swept the area, including Koyukuk. In 1867, the U.S. built a military telegraph line on the north side of the Yukon River, and Koyukuk was selected as a telegraph station. By 1900, the village had a trading post and a post office, and steamboats traveled the rivers, carrying and supplying gold prospectors. A food shortage and a measles outbreak in 1900 devastated the local population, reducing it by one-third. Gold mining activity in the Koyukuk area diminished after 1906, but lead mining upriver in Galena began 13 years later. Once a school was constructed in Koyukuk in 1939, families began to live there year-round. Most residents of Koyukuk are Alaska Native or part Native, mainly Koyukon Athabascan. Subsistence activities are important to their way of life. Employment includes work in the school, store, and clinic, and in local and tribal government, firefighting, and construction. Koyukuk is not on the road system, but a lighted gravel runway permits year-round air transportation. When the Yukon River is ice-free, generally, from mid-May through October, people travel it by boat regularly and barges bring cargo. Residents have many local trails to use, as well as winter trails to Chance and Nulato.

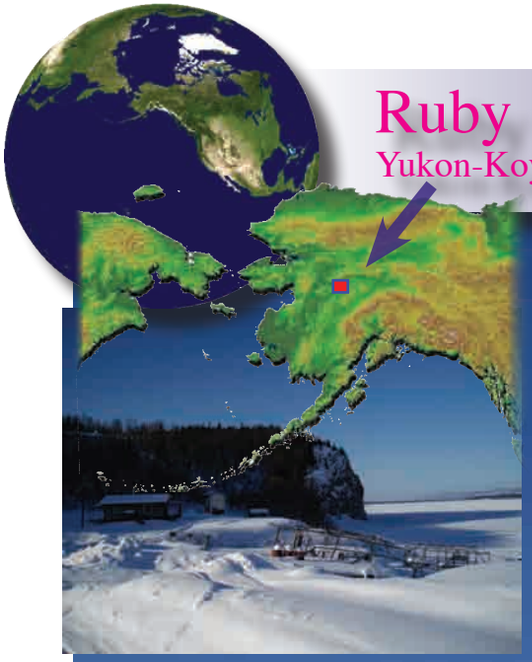


Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

Location: 64.74° N, 155.45° W

Ruby

Yukon-Koyukuk School District



Student population: 33

Ruby, a village with 160 residents (2008 DCCED Certified Population), is located on the south bank of the Yukon River, upriver from Galena, in the Kilbuck-Kuskokwim Mountains. Koyukon Athabascans of the Nowitna-Koyukuk band are the indigenous people of this area; they had seasonal camps throughout where they hunted and fished. Gold prospectors selected this location as a supply point, naming it Ruby, because they thought that red-colored stones they found here were rubies. Hundreds of gold prospectors were drawn to the area because of a gold strike at nearby Ruby Creek in 1907 and Long Creek in 1911. The population of the area grew to 1,000, with boom settlements in Placerville, Poorman, Sulatna Crossing, Kokrines, and Long Creek. As gold finds diminished and mines closed because of World War II, most non-Natives left the country. After the war, Ruby's population began to grow again when people from nearby Kokrines moved there. Most residents of Ruby are Alaska Native or part Native, mainly Athabascan, with a strong traditional culture. Subsistence practices are important to their way of life. Ruby is not on the road system, but has a lighted gravel airstrip for air carriers. The community has a boat launch and an off-loading area for barges, which make deliveries during the summer. The Yukon River, which is ice-free from mid-May through mid-October, is traveled summer and winter. One road leads south from Ruby to Long Creek Mine.

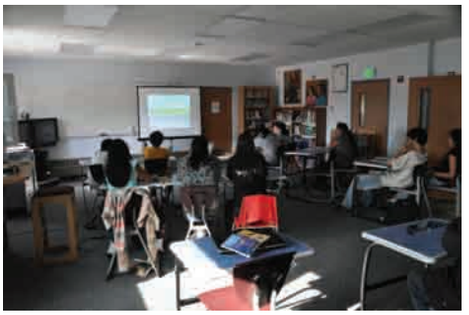
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

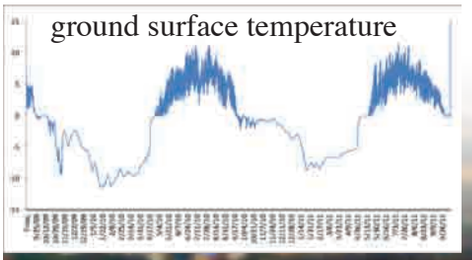
pingos

Over hundreds of open system pingos have been reported in these regions. The first pingo report was made in 1915 by George L. Harrington (United States Geological Survey) at Main Creek, Ruby district (in Leffingwell, E. de K., 1919: The Canning River region, northern Alaska. U.S.Geol.Surv. prof. paper. 109. 251p.)

Allakaket

Yukon-Koyukuk School District

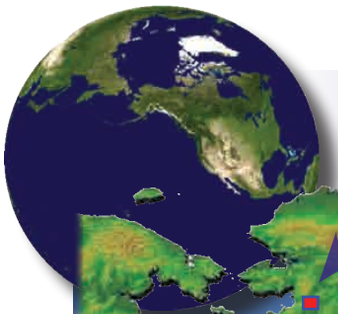




Student population: 40

Allakaket, a village with 96 residents (2008 DCCED Certified Population), is located on the south bank of the Koyukuk River, southwest of the mouth of the Alatna River. Across the Koyukuk River from Allakaket is the Inupiat village of Alatna, and down the river 92 kilometers (57 miles) is the village of Hughes. Historically, this part of Alaska has been home to Koyukon Athabascans and Inupiat from Kobuk, Selawik, and further northwest. The Koyukon Athabascans lived in camps, moving with the season and availability of resources, but in 1851, a band established a settlement in Allakaket. Athabascans and Inupiat traded at the old site of Alatna. In 1906, the first mission on the Koyukuk River was established in Allakaket, and by 1957, the village had both a post office and a public school. After Allakaket experienced severe flooding from the Koyukuk River twice in thirty years—the most recent time, in 1994—the community decided to rebuild further from the river, calling the site New Allakaket. Much of the village is still at the original site. Most residents at Allakaket are Alaska Native or part Native, mainly Athabascan. Traditional subsistence practices are important to the way of life here. Employment includes work at the school, for the government and tribe, and for the village corporation store, and seasonal construction and firefighting. Allakaket is not on the road system, but there is air carrier service, and winter trails lead to Hughes, Bettles, and Tanana. The Koyukuk River, which is ice-free from June through October, is an important transportation route, though it is too shallow for a commercial barge.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days



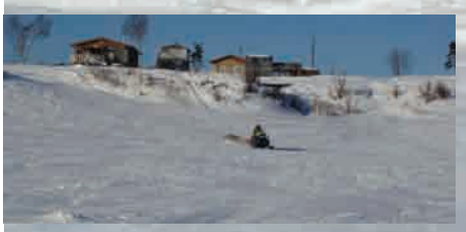
Location: 64.72° N, 158.11° W

Nulato

Yukon-Koyukuk School District

Student population: 46

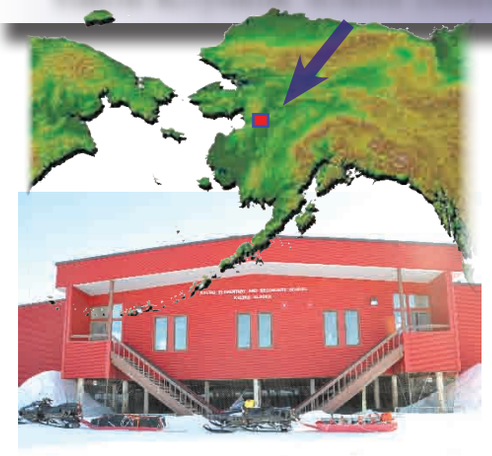
Nulato, a village with 274 residents (2008 DCCED Certified Population), is located on the west bank of the Yukon River, between Kaltag and Koyukuk. The indigenous people of this area are Koyukon Athabascans; they lived in seasonal camps where game and fish were available. Trade between Inupiat from the Kobuk area and Athabascans took place at Nulato. Before the 1830s, contact with non-Natives was limited. In 1839, a Russian explorer opened a trading post here. That same year, a smallpox epidemic swept through the region. A dispute between the Koyukuk River people and those of Nulato led to the massacre of many Nulato villagers in 1951. Over the next thirty-five years, the Western Union Telegraph Company explored the area, a Roman Catholic mission and school was established, and the Yukon and Koyukuk gold rush occurred. Steamboats traveled the Yukon River, stopping at Nulato for firewood. More than a third of the Nulato population was killed during a measles epidemic and food shortage in 1900. Gold mining decreased in the area around 1906, but several years later, lead mining upriver near Galena began. Most residents of Nulato are Alaska Native or part Native, mainly Koyukon Athabascans. Traditional subsistence activities are important to the way of life here. Employment includes work with the school, clinic, local and tribal government, and store. Some residents work at seasonal jobs in firefighting, construction, and commercial fishing. Nulato is not on the road system, but has a lighted airstrip for air carriers. The Yukon River is an important transportation route for villagers both winter and summer. Barges bring supplies while the Yukon is ice-free from mid-May through mid-October. A new townsite is being developed on the hills a few kilometers north of the village.

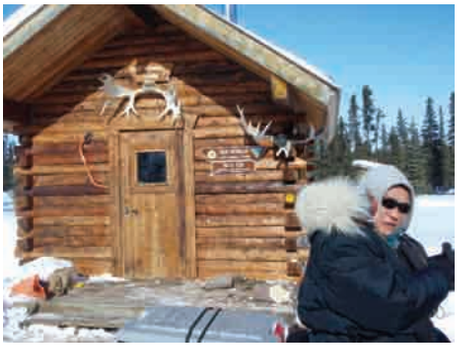


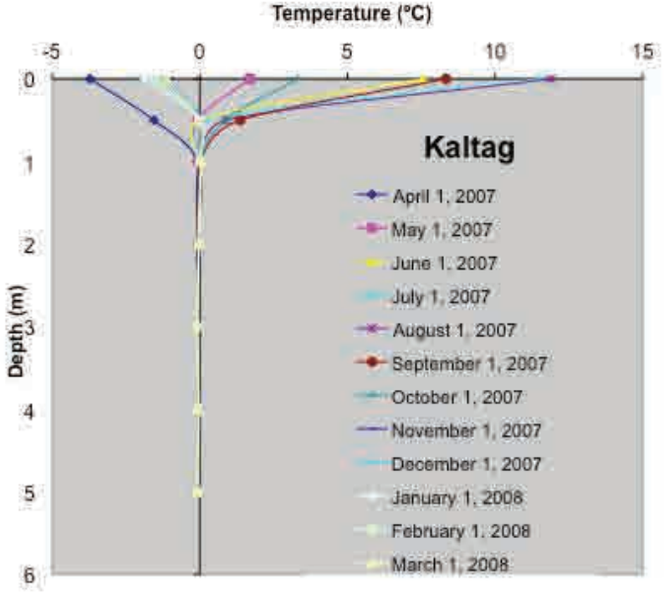
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

Kaltag

Yukon-Koyukuk School District







Student population: 26

Kaltag, a village with 188 residents (2008 DCCED Certified Population), is located on the west bank of the Yukon River, between Nulato and Grayling. Situated on a bluff at the base of the Nulato Hills, Kaltag was the site of a cemetery used by Koyukon Athabascans from surrounding villages. An old portage trail runs west through the village and the mountains, leading to Unalakleet. The original inhabitants of this area had numerous fish camps along the Yukon River and seasonal camps throughout the land, moving as the game migrated. Russians exploring the Yukon River called this site Kaltaga. In 1839, a smallpox epidemic struck the Koyukon Athabascan, the first of several epidemics that would affect the people living here. During the latter half of the 1800s, a telegraph line had been built along the north side of the Yukon River, a Roman Catholic mission and school had opened upriver in Nulato, and steamboats traveled the Yukon River, supplying gold prospectors. A food shortage occurred in 1900, and then another epidemic, this time measles, which killed one-third of the local population. Survivors from three neighboring seasonal villages moved to Kaltag and settled there. Continued mining activity upriver placed Kaltag on a major transportation route, leading to economic growth. A school was built hee in 1925, and a post office opened permanently in 1933. The majority of residents in Kaltag are Alaska Native or part Native, mainly Koyukon Athabascan. Subsistence activities are important to the way of life here. Employment includes work with the tribe, school, and local government, and firefighting, commercial fishing, and fish processing. Every two years, a Stick Dance Festival is held in Kaltag, drawing visitors from neighboring villages. Relatives of people who are recently deceased sponsor this one-week festival of potlatches to show appreciation to those who helped them during their time of mourning. Kaltag has a gravel airstrip that allows year-round air transportation. When the Yukon River is ice-free from mid-May through mid-October, barges deliver supplies to the community. There are numerous trails and the frozen river used for travel as well.

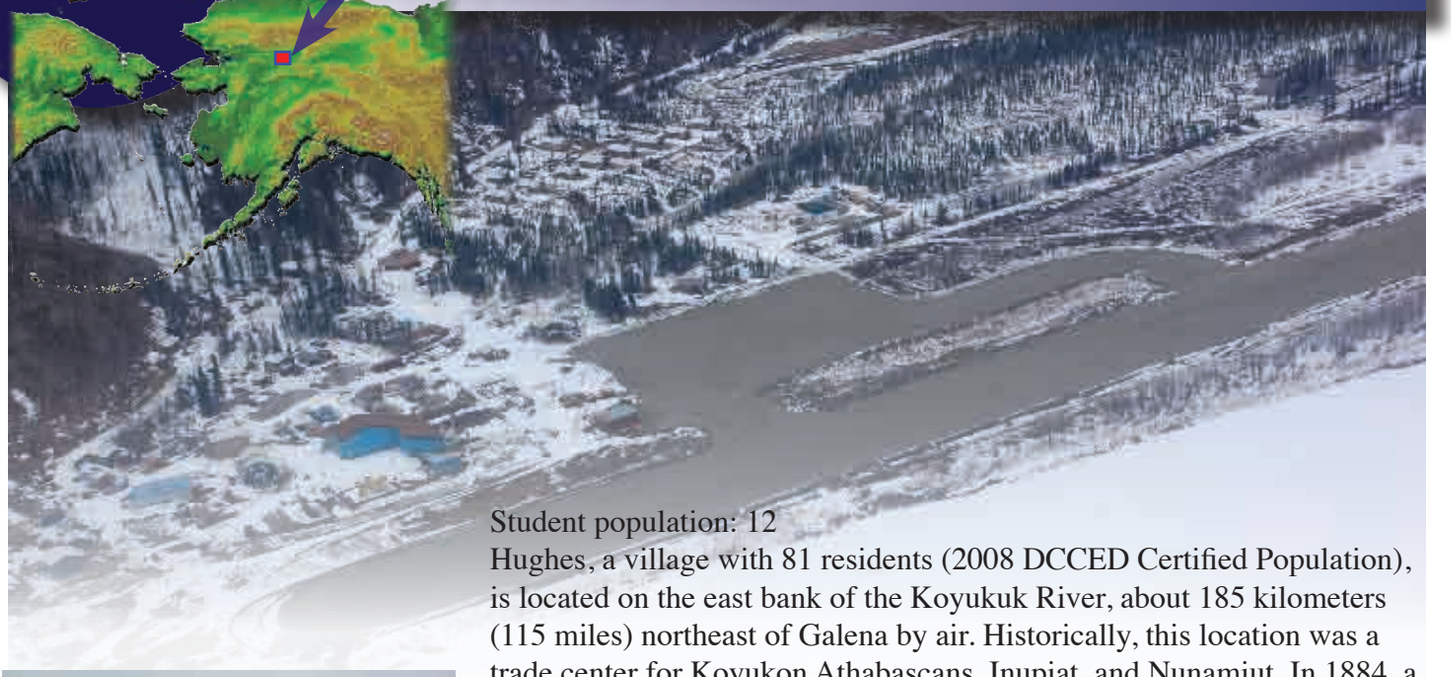
Key Facts:

Annual mean ground temperature: nd°C

Location: 66.05° N, 154.26° W

Hughes

Yukon-Koyukuk School District



Student population: 12

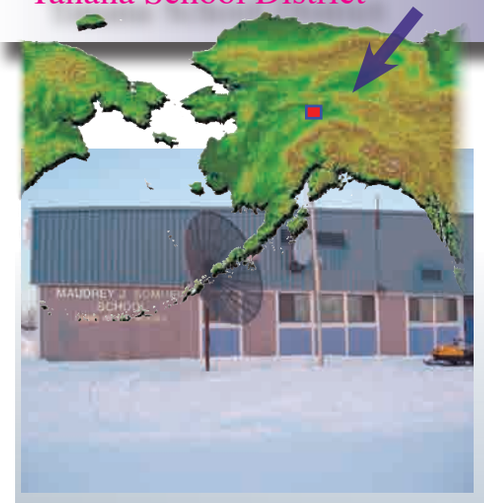
Hughes, a village with 81 residents (2008 DCCED Certified Population), is located on the east bank of the Koyukuk River, about 185 kilometers (115 miles) northeast of Galena by air. Historically, this location was a trade center for Koyukon Athabascans, Inupiat, and Nunamiut. In 1884, a gold miner named Roy Hughes prospected a site a few kilometers upstream. Until 1915, when the gold mining industry in the area began to decline, riverboats used Hughes as a landing and supply port for supplies headed to the Indian River gold fields. By the mid-1950s, a post office, an airstrip, and a school had been built here. Most residents of Hughes are Alaska Native or part Native, mainly Koyukon Athabascan. Traditional subsistence practices are important to the way of life here. Employment includes part-time work with the local government, school, tribal clinic, or store. Seasonal employment in construction and firefighting is sometimes available. The Koyukuk River is an important local transportation route, and the residents of Hughes travel on it year-round. Hughes is not on the road system, but a gravel runway permits air transportation.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

Lenticular clouds (Altocumulus lenticularis), by the Indian Mountains, near Hughes are stationary lens-shaped clouds that form at high altitudes.

Tanana

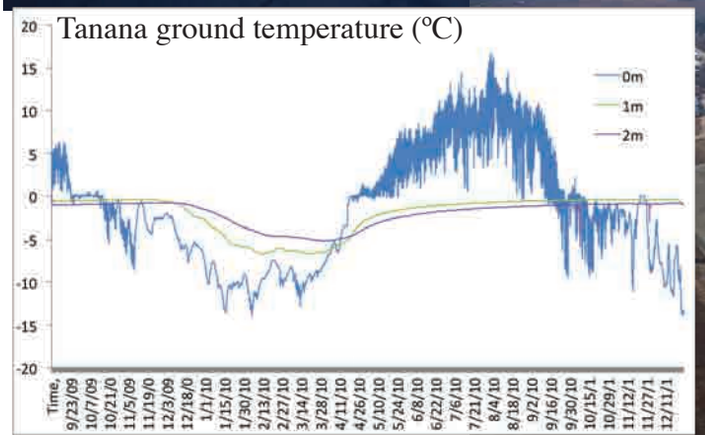
Tanana School District



Student population: 38

Tanana, a village with 252 residents (2008 DCCED Certified Population), is located on the north bank of the Yukon River, 3 kilometers (2 miles) downriver from its confluence with the Tanana River. The community is about 209 kilometers (130 miles) west of Fairbanks by air. Historically, Tanana was a trading settlement for Koyukon and Tanana Athabascans. In 1880, the Alaska Commercial Company established a trading post several kilometers downriver from Tanana, calling it Harper's Station, and a year later, missionaries with the Church of England in Canada built a mission between Harper's Station and Tanana. By 1898, the St. James Episcopal Mission had constructed a school and hospital in Tanana, and a telegraph station opened to maintain the telegraph line between Fairbanks and Nome. Gold miners, who had been in the area since the late 1800s, began leaving the Yukon River after 1906, and the telegraph station was eventually abandoned. An air base that served as a refueling stop for the lend-lease aircraft program was built near the community during World War II. The population in Tanana is mixed, but most residents are Alaska Native or part Native, mainly Athabascan. A traditional Athabascan way of life is predominant. Employment includes work with the local government, school, and Native council, and in business and services. Seasonal work includes construction, BLM firefighting, and commercial fishing. Tanana has a lighted gravel runway, many kilometers of local roads, and a dock where barges can offload supplies. The Yukon River is ice-free from mid-May to mid-October.

Key Facts (2009):
Annual mean ground temperature: -1.18°C
Freezing days: 202 days
Freezing degree-days: 1265°C days
Thawing degree-days: 865°C days



Location: 61.14° N, 146.35° W

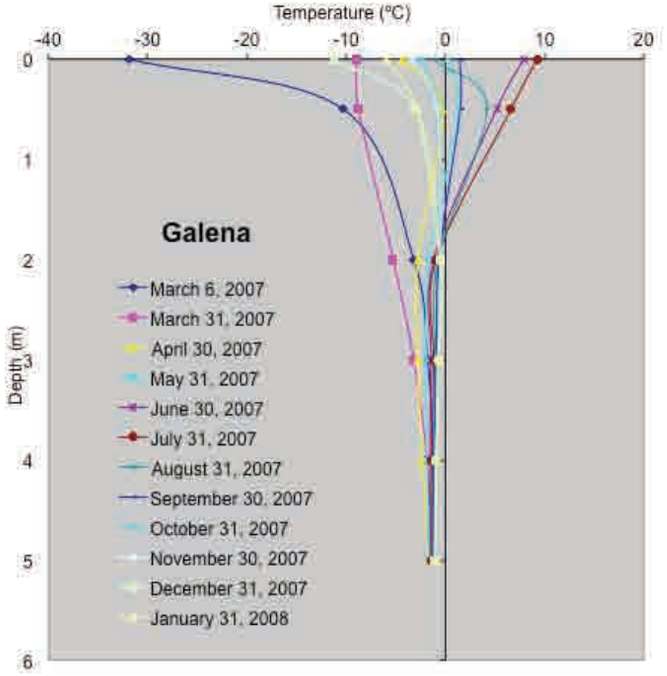
Galena

Galena City Schools District

Student population: 3,721 (there is a boarding school here)

Galena, a village with 580 residents (2008 DCCED Certified Population), is located on the north bank of the Yukon River, 48 kilometers (30 miles) east of Koyukuk. For thousands of years, this area has been home to Koyukon Athabascans. One of the several fish camps they used along the Yukon River, called Henry's Point, is near where Galena was established in 1918. Lead ore mines operating nearby used this site as a supply and shipping point. A group of Athabascans who lived upriver at a place named Louden moved to Galena around 1920 for employment, hauling freight for the mines and selling wood to steamboats. By the mid-1920s, a school had been established, and by 1932, a post office was opened. During World War II, the U.S. military constructed an airfield here, which became the Galena Air Force Station. Improvements to military facilities, the airport, and roads were made in the 1950s.

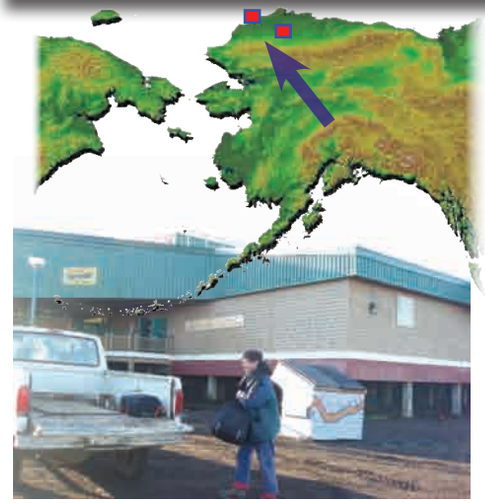
The original site of Galena withstood a flood in 1945 and one in 1971. After the one in 1971, residents decided to develop a new community site just east of the original settlement. The new location at Alexander Lake is referred to locally as New Town. After the Air Force station closed in 1993, the Galena School District converted vacant military buildings into a boarding school. Galena's population is diverse. Those who are Alaska Native or part Native are mainly Athabascan, of which many are descendants of Louden. Galena is the hub for commercial, government, and transportation activities in western Interior Alaska. These activities provide most of the local employment. There is also seasonal employment in construction, firefighting, and commercial fishing. Though Galena is not located on the road system, its airport allows year-round air transportation. The Yukon River, ice free from mid-May through mid-October, is a major transportation route. Barges bring cargo upriver during summer. After freeze-up, travel to neighboring villages is common on the frozen river. There is a winter trail between Galena and Huslia.



Key Facts (2007):
Annual mean ground temperature: 1.6°C
Freezing days: 205 days
Freezing degree-days: 1329°C days
Thawing degree-days: 1898°C days

Wainwright/ Atqasuk

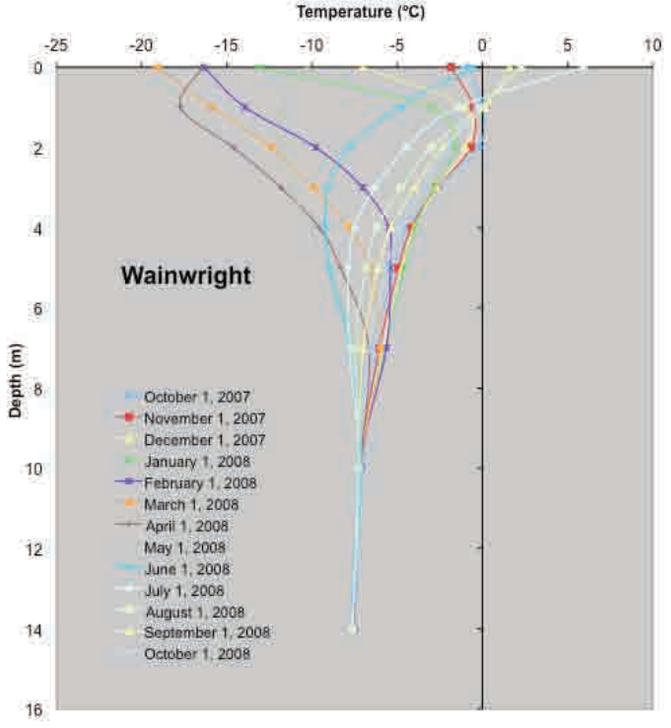
North Slope Borough School District

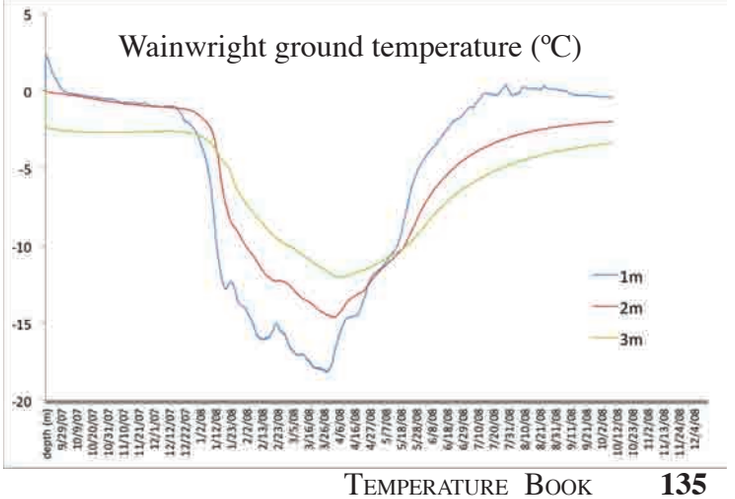


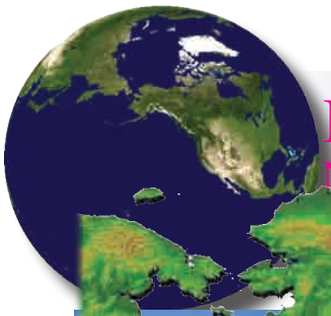
Student population: 158

Wainwright, a village with 534 residents (2008 DCCED Certified Population), is located on the Chukchi Sea coast, northeast of Pt. Lay. The Inupiat name for this site on the Chukchi Sea coast was Olgoonik. Historically, the Utukamiut (people of the Utukok River) and Kukmiut (people of the Kuk River) lived in the area. The mouth of the Kuk River is nearby. A lagoon just southwest of the village—Wainwright Lagoon—was named in 1826 by a British sea captain for an officer in his crew. Settlement of the village began in 1904, when the Alaska Native Service built a school and began to offer medical and other services. By 1916, a post office had opened. In the 1950s, a Distance Early Warning site was installed nearby. Most residents of Wainwright are Alaska Native or part Native, mainly Inupiat. A traditional subsistence way of life is predominant in the community. Employment is mostly with borough services. Residents produce and sell their artwork. Wainwright has two gravel airstrips: one in the community and one at the old Wainwright Air Station. The Chukchi Sea is ice-free from mid-July through September.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days



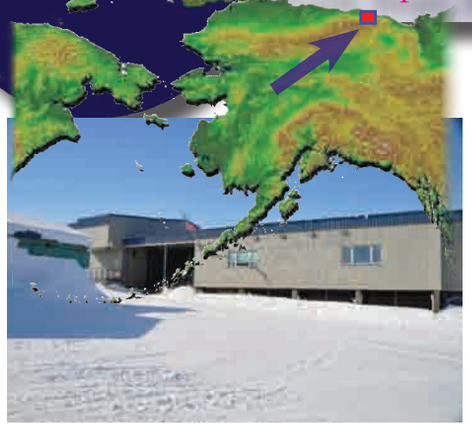




Location: 70.11° N, 143.63° W

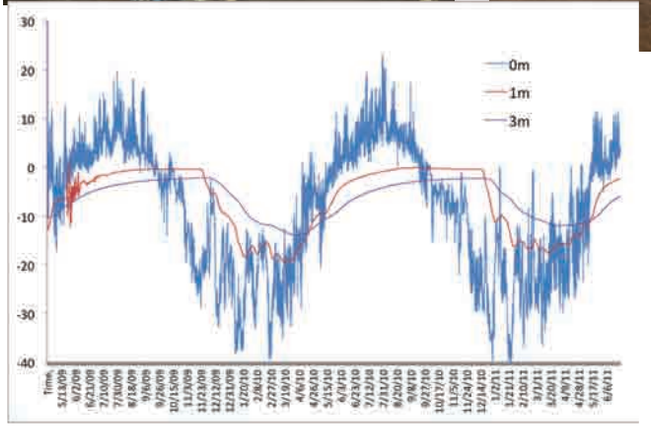
Kaktovik

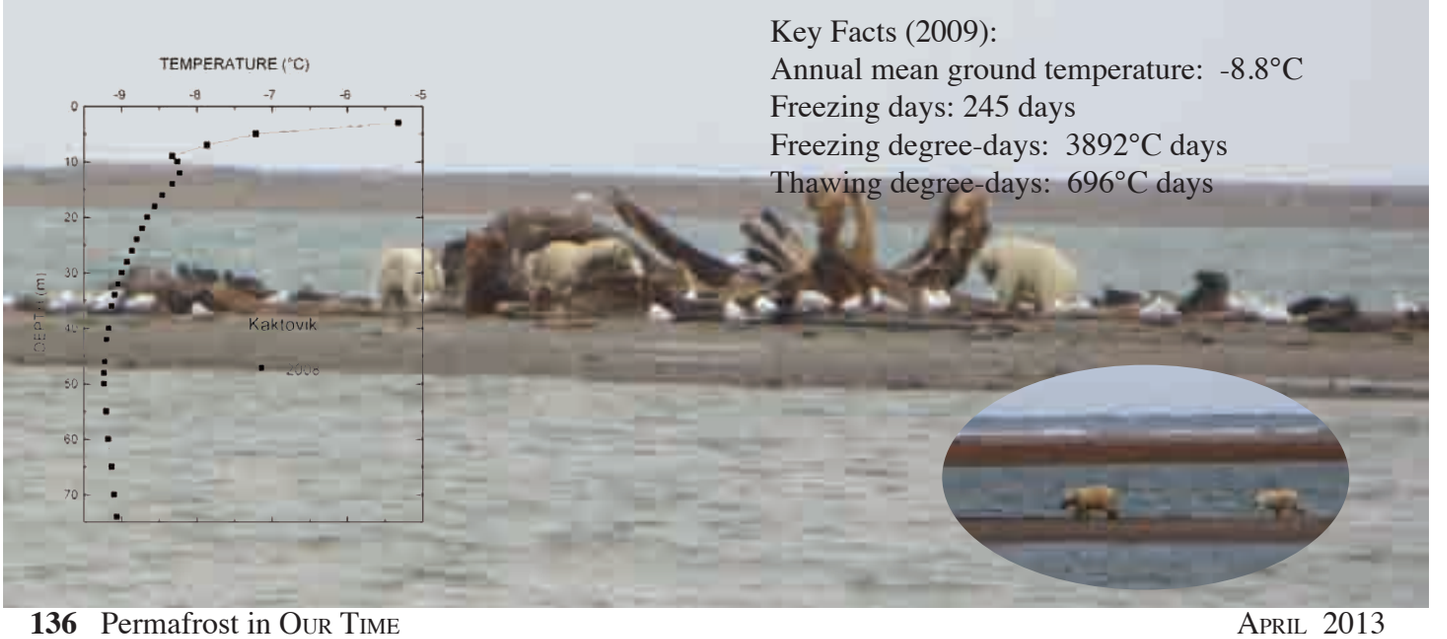
North Slope Borough School District



Student population: 58

Kaktovik, a village with 272 residents (2008 DCCED Certified Population), is located on the north shore of Barter Island on the coast of the Beaufort Sea in northeast Alaska. The area around Kaktovik has been inhabited for thousands of years by the Inupiat. Historically, this site was a major trade center for the Inupiat of Alaska and the Inuit of Canada. In the 1950s, the U.S. built a Distant Early Warning Line station here. Most residents of this community are Alaska Native or part Native, mainly Inupiat. Traditional subsistence practices are important to the way of life here. Employment includes work in the school, with local services, and seasonal construction. Kaktovik is not on the road system, but an airport, owned by the U.S. Air Force and operated by the North Slope Borough, allows year-round air transportation.

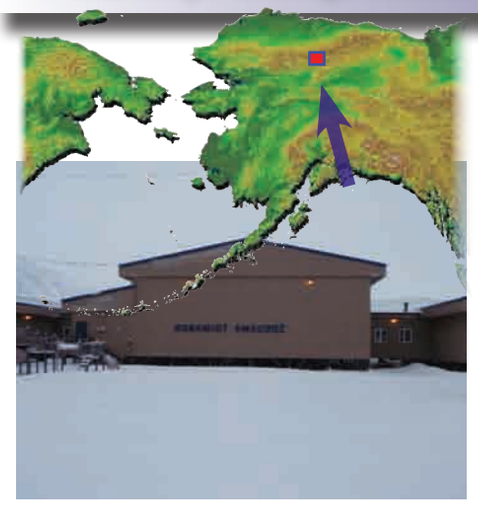




Key Facts (2009):
Annual mean ground temperature: -8.8°C
Freezing days: 245 days
Freezing degree-days: 3892°C days
Thawing degree-days: 696°C days

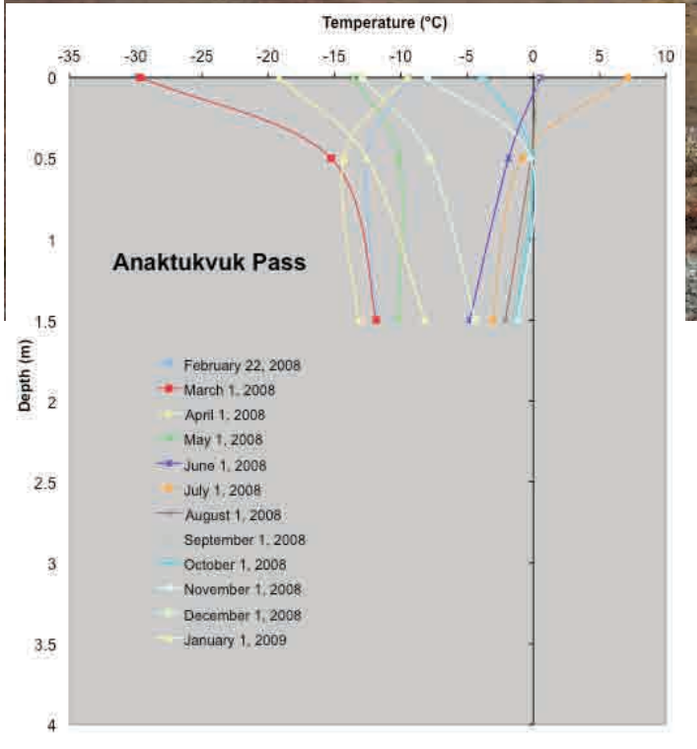
Anaktuvuk Pass

North Slope Borough School District

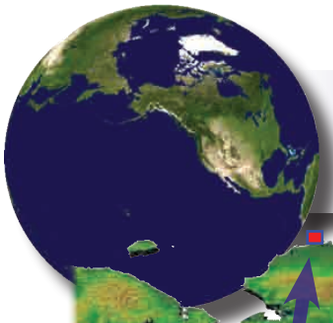


Student population: 86

Anaktuvuk Pass, a village with 284 residents (2008 DCCED Certified Population), is located in the central Brooks Range, on the divide between the Anaktuvuk and John Rivers. Settlement at this particular location by Nunamiut (inland northern Inupiat) began in 1949, but long before that, these people lived throughout the Brooks Range. Caribou were (and still are) an important subsistence resource to this culture. When the numbers of caribou in the Arctic caribou herd dwindled in the mid-1920s, the depletion of such an essential food source forced the Nunamiut to leave the area for many years, many moving to the coast, where food was more plentiful. In the late 1930s, several Nunamiut families moved inland to Chandler Lake and the Killik River, and later settled at the present site of Anaktuvuk Pass. The word anaktuvuk in Inupiaq (the language of the Inupiat) means "place of caribou droppings." Most residents in the village are Alaska Native or part Native who lead a traditional subsistence way of life. Anaktuvuk Pass is not located on the road system, but air service is available. In winter, cargo is transported by "Cat-trains" that head west from the Trans-Alaska Pipeline haul road. The annual mean air temperature in Anaktuvuk Pass is 8°C (18°F). Annual precipitation averages 28 centimeters (11 inches); annual snowfall averages 1.6 meters (63 inches).



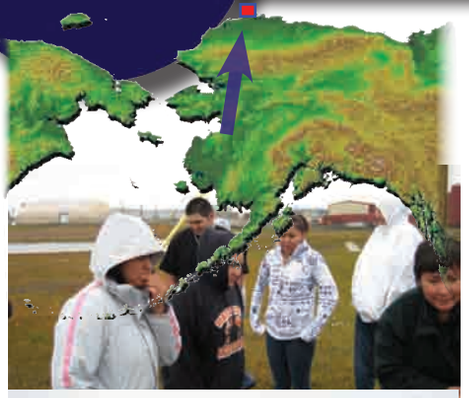
Key Facts (2009):
Annual mean ground temperature: -6.4°C
Freezing days: 244 days
Freezing degree-days: 3057 °C days
Thawing degree-days: 709 °C days



Location: 71.29° N, 156.77° W

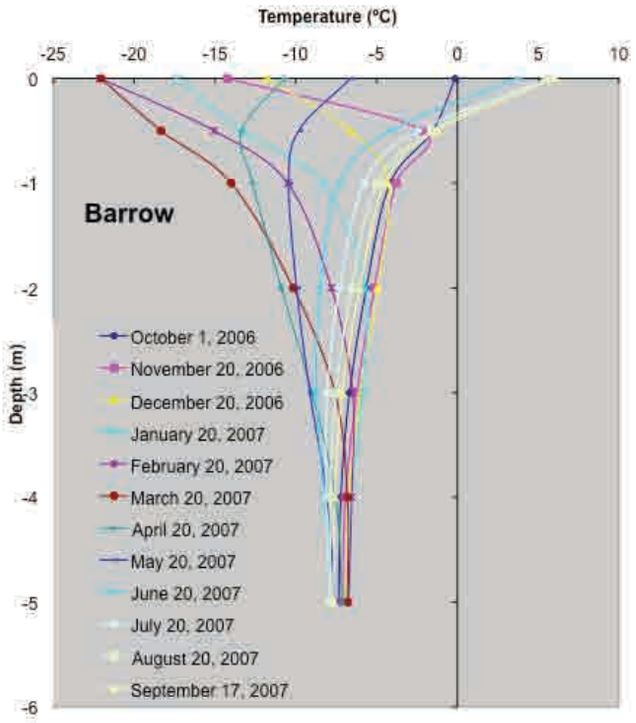
Barrow

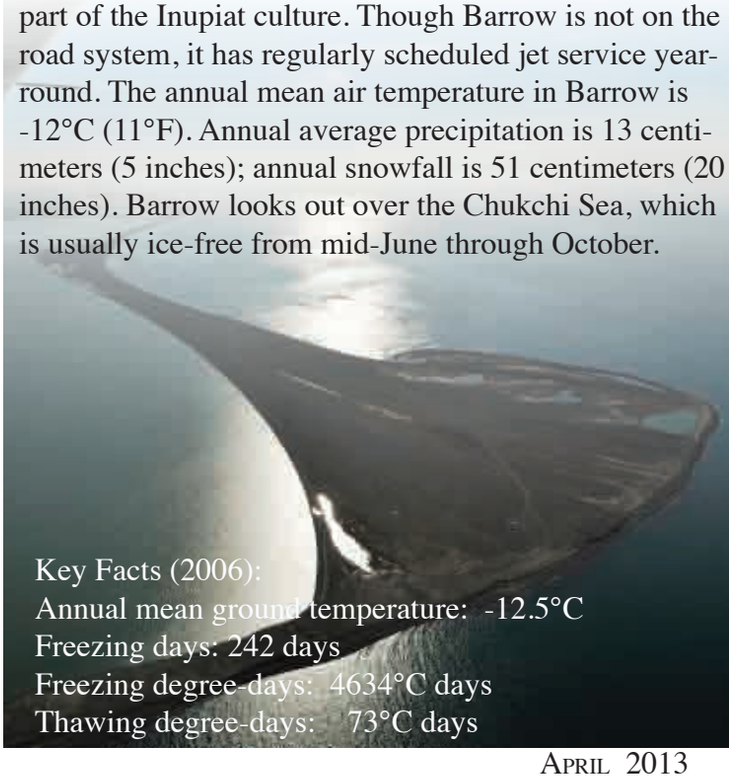
North Slope Borough School District



Student population: 1,037

Barrow, a community with 4,054 residents (2008 DCCED Certified Population), is located on the coast of the Chukchi Sea. Archaeological evidence indicates that people have lived at this particular site for over 1500 years. Barrow is an Inupiat community; its name in Inupiaq is Ukpeagvik, meaning "place where owls are hunted." In 1825, a British geographer named a point of land 16 kilometers (10 miles) north of Ukpeagvik after Sir John Barrow of the British Admiralty; he called it Point Barrow. It is from that name that Barrow is derived. Point Barrow is the northernmost point of land in the United States. Barrow is so far north that, in the summer, the sun does not set for nearly three months; during the winter, the sun does not rise for over two months. In 1881, a meteorological and magnetic research station was established near Barrow by the U.S. Army. By 1901, a trading station, a church, and a post office were located in the community. Barrow has seen significant development over the years because of research interests, petroleum exploration, oil pipeline construction, and growth in local government and the Arctic Slope Regional Corporation. Barrow is considered the economic center of the North Slope Borough. The population in Barrow is largely Alaska Native or part Native. Traditional marine mammal hunts and other subsistence practices are an important part of the Inupiat culture. Though Barrow is not on the road system, it has regularly scheduled jet service year-round. The annual mean air temperature in Barrow is -12°C (11°F). Annual average precipitation is 13 centimeters (5 inches); annual snowfall is 51 centimeters (20 inches). Barrow looks out over the Chukchi Sea, which is usually ice-free from mid-June through October.

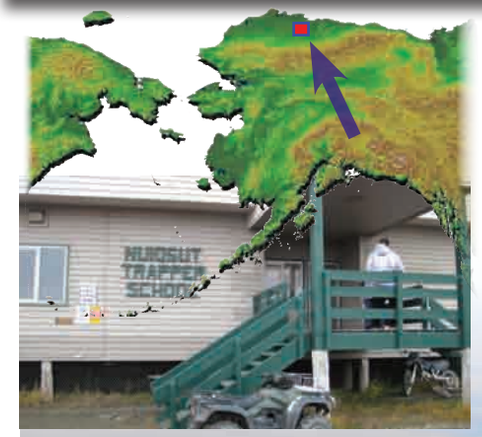




Key Facts (2006):
Annual mean ground temperature: -12.5°C
Freezing days: 242 days
Freezing degree-days: 4634°C days
Thawing degree-days: 73°C days

Nuiqsut

North Slope Borough School District

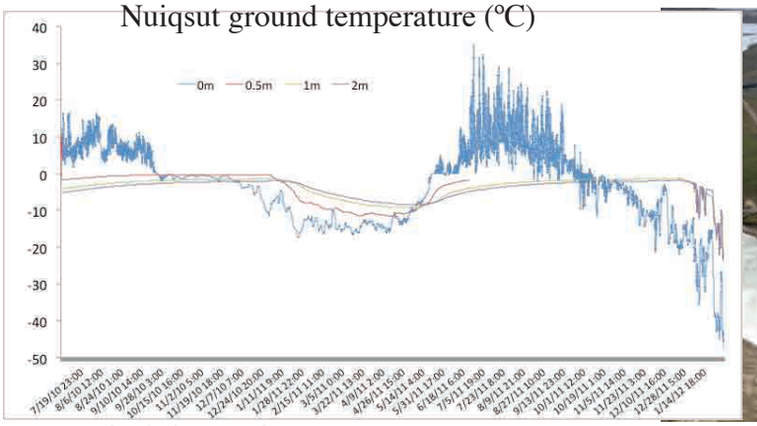


Student population: 106

Nuiqsut, a village with 424 residents (2008 DCCED Certified Population), is located on the west bank of the Nechelik Channel of the Colville River Delta, about 56 kilometers (35 miles) from the Beaufort Sea coast. The indigenous people of the Colville Delta region are Inupiat. In the late 1940s, the old village of Nuiqsut, which was called Itqulippaa, was abandoned. About thirty years later, the location was resettled by families that moved from Barrow. By 1974, houses, a school, and other facilities had been constructed. Most residents of Nuiqsut are Alaska Native or part Native, mainly Inupiat. Traditional subsistence practices are important to the way of life here. Employment includes work for the school, the community store, and borough services. Nuiqsut is not on the road system, but it has a gravel airstrip for air transportation.

Key Facts:
Annual mean ground temperature: -3.3 °C
Freezing days: available
Freezing degree-days: available
Thawing degree-days: available

Nuiqsut ground temperature (ºC)



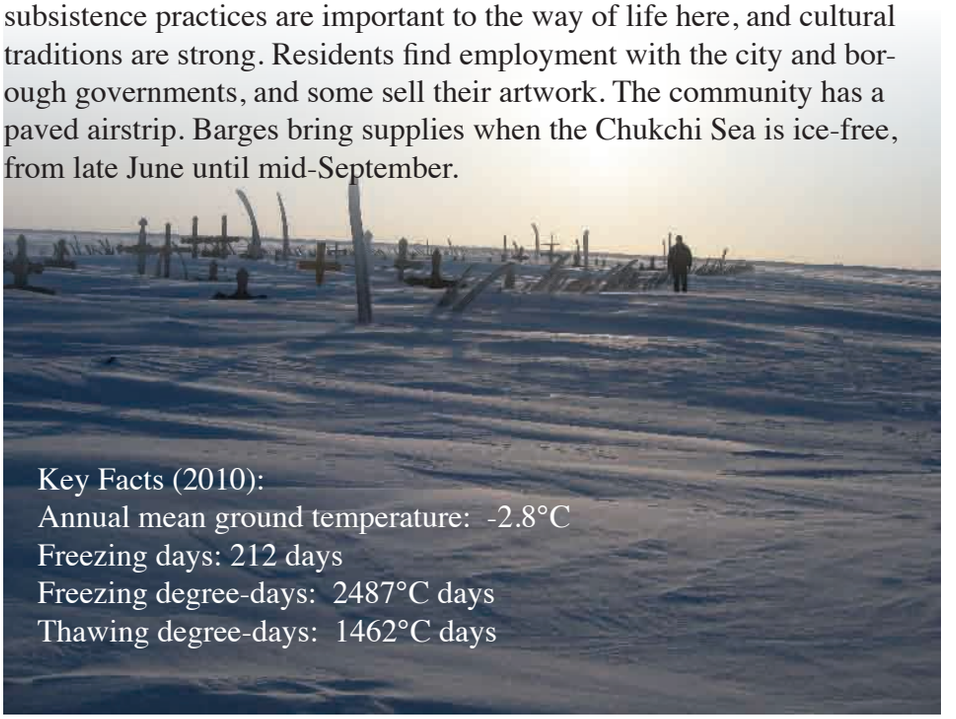
Location: 68.35° N, 166.74° W

Point Hope

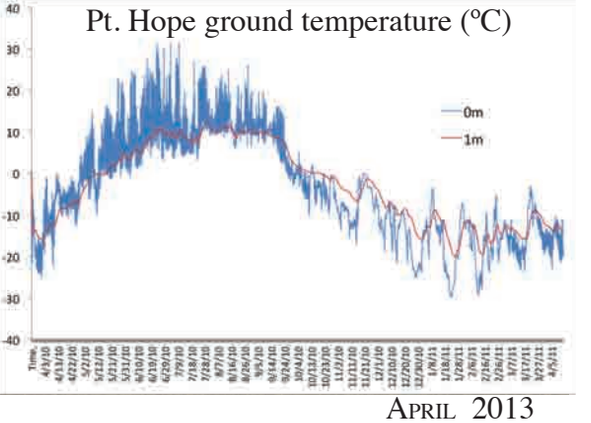
North Slope Borough School District

Student population: 223

Point Hope, a village with 713 residents (2008 DCCED Certified Population), is located on the northwest coast of Alaska, near the end of a point of land. Immediately to the west is the Chukchi Sea; along the coastline to the north is Point Lay. The peninsula that Point Hope is located on is called Tikeraq, one of the oldest continuously inhabited locations in Alaska. The indigenous people of this area are Inupiat. Over the past 2,500 years, the peninsula has supported other settlements—Old and New Tigara, Ipiutak, and Jabbertown—because its location provides good access to marine mammals. Commercial whaling activities brought many non-Natives to the area by 1848. Shore-based whaling stations located here in the late 1880s, remaining until the early 1900s, when commercial whaling declined. Point Hope's location is further east now than before the early 1970s. The community had to move because of coastline erosion and periodic storm-surge flooding. Most residents in Point Hope are Alaska Native or part Native, mainly Tikeraqmuit Inupiat. Traditional subsistence practices are important to the way of life here, and cultural traditions are strong. Residents find employment with the city and borough governments, and some sell their artwork. The community has a paved airstrip. Barges bring supplies when the Chukchi Sea is ice-free, from late June until mid-September.

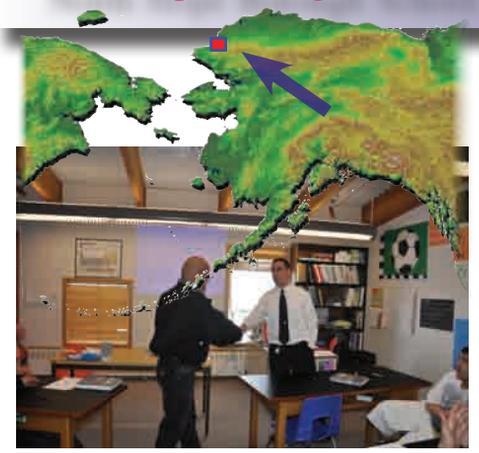


Key Facts (2010):
Annual mean ground temperature: -2.8°C
Freezing days: 212 days
Freezing degree-days: 2487°C days
Thawing degree-days: 1462°C days



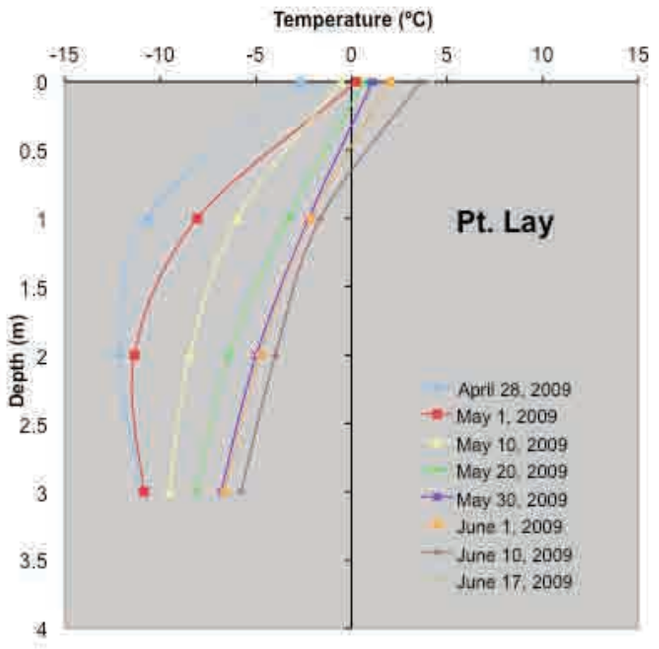
Point Lay

North Slope Borough School District



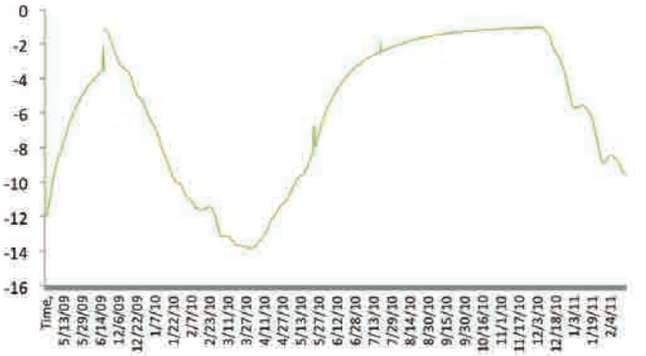
Student population: 76

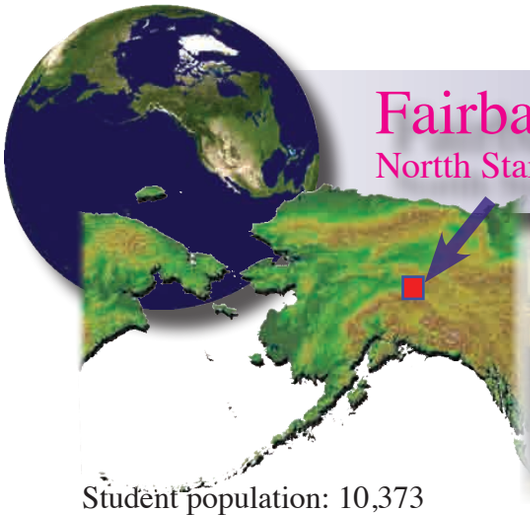
Point Lay, also known as Kali, is a village with 257 residents (2008 Estimated Population, not Certified) located on Alaska's northwest coast just south of the Kokolik River and southwest of the village of Wainwright. The indigenous people of this area are Inupiat. Historically, they have lived here in small numbers. The population increased after several families from Point Hope moved here in 1929–1930. The old village site, now used as a summer hunting camp, was located on a gravel barrier island just offshore. The community's present location, near the Air Force Distance Early Warning station, was chosen to avoid seasonal flooding from the Kokolik River. Most residents in Point Lay are Alaska Native or part Native, mainly Inupiat. Traditional subsistence practices are important to providing food. Employment opportunities include work for the borough government. The community has a gravel airstrip, owned by the U.S. Air Force. From late June until September, the Chukchi Sea is ice-free.



Key Facts (2009):
Annual mean ground temperature: -3.4°C
Freezing days: 242 days
Freezing degree-days: 2672°C days
Thawing degree-days: 1423°C days

Pt. Lay 2m depth temperature (°C)





Fairbanks

Nortth Star Borough School District

Student population: 10,373

Fairbanks, the second largest city in Alaska with 30,367 residents (2008 DCCED Certified Population), is located in the Tanana Valley on the banks of the Chena River. Fairbanks is Interior Alaska's regional service and supply center. The city is 576 kilometers (358 miles) north of Anchorage by road, or a 45-minute trip by air. For thousands of years, this area has been the home of Koyukon Athabascans. A trading post was built in 1901 near the Chena River, just a year before gold was discovered nearby. Steamboats traveling the Yukon and Tanana Rivers brought gold prospectors into the Interior. By 1902, the town had been named Fairbanks, after Indiana Senator Charles Fairbanks. With the establishment of stores, government offices, and a court, jail, and post office, Fairbanks grew. The Alaska Agricultural College and School of Mines, which would later become the University of Alaska, offered its first classes in 1922, and a year later, the Alaska Railroad was completed, linking Fairbanks to Seward and all points between. Further development occurred during the 1940s,

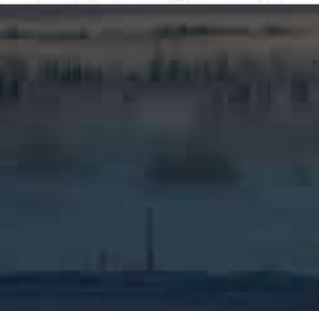
Pearl Creek

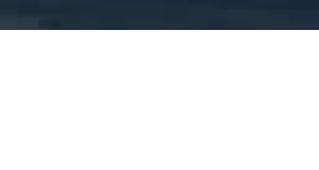
UAF

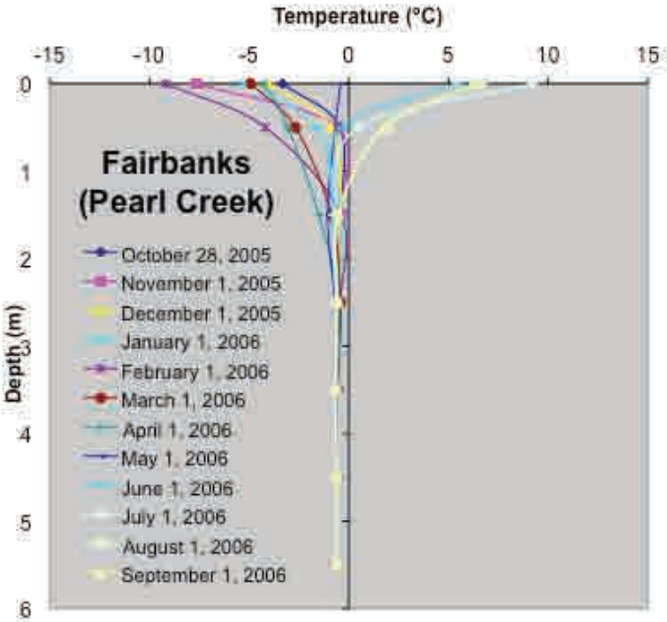
Hatchson

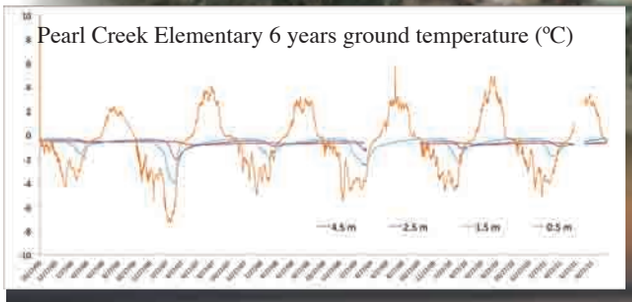
University Park

Watershed









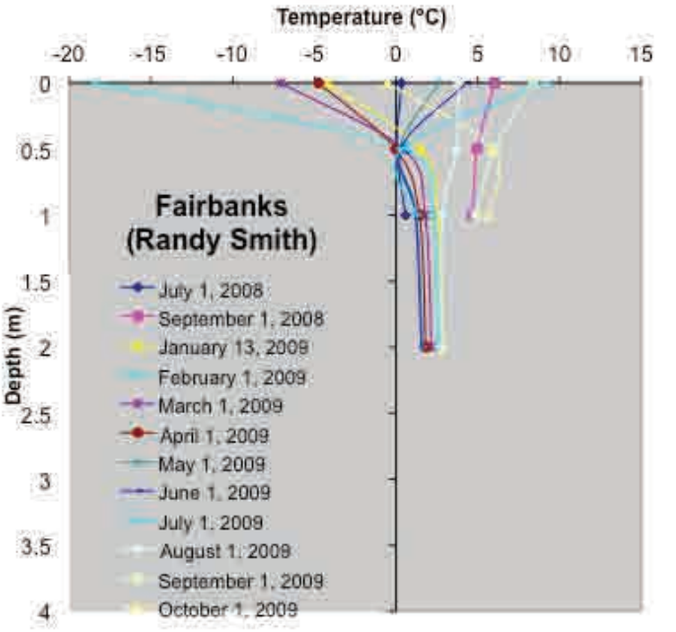
Key Facts (Randy Smith 2009):
Annual mean ground temperature:-0.7°C
Freezing days: 184 days
Freezing degree-days: 1673°C days
Thawing degree-days: 1793°C days

Weller

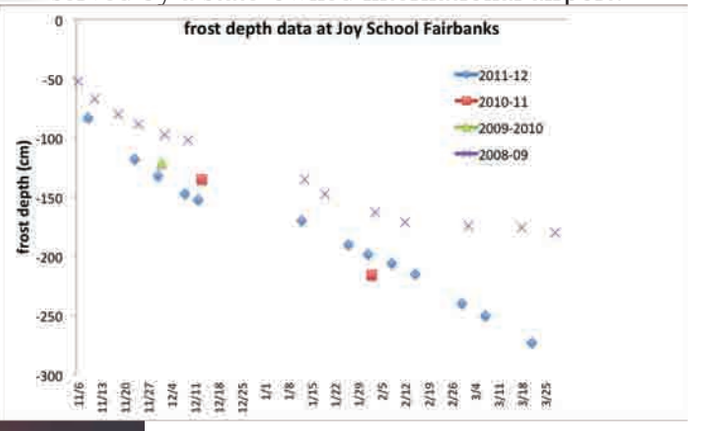
Joy

Randy Smith

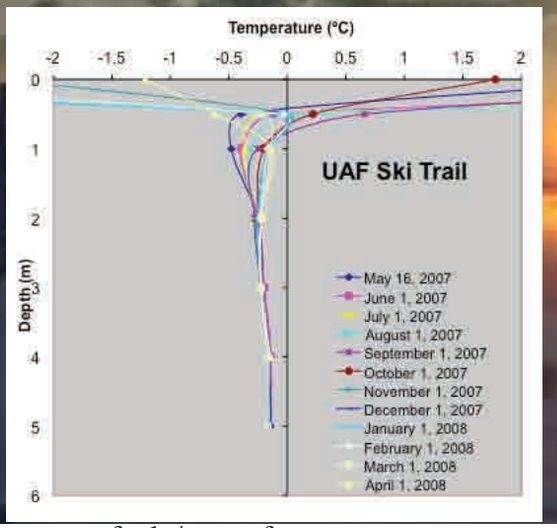
Nordale



when wartime pressures brought construction of the Alcan Highway, connecting Fairbanks to Canada via the Richardson Highway, as well as establishment of two military bases nearby—Fort Wainwright Army Base (originally Fort Ladd) and Eielson Air Force Base. Construction and operation of the Trans-Alaska oil pipeline brought opportunities and economic growth to Fairbanks in the 1970s and 1980s. Four of the state's major highways meet in Fairbanks, and the area is served by a state-owned international airport.



Key Facts (Joy 2010):
Annual mean ground temperature:-2.3°C
Freezing days: 200 days
Freezing degree-days: 2553°C days
Thawing degree-days: 1731°C days



Travel into the Ground

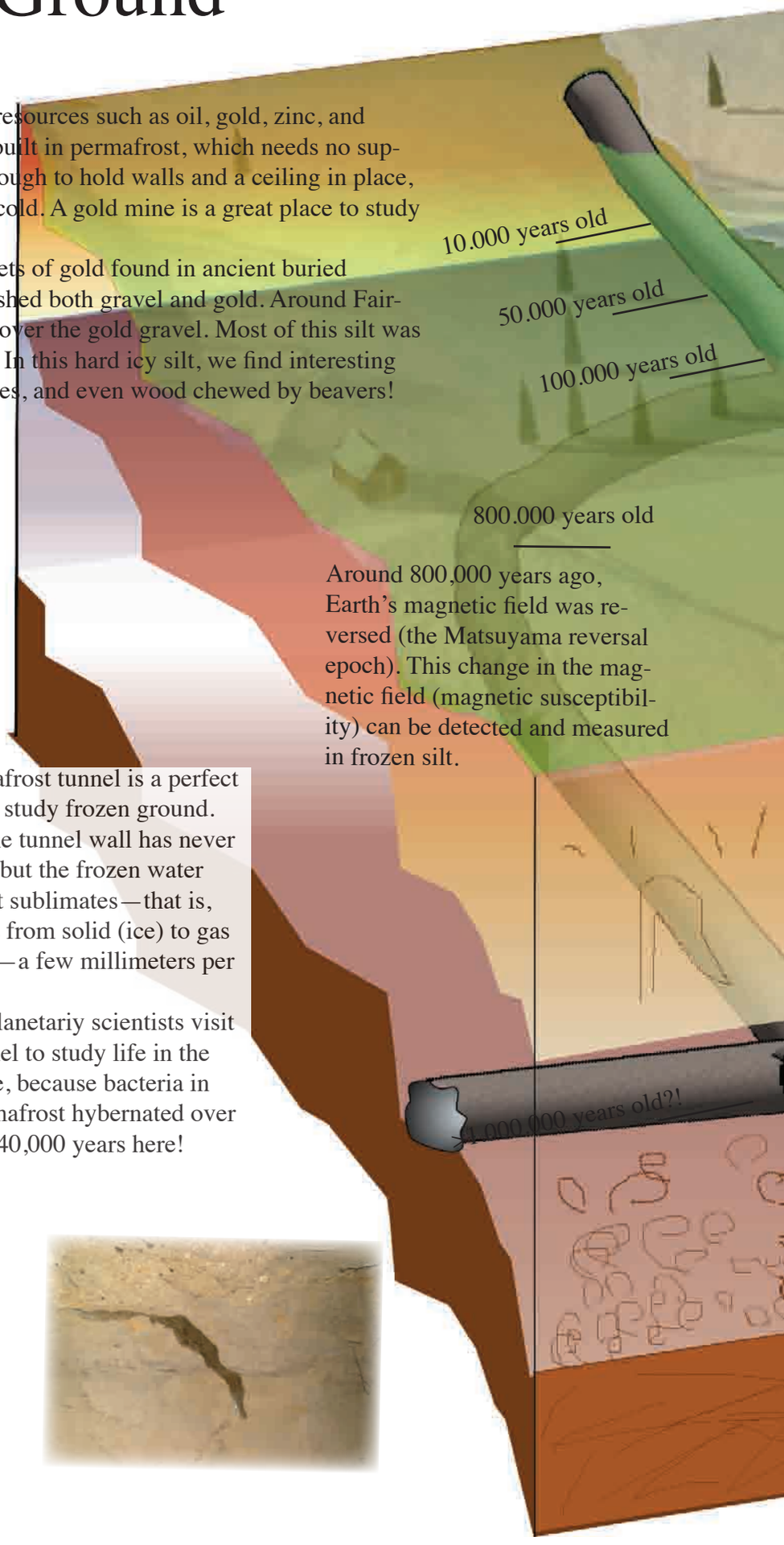
Alaska is a mining state, rich with natural resources such as oil, gold, zinc, and platinum. Underground mines are sometimes built in permafrost, which needs no support for strengthening. Permafrost is strong enough to hold walls and a ceiling in place, as long as underground temperatures are kept cold. A gold mine is a great place to study permafrost.

Many gold miners look for placer gold—nuggets of gold found in ancient buried streambeds, where long ago, flowing water pushed both gravel and gold. Around Fairbanks, massive deposits of icy silt sediments cover the gold gravel. Most of this silt was carried by winds that blew during the Ice Age. In this hard icy silt, we find interesting ice formations and things like mammoths, bones, and even wood chewed by beavers!

A permafrost tunnel is a perfect place to study frozen ground. Ice in the tunnel wall has never melted, but the frozen water within it sublimates—that is, changes from solid (ice) to gas (vapor)—a few millimeters per year.

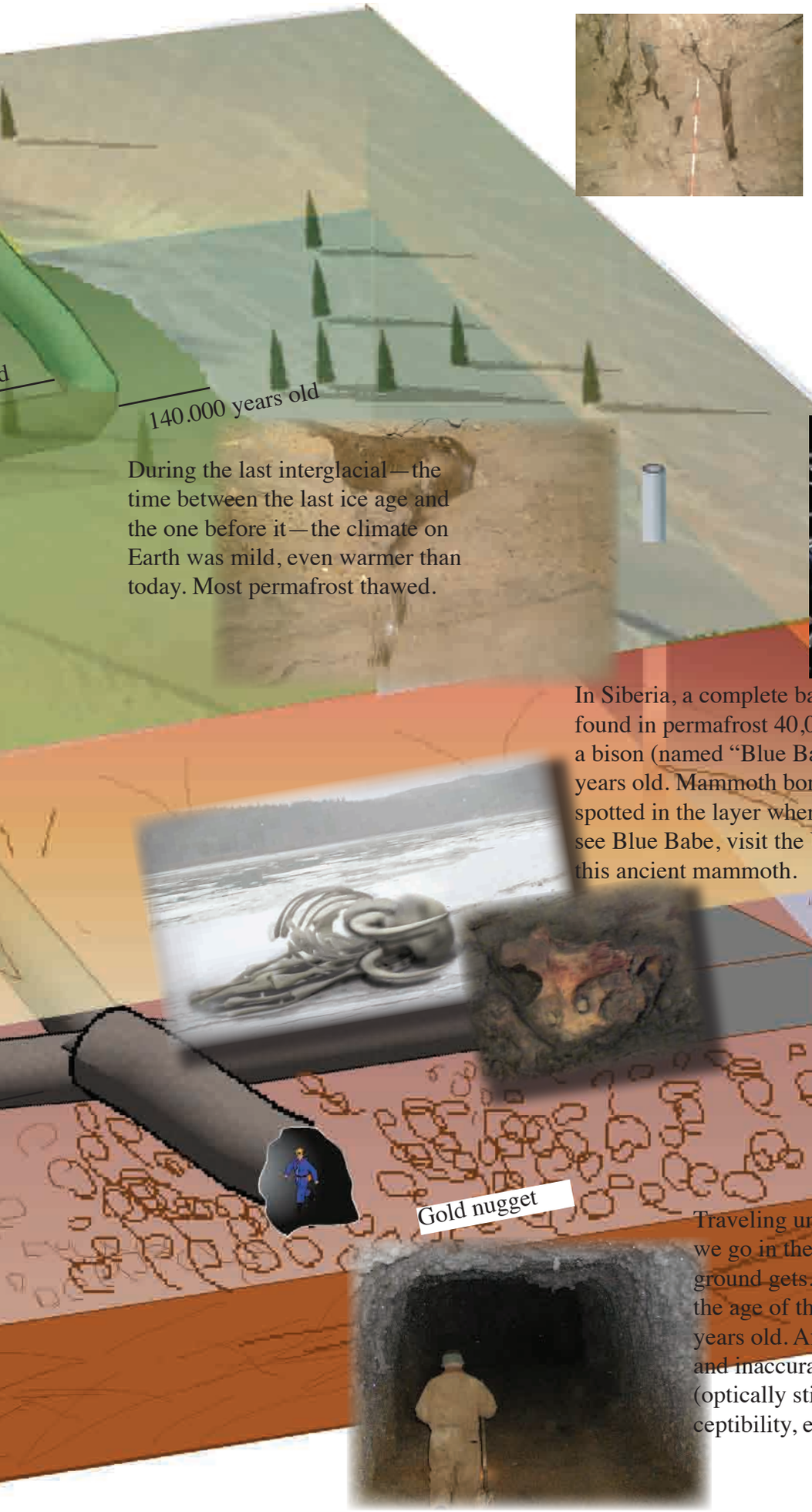
Many planetariy scientists visit the tunnel to study life in the universe, because bacteria in the permafrost hybernated over 30,000-40,000 years here!

Near Fairbanks, there is a permafrost tunnel for education and research. This is likely one of the coolest spots in the area!!

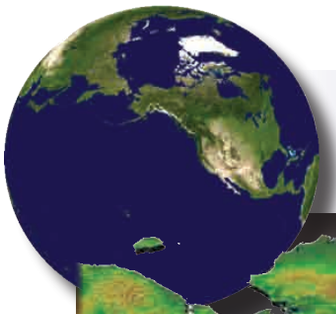


It is common to see an ice wedge in a permafrost tunnel. You can also see segregated ice, such as ancient buried lake ice, pingo ice, buried snowdrifts, and glaciers. If you know something about the structure of ice, this is the most exciting place in the world! Air temperature in the tunnel is usually –2°C (28°F), just like the permafrost that's there. You'll feel cold if you visit in the summer, but you'll feel warm in the winter, especially when the outdoor temperature is –40°C (–40°F).

In Siberia, a complete baby mammoth (named "Dema") was found in permafrost 40,000 years old. In Alaska, near Fairbanks, a bison (named "Blue Babe") was found in permafrost 36,000 years old. Mammoth bones found in permafrost are commonly spotted in the layer where silt and gravel meet. If you'd like to see Blue Babe, visit the UAF Museum; that's where you'll find this ancient mammoth.



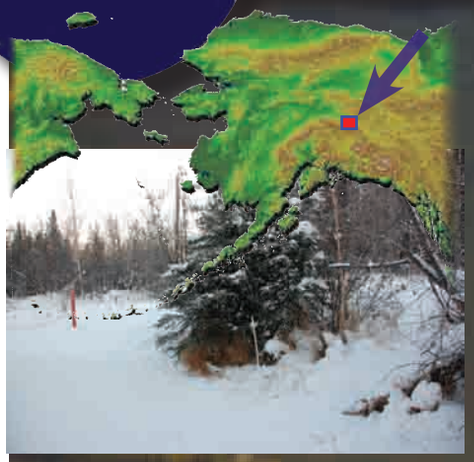
Traveling underground is a trip in time. The deeper we go in the permafrost tunnel, the older the frozen ground gets. Using carbon materials, we can learn the age of things frozen in permafrost, up to 45,000 years old. After that, determining age gets difficult and inaccurate. We use tephra (volcanic ash), OSL (optically stimulated luminescence), magnetic susceptibility, etc., in these cases.



Location: 64.48° N, 146.98° W

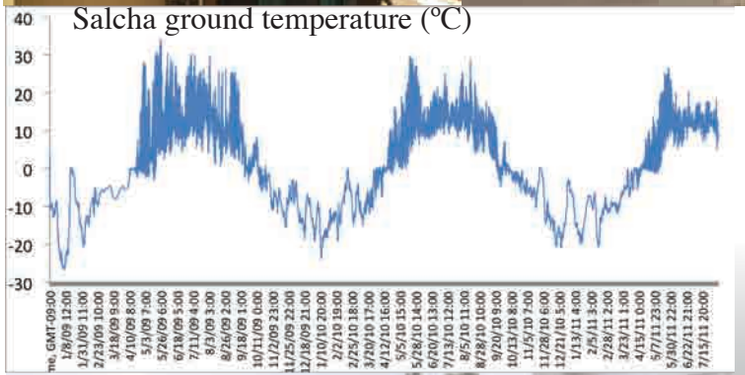
Salcha

Northh Star Borough School District



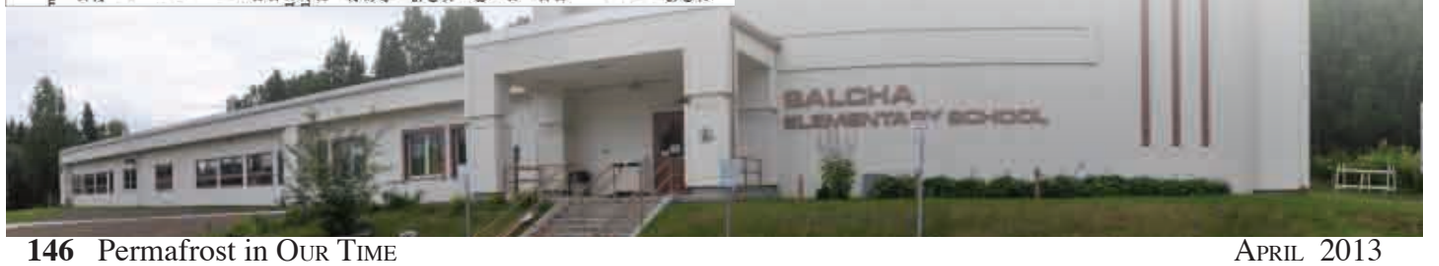
Student population: 94

Salcha, a town with 953 residents (2008 Estimated Population, not Certified), is located near the mouth of the Salcha River, a 64-kilometer (40-mile) drive southeast of Fairbanks on the Richardson Highway. The indigenous people of this area are Athabascans; they called their village Salchaket, which means "mouth of the Salcha." The proximity of the Salcha River to Eielson Air Force Base, North Pole, Fort Wainwright, and Fairbanks allow residents to live in Salcha and find employment in nearby communities. Proximity also contributes to the Salcha River's popularity as a recreational spot. Many people who live in nearby communities fish or float the river and own occasional-use cabins in the area.



Salcha ground temperature (ºC)

Key Facts (2009):
Annual mean ground temperature: 0.3°C
Freezing days: 189 days
Freezing degree-days: 1673°C days
Thawing degree-days: 1793°C days



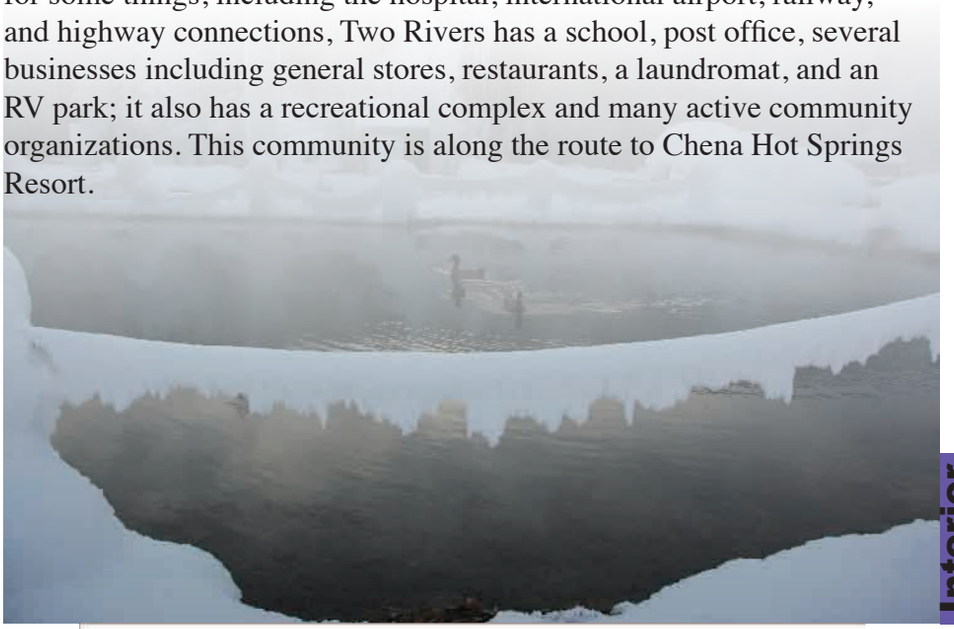
Two Rivers / Chena Hot Springs

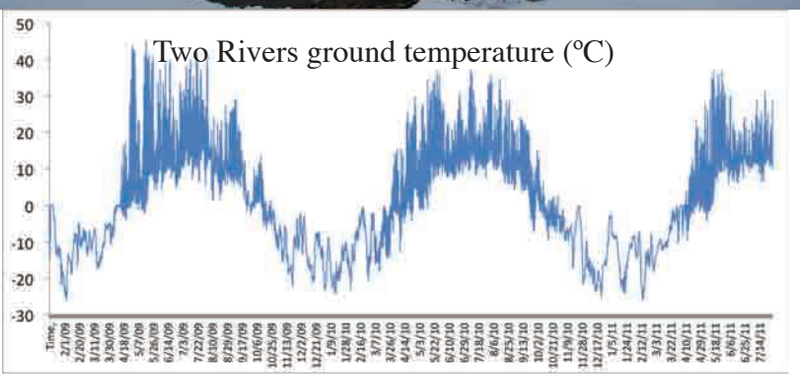
Northh Star Borough School District

Key Facts (2009):
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: 1876°C days

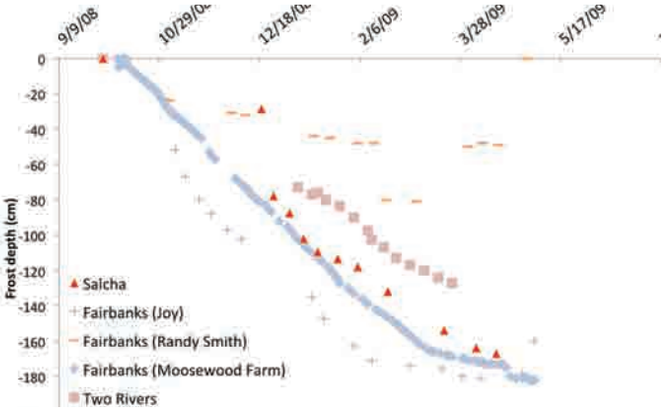
Student population: 99

Two Rivers, a community with 644 residents (2008 Estimated Population, not Certified), is located along Chena Hot Springs Road, between the Little Chena River at 21 kilometer (13 mile) and the Upper Chena River at 40 kilometer (25 mile). This rural community, northeast of Fairbanks, has developed as Fairbanks has grown. Though it relies on Fairbanks for some things, including the hospital, international airport, railway, and highway connections, Two Rivers has a school, post office, several businesses including general stores, restaurants, a laundromat, and an RV park; it also has a recreational complex and many active community organizations. This community is along the route to Chena Hot Springs Resort.





Frost tube results in 2008 around Two Rivers and Sulcha



North Pole

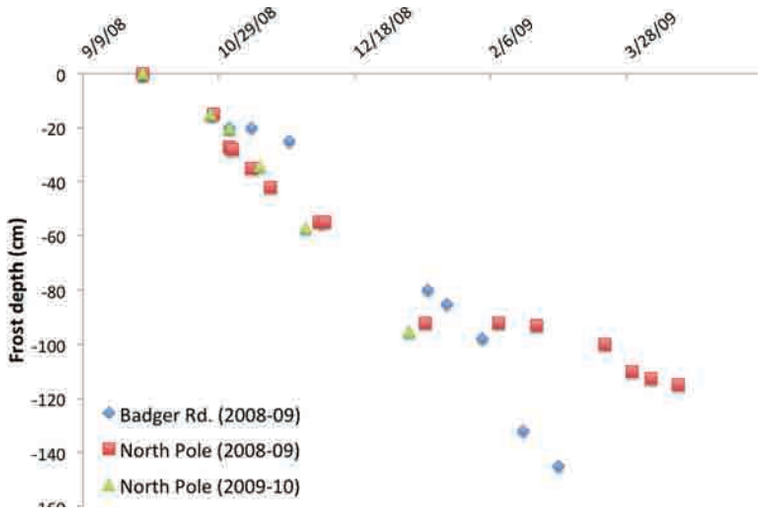
Nortth Star Borough School District

North pole middle

Badger Rd. Elem

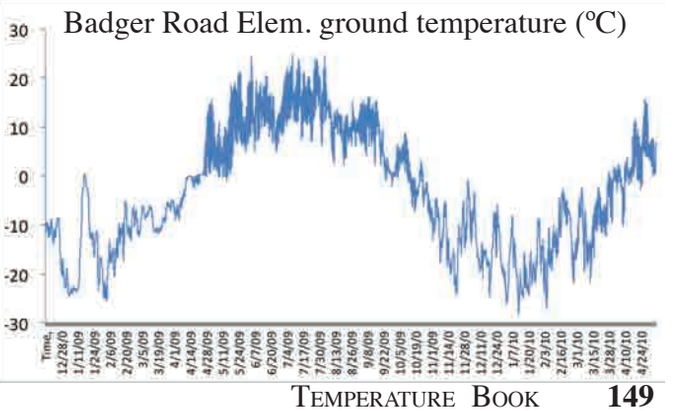
North pole Elem

Frost tube results at North pole (2008-2010)



Student population: 3,262
North Pole, a city with 2,099 residents (2008 DCCED Certified Population), is located along the Richardson Highway, 23 kilometers (14 miles) southeast of Fairbanks. The community is situated south of Fort Wainwright Army Base and north of Eielson Air Force Base. North Pole grew from the subdivision of a patented homestead that was purchased by a development company. The city's name was chosen for business potential. During the Christmas season, letters addressed to Santa Claus arrive at North Pole, and they are answered by "Santa's helpers." North Pole's location near Fairbanks and two military bases has helped it grow and develop. An oil refinery produces jet fuel, heating oil, gasoline, and diesel from North Slope crude oil. There are many businesses in North Pole and employment opportunities are varied. Residents also commute to nearby Fairbanks and military stations for employment. There are six schools in North Pole.

Key Facts Badger Road Elem. (2009):
Annual mean ground temperature: -0.8°C
Freezing days: 178 days
Freezing degree-days: 2125°C days
Thawing degree-days: 1847°C days



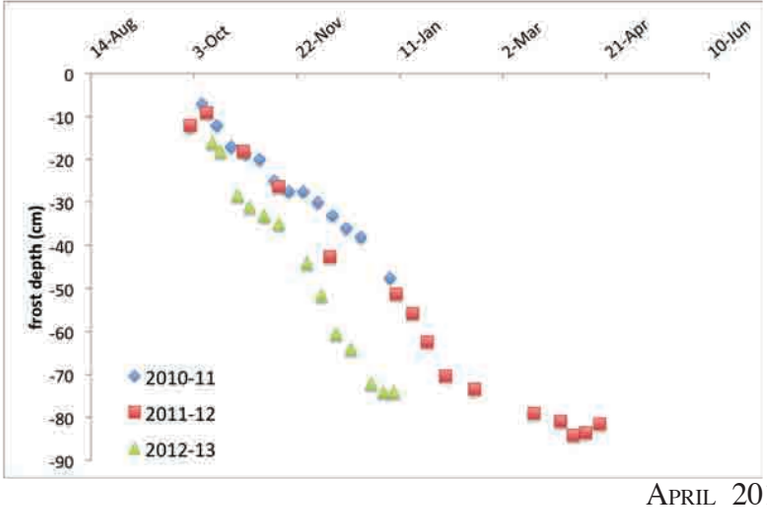
Delta Junction/ Fort Greely

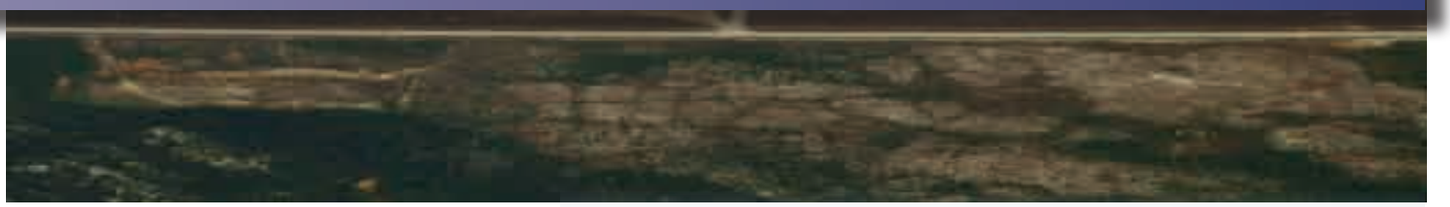
Delta Greely School District

Student population: 993

Delta Junction, a town with 1,058 residents (2008 DCCED Certified Population), is located where the Richardson Highway and the Alaska Highway intersect, about 153 kilometers (95 miles) southeast of Fairbanks. This area is home to Tanana Athabascans, who lived here at the time that gold prospectors entered Interior Alaska, following the gold rush in the late 1800s. Soon after the 1902 gold discovery in the Tanana Valley, a spur trail was built from Gulkana, which was on the Trans-Alaska Military Road that had been built from Valdez to Eagle, to Fairbanks. This spur trail, which passed through Delta Junction, became known as the Valdez–Fairbanks Trail; it was used by many gold seekers and travelers heading north. A roadhouse was built in Delta Junction in 1905. In 1928, American bison were transplanted here from Montana. Construction began in 1942 on the Alaska Highway, which was to cross parts of Canada and terminate in Delta Junction, and a military base—Fort Greely—was completed just south of the town, with associated growth to the community. In the 1970s and early 1980s, Delta Junction experienced additional growth with construction of the Trans-Alaska Pipeline and related support services, and the state-initiated Delta Agricultural Project and farms that developed. Since 2004, Ft. Greely nearby has been the site of the U.S. Missile Defense Testbed. Tourism and travel-related services are part of Delta Junction's economy, with its location at the intersection of two main Alaskan highways.

Frost tube results at Delta Junction Elementary (2010-2013)

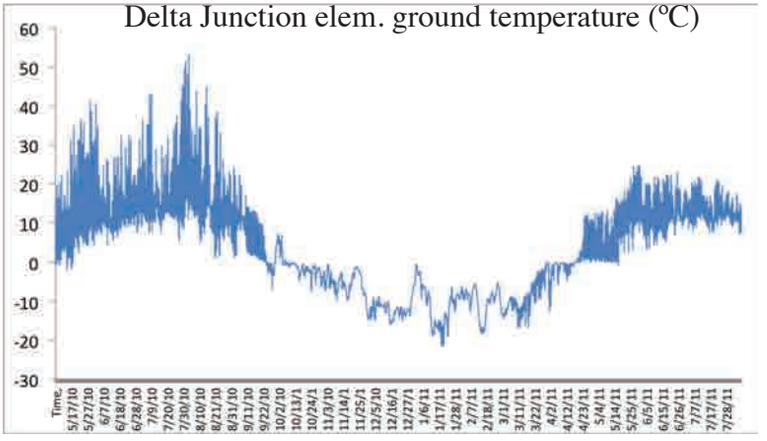




Sand wedge polygons are seen along the Richardson Highway (above) and Big Delta River bank (right).

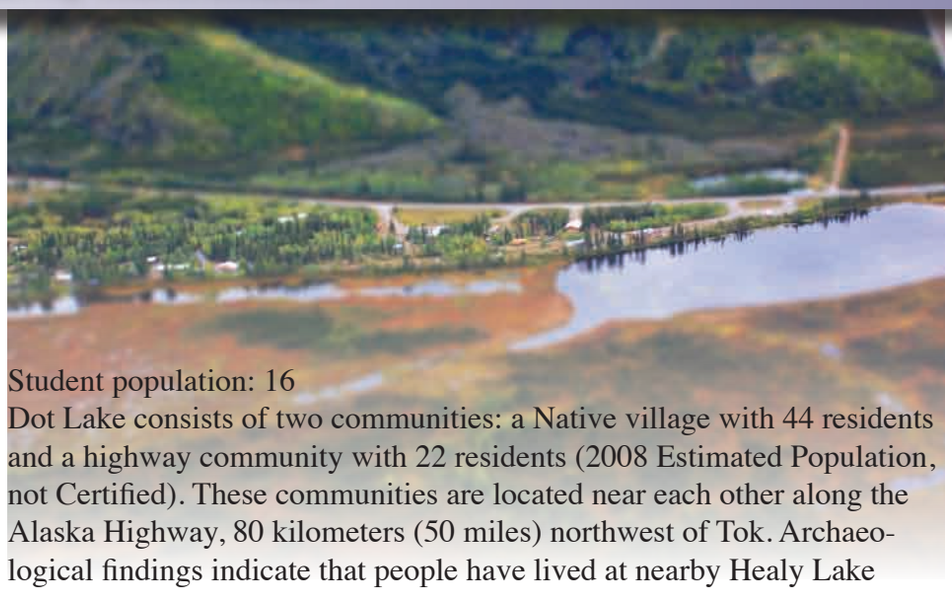
Key Facts Delta Junction (2010):
Annual mean ground temperature: 0.7°C
Freezing days: 200 days
Freezing degree-days: 1515 °C days
Thawing degree-days: 1788 °C days

Delta Junction elem. ground temperature (ºC)



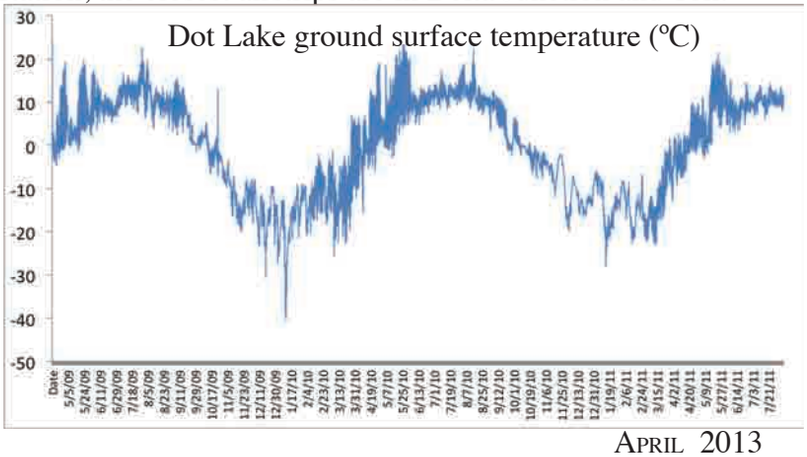
Dot Lake

Alaska Gateway School District



Student population: 16

Dot Lake consists of two communities: a Native village with 44 residents and a highway community with 22 residents (2008 Estimated Population, not Certified). These communities are located near each other along the Alaska Highway, 80 kilometers (50 miles) northwest of Tok. Archaeological findings indicate that people have lived at nearby Healy Lake more than 10,000 years. Historically, Athabascans from George Lake and Tanacross used Dot Lake as a seasonal hunting camp. This location also formed part of a freight trail that Athabascans used to reach the Yukon River. When the Alaska Highway was under construction in 1942, a work camp called Sears City was established at this location. Several Alaska Natives found employment with the project. In 1946, Doris Charles and her family settled Dot Lake Village. Over the next four years, families from other villages joined them, relocating from George Lake, Sam Lake, and Tanacross. Development of the highway community began after a non-Native couple acquired a home site in the Dot Lake location. By 1949, construction had been completed on a post office, lodge, chapel, and school, and in the years that followed, other homesteaders moved into the area. In Dot Lake Village, the majority of residents are Alaska Native or part Native, mainly Upper Tanana Athabascan. Subsistence activities are important to their way of life. Employment in the village includes work with the village council and Tanana Chiefs Conference, in the school, or seasonal firefighting. Some village residents make and sell artwork. Employment in the Dot Lake highway community includes work with a family-owned lodge. Both communities are accessible by road. For air transportation, the closest airstrips are in Delta Junction and Tok.



Key Facts (2010):
Annual mean ground temperature: -1.2°C
Freezing days: 197 days
Freezing degree-days: 1892 °C days
Thawing degree-days: 1451 °C days

When people think of pipelines in Alaska the first thing that usually comes to mind is the Trans-Alaska Pipeline. But the state has actually been host to several large pipeline systems over the past 60 years. The Haines-Fairbanks Pipeline was a lesser known Cold War era project owned and operated by the U.S. Army from 1955 to 1973. The eight-inch diameter pipeline transported refined fuel from a deep-water port at Haines to Fort Greely, Eielson Air Force Base, and Ladd Air Force Base (Ladd AFB was transferred to the Army and became Fort Wainwright in 1961).

Trans-Alaska Pipeline

The Haines-Fairbanks Pipeline

The pipeline was designed from 1950 to 1952 and construction occurred over 22 months, from 1953 to 1955. Four types of fuel were conveyed over the 626-mile route including diesel, automotive gas, jet fuel and aviation gas. In 1961, six booster stations were added to the system to increase the fuel output. When operating at maximum capacity, the pipeline could deliver 27,500 barrels of fuel a day, most of which was for Air Force use.

In 1970 investigations revealed the pipeline metal was deteriorating, particularly on the southern half of the system. Repair costs were prohibitive, and plans to shut the Haines to Tok section of the line were implemented. The Tok to Fairbanks section continued operating until 1973 when it too was closed.

One of booster stations remaining today

Line Freeze-Up

Though pipeline construction was completed in late 1955, it was not in operation until 1956 because of ice that developed in the line. The pipeline was cut in 28 locations over a 176-mile section. The amount of fuel lost during the operation varied at each location. Several former employees recall seeing pictures of ice removed from the pipeline stacked up like cordwood along the right-of-way.61 The last cut was made on March 16, 1956. A valuable lesson was learned; water should not be used to test the pipeline in such a cold climate. After this initial freeze-up, the Haines-Fairbanks Pipeline operated without major interruption for over 15 years. (CEMML TPS 03-04: The Haines-Fairbanks Pipeline, Kristy Hollinger, Edited by: Glenda R. Lesondak, April 2003)

Location: 63.33° N, 142.98° W

Tok

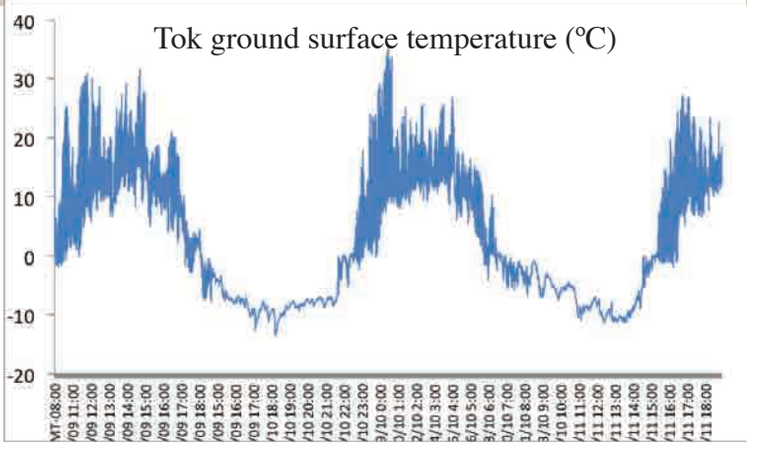
Alaska Gateway School District

Student population: 316

Tok, a town with 1,382 residents (2008 Estimated Population, not Certified), is located at the junction of the Alaska Highway and the Tok Cutoff, a road that leads to the Glenn Highway. This town, 150 kilometers (93 miles) from the Canadian border, is the first major community encountered after entering Alaska on the Alaska Highway. Historically, the area around Tok is the home of Athabascans. The development of Tok began in 1942 with the construction of a camp for workers during the time that the Alaska-Canadian Highway was being built. The Northern Commercial Company opened a store in 1944. The highway was completed two years later, and by 1947, the community had a post office, a roadhouse, and a school. Over time, Tok has been the site of a U.S. Customs Office (later moved closer to the border) and a pump station for a U.S. Army fuel pipeline that operated between Haines and Fairbanks. In 1976, the U.S. Coast Guard constructed a LORAN station. In the Upper Tanana region, Tok is the center for transportation, business, service, and governmental offices. The community has a gravel runway and a paved runway.

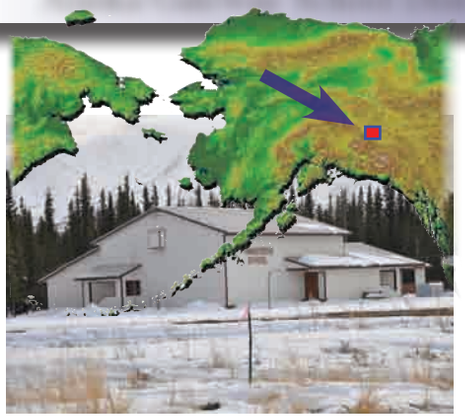
Key Facts (2009):
Annual mean ground temperature: 1.7°C
Freezing days: 187 days
Freezing degree-days: 1320 °C days
Thawing degree-days: 1951 °C days

Tok ground surface temperature (ºC)



Tanacross

Alaska Gateway School District

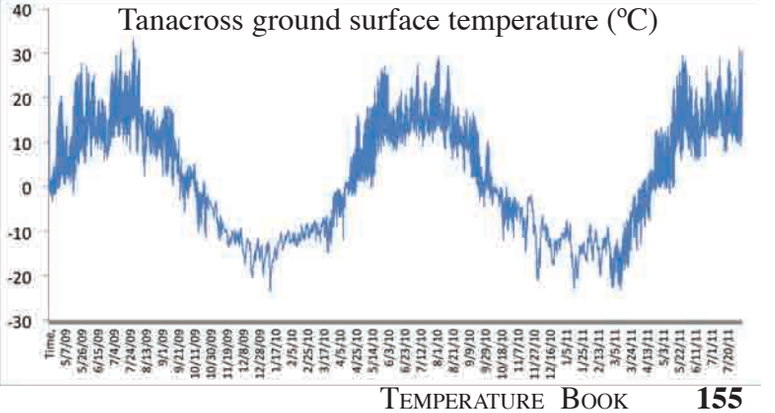


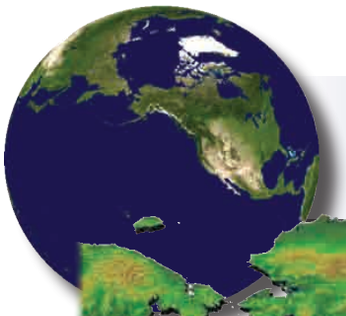
Student population: 17

Tanacross, a village with 189 residents (2008 Estimated Population, not Certified), is located on the south bank of the Tanana River, at the end of a spur road that leaves the Alaska Highway at milepost 1324, about 19 kilometers (12 miles) northwest of Tok. The Tanah, or Tinneh, Athabascans originally located their village on the north side of the Tanana River, where the Eagle Trail met the river. The location was called Tanana Crossing, which later was shortened to Tanacross. In 1912, an Episcopal Mission was established and a trading post opened. By the mid-1930s, the community had a post office, a school, and an airstrip. During World War II, the village gave the U.S. military permission to use its airfield as an emergency deployment post. The airstrip was paved, camps were built, and thousands of troops were deployed from this site during the war. Residents of Tanacross participated in the war effort, serving as volunteer scouts and backup support for the Army. After the war ended, the Army closed its airfield. Due to water contamination discovered in 1972, villagers moved to a new site—the present site—on the south bank of the Tanana River. Most residents of Tanacross are Athabascan. Subsistence activities are an important source of food here. Employment includes firefighting for BLM during the summer, work at the washeteria, and work with the clinic and local businesses. Air and bus service is available out of Tok. The BLM owns a paved runway just south of the community, but it is not maintained in winter.

Key Facts (2009):
Annual mean ground temperature: 0.4°C
Freezing days: 186 days
Freezing degree-days: 1861 °C days
Thawing degree-days: 2015 °C days

Tanacross ground surface temperature (ºC)

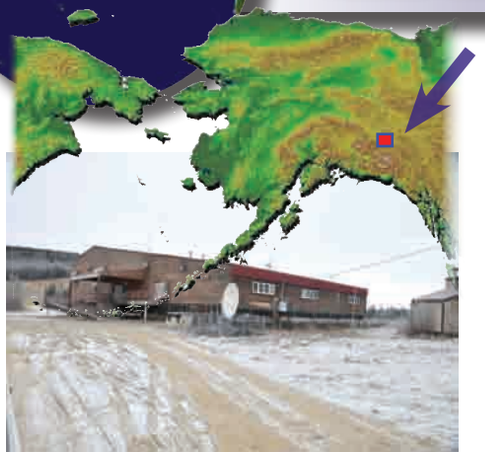




Location: 63.14° N, 142.52° W

Tetlin

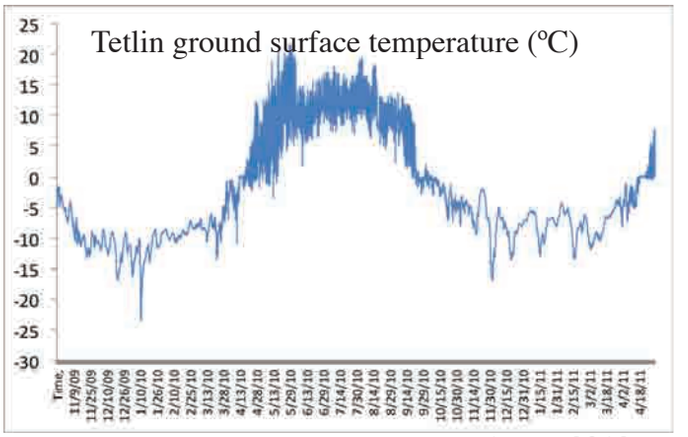
Alaska Gateway School District



Student population: 27

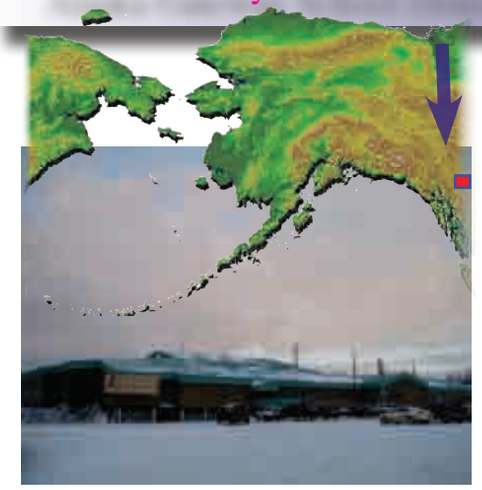
Tetlin, a village with 136 residents (2008 Estimated Population, not Certified), is located along the Tetlin River, between Tetlin Lake and the Tanana River. The village, which is 32 kilometers (29 miles) southeast of Tok and at the end of a long spur road off the Alaska Highway, is within the boundary of the Tetlin National Wildlife Refuge. The original inhabitants of this area, Athabascans, moved with the seasons and the availability of food resources. By 1912, villagers of Tetlin were traveling to Tanana Crossing to trade at the trading post there. The Chisana gold stampede in 1913 brought construction of a trading post across the river from Tetlin. By 1932, the community had two trading posts, a school, and a post office. Residents to the south, from a village called Last Tetlin, joined those living in Tetlin. Most residents here are Alaska Native or part Native, mainly Athabascan. Tetlin is relatively isolated and has a strong Athabascan culture. Traditional subsistence activities are important to the livelihood of people living here. The community has a gravel runway and a turf airstrip.

Key Facts (2009):
Annual mean ground temperature: -0.3°C
Freezing days: 202 days
Freezing degree-days: 1631 °C days
Thawing degree-days: 1533 °C days



Northway

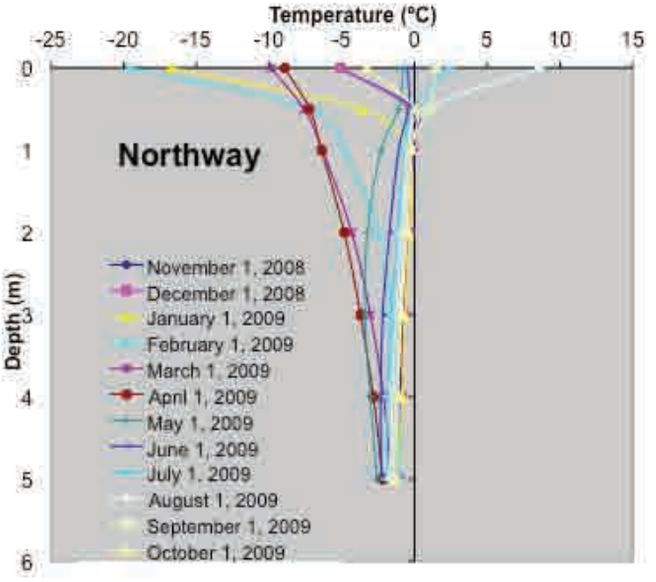
Alaska Gateway School District



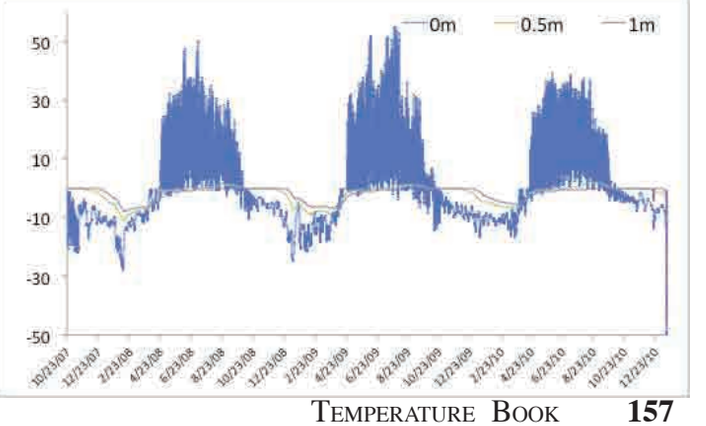
Student population: 48

Northway, a community with 88 residents (2008 Estimated Population, not Certified), is located off the Alaska Highway about 68 kilometers (42 miles) west of the Canadian border. Northway consists of three settlements: Northway Junction at milepost 1264 of the Alaska Highway, an airport site located on a 9-mile spur road southwest of the highway junction, and a Native village on the east bank of Nabesna Slough, a few kilometers north of the airport. Athabascans are the indigenous people of this area. The village was named after Chief Walter Northway. During World War II, an airport was constructed here as part of the Northwest Staging Route, a cooperative effort between the U.S. and Canada to link air bases for defense. The highway from Canada to Alaska (the Alaska Highway) was being built at the same time. Development and settlement of Northway was due to this construction work. Northway's population is mixed, with most residents being Alaska Native or part Native, mainly Athabascan, for whom subsistence practices are important. Northway has an asphalt-gravel runway and regular flights to Fairbanks. An FAA station and U.S. Customs office are located here.

Key Facts (2009):
Annual mean ground temperature: 0.7°C
Freezing days: 199 days
Freezing degree-days: 1573 °C days
Thawing degree-days: 1824 °C days



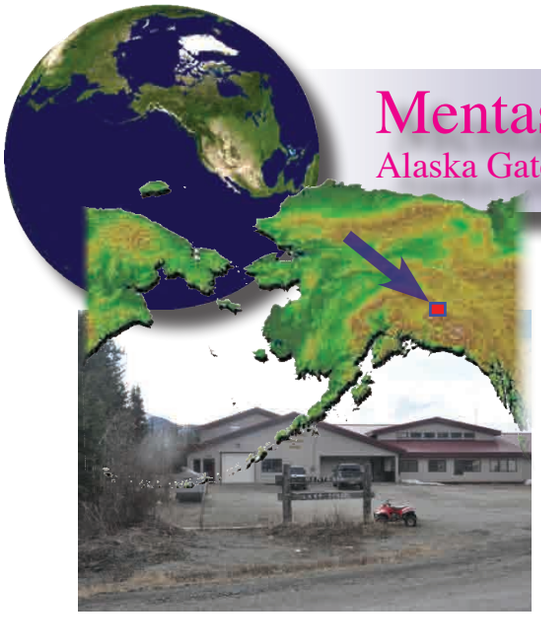
Northway ground temperature (°C)



Location: 62.93° N, 143.64° W

Mentasta Lake

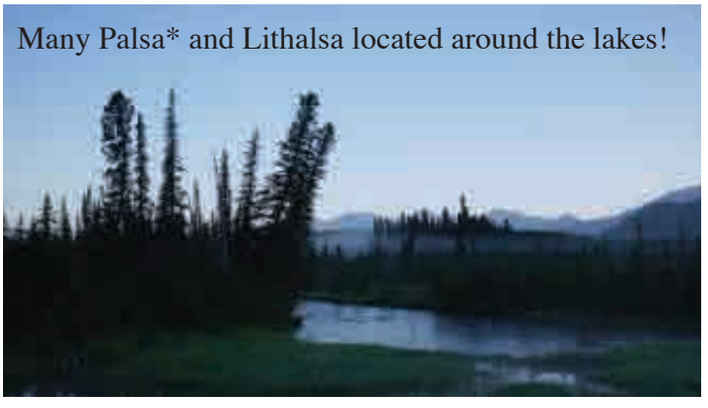
Alaska Gateway School District

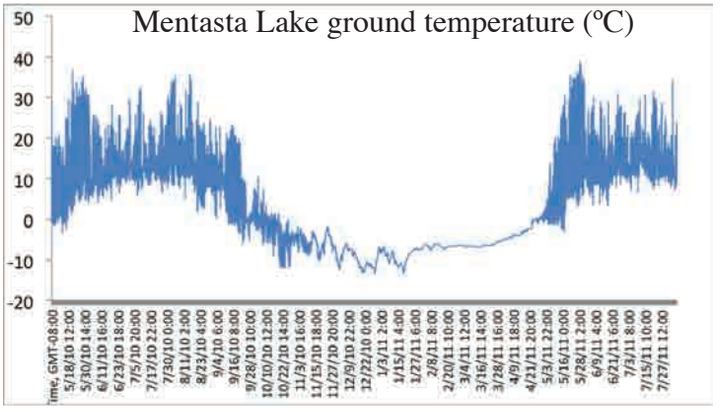


Student population: 18

Mentasta Lake, a village with 112 residents (2008 Estimated Population, not Certified), is located near the west side of a lake of the same name. The community is on a 10-kilometer (6-mile) spur road that heads west from the Tok Cutoff Highway, 61 kilometers (38 miles) southwest of Tok Junction. The indigenous people of this region are Athabascan. Signs of early settlement have been found at sites around the lake. Historically, this area formed part of a well-known route for Alaska Natives who were crossing the Alaska Range. In 1902, a telegraph station was established here by the U.S. Army Signal Corps. Most residents of Mentasta Lake are Alaska Native or part Native, mainly Athabascan, whose families have moved from other villages, such as Nabesna, Suslota, and Slana. Traditional subsistence practices are important to the way of life here. Employment opportunities are limited. An airstrip is nearby at Mentasta Lodge.

Key Facts (2009):
Annual mean ground temperature: 3.1°C
Freezing days: 182 days
Freezing degree-days: 765 °C days
Thawing degree-days: 1907 °C days

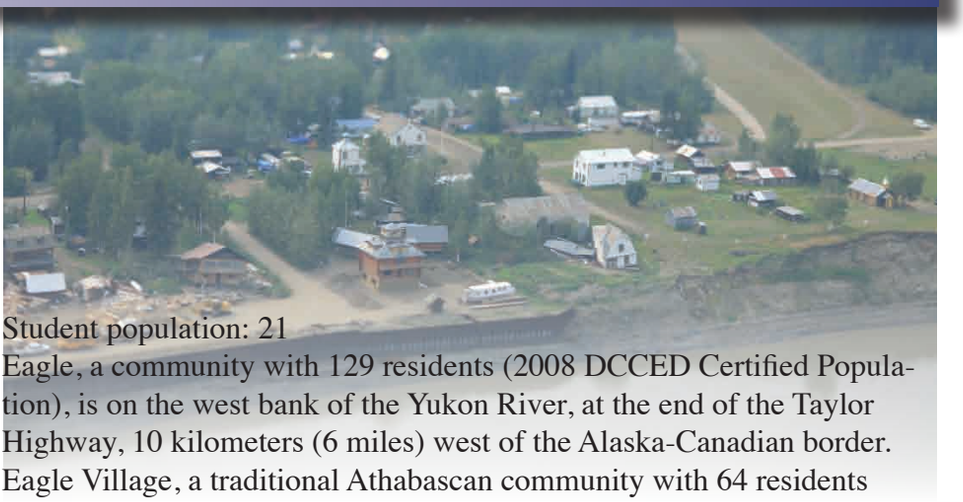




* Palsas are low, often oval, frost heaves occurring in polar and subpolar climates, which contain permanently frozen ice lenses. Like pingos, palsas consist of an ice core with overlying soil, but they are generally smaller than pingos and often occur in groups. Palsas need large quantities of water for the formation of their ice lenses, and for this reason they occur particularly in bogs.

Eagle

Alaska Gateway School District



Student population: 21

Eagle, a community with 129 residents (2008 DCCED Certified Population), is on the west bank of the Yukon River, at the end of the Taylor Highway, 10 kilometers (6 miles) west of the Alaska-Canadian border. Eagle Village, a traditional Athabascan community with 64 residents (2008 Estimated Population, not Certified), is a few kilometers east of Eagle. The area around Eagle is home to the Han Kutchin. In 1874, a trading station opened here; it supplied miners who worked the upper Yukon and its tributaries. When Eagle was officially established 23 years later, it was named for the eagles that nest on a nearby bluff. By 1903, a U.S. Army outpost named Fort Egbert had been established here, and construction had been completed on a telegraph line that ran between Valdez and Eagle. In 1901, Eagle became an incorporated city—the first one in Interior Alaska. Gold discoveries in Nome and Fairbanks drew many people away from Eagle. By 1910, the city's population had dropped from 1,700 to 178. The U.S. Army closed Fort Egbert in 1911. In Eagle today, people work in retail businesses, in the school, and at mining, firefighting, and tourist-related business. Eagle has a gravel airstrip for small aircraft; floatplanes use the Yukon River. The Taylor Highway is part of the Alaska road system, and connects Eagle to Dawson City, Yukon, where it meets the Top of the World Highway into Canada.

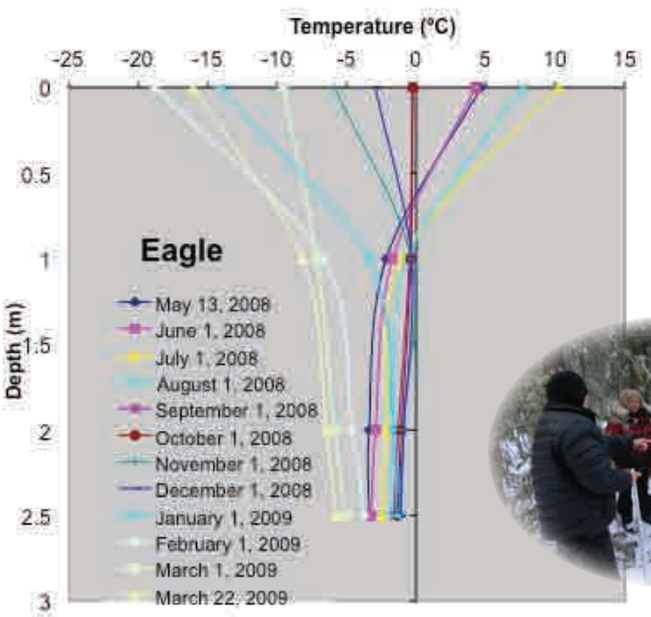
Key Facts:

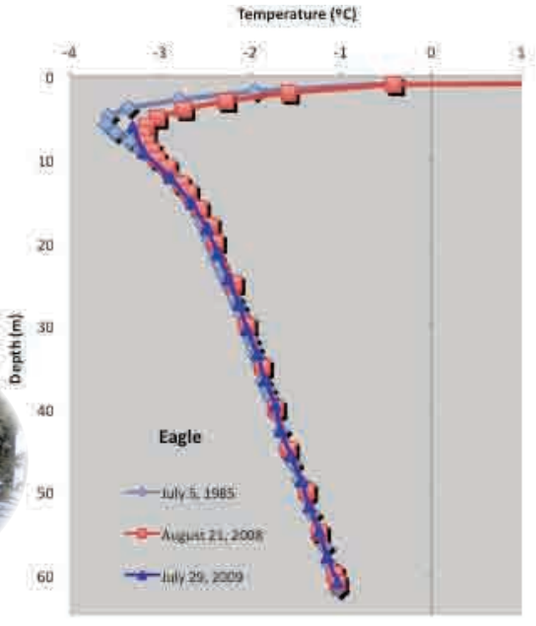
Annual mean ground temperature: nd°C

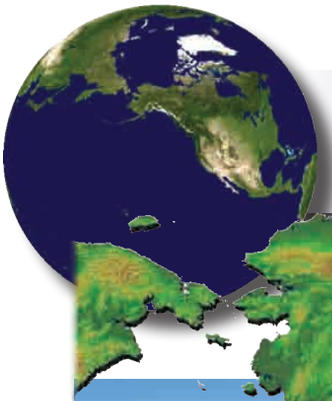
Freezing days: nd days

Freezing degree-days: nd °C days

Thawing degree-days: nd°C days







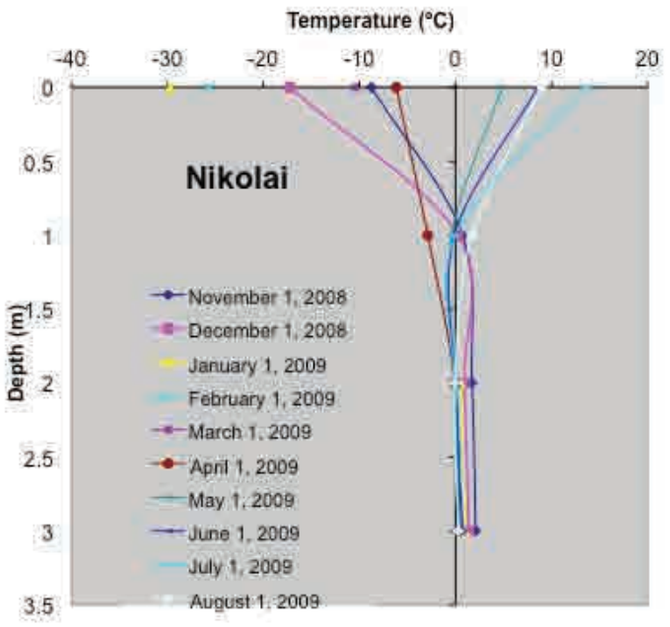
Location: 63.01° N, 154.37° W

Nikolai

Iditarod Area School District

Student population: 20

Nikolai, a village with 90 residents (2008 DCCED Certified Population), is located on the north bank of the south fork of the Kuskokwim River, 74 kilometers (46 miles) east of McGrath by air. The village has been at its present location since 1918, having relocated twice before. During the gold rush, a trading post and roadhouse were located at Nikolai, which was situated on the Rainy Pass Trail, connecting the Ophir gold mining district with Cook Inlet. Nikolai was the site of a winter trail station along the Nenana-McGrath Trail. Between 1927 and 1963, a chapel was built by the St. Nicholas Orthodox Church, a private school was established, a post office was opened, and an airstrip had been cleared. Most residents in Nikolai are Alaska Native or part Native, mainly Athabascan. The community relies on food provided by subsistence activities. Employment includes work for the government and seasonal construction. The community has a gravel airstrip. Barges bring fuel and supplies up the Kuskokwim River when the river is ice-free, generally from June through October. Nikolai is not on the road system, but is connected to McGrath by a marked winter trail. During the Iditarod Sled Dog Race each March, Nikolai is a checkpoint.



Key Facts (2009):
Annual mean ground temperature: -0.7°C
Freezing days: 177 days
Freezing degree-days: 2444 °C days
Thawing degree-days: 2207 °C days

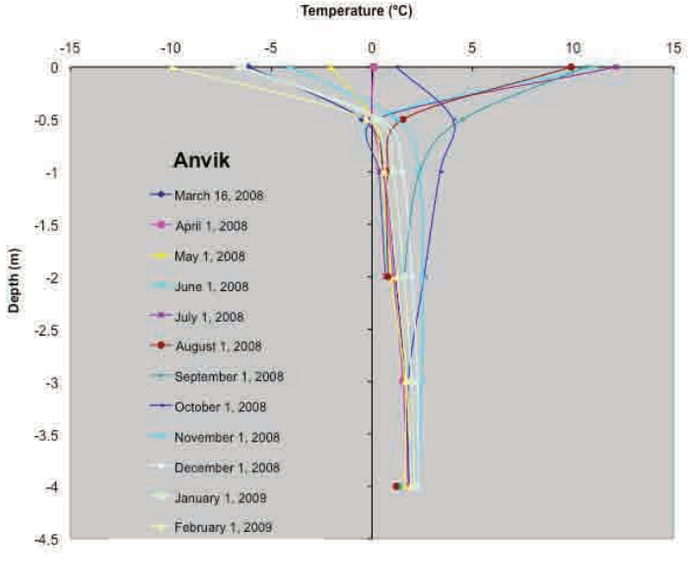
Anvik

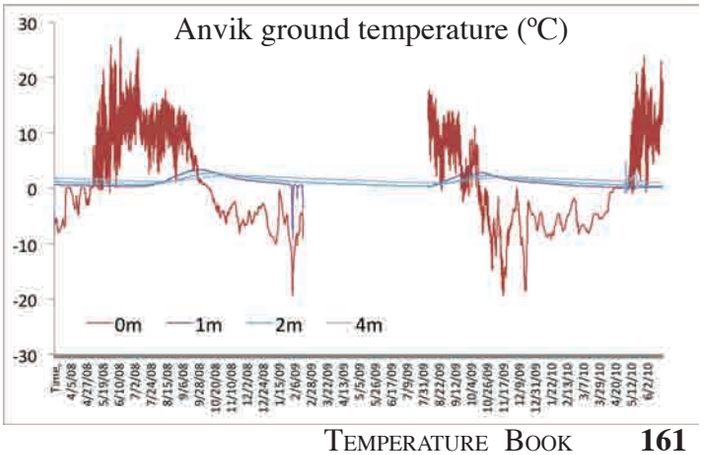
Iditarod Area School District

Student population: 18

Anvik, a village with 84 residents (2008 DCCED Certified Population), is located in Interior Alaska near the mouth of the Anvik River, which flows toward the Yukon River to the east. The village is 55 kilometers (34 miles) north of Holy Cross. The people of Anvik moved from their original location across the river at a site called The Point, following the establishment of an Episcopal mission and school at the present site in 1887. The flu epidemic of 1918–19 and another in 1927 killed many people who lived here. The majority of Anvik's residents are Alaska Native or part Native, mainly Ingalik Athabascan. Subsistence activities are important to the people here; traveling to fish camps during the summer is common. Anvik is not on the road system, but there are a few kilometers of local roads. Barges deliver supplies from June through October, when the Anvik and Yukon Rivers are ice-free, and air carriers fly to the village year-round.

Key Facts (2009):
Annual mean ground temperature: 0.8°C
Freezing days: 188 days
Freezing degree-days: 1162 °C days
Thawing degree-days: 1470 °C days

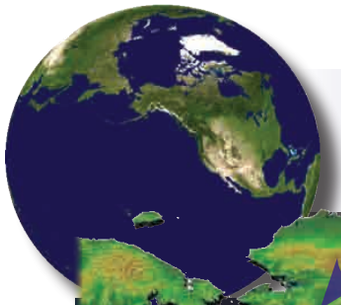


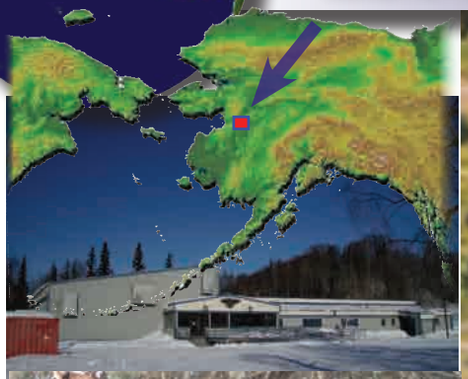


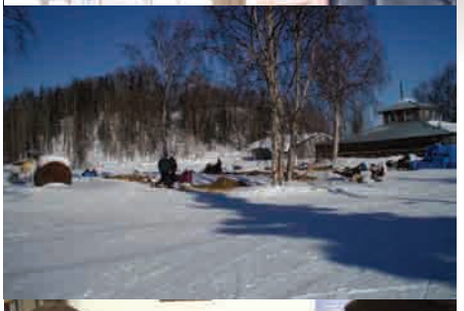
Location: 62.91° N, 160.07° W

Grayling

Iditarod Area School District



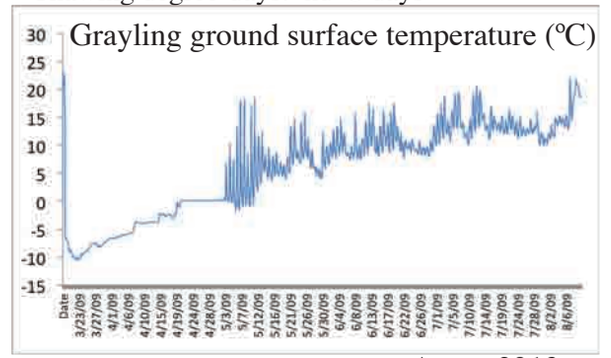




Student population: 43

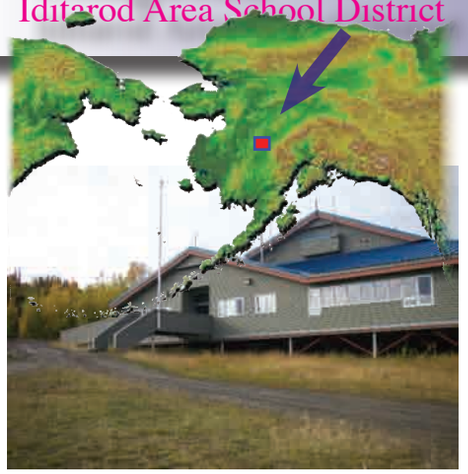
Grayling, a village with 168 residents (2008 DCCED Certified Population), is located on the west bank of the Yukon River, between Anvik and Kaltag. Historically, this area is home to Athabascans. In 1900, Grayling had a population of 75, a store, and a wood yard that supplied wood to the steamers that traveled the Yukon River. The village grew by 25 families in the early 1960s, when people living at Holikachuk on the Innoko River moved to Grayling to escape yearly flooding each spring and low water conditions later in the year that made river travel difficult. Most residents in Grayling are Alaska Native or part Native, mainly Ingalik and Holikachuk Athabascan. Subsistence activities are important to the livelihood of the people living here. Employment includes commercial fishing and some seasonal work. Grayling is not on the road system, but the community has a gravel runway for air transportation and river travel is common. From June through October, the Yukon River is ice-free. On alternate years, Grayling is one of the checkpoints in the Iditarod Sled Dog Race.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days



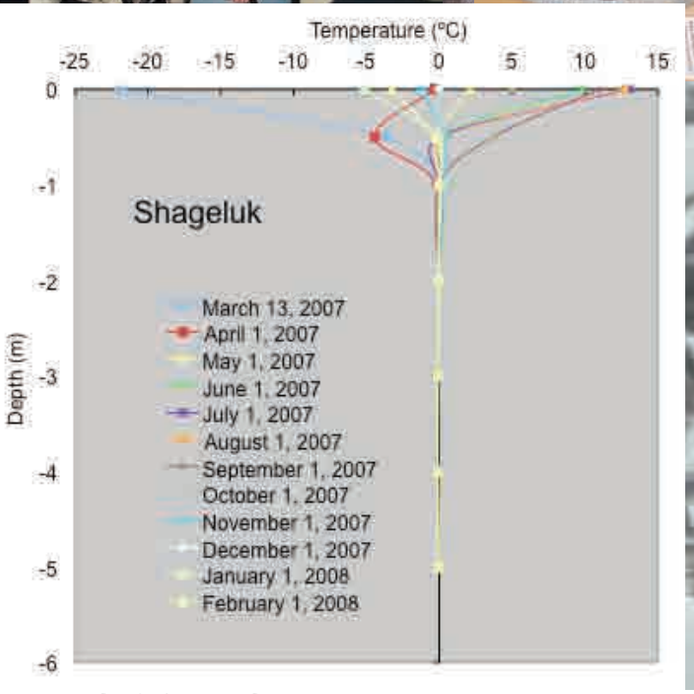
Shageluk

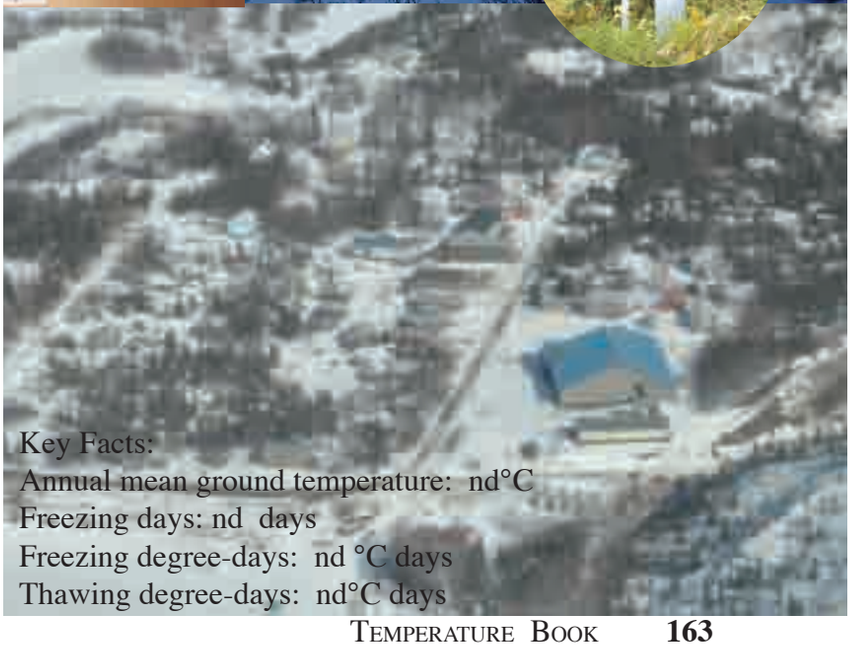
Iditarod Area School District



Student population: 13

Shageluk, a village with 102 residents (2008 DCCED Certified Population), is located on the east bank of the Innoko River, a tributary to the Yukon River. The village is east of Anvik and northeast of Holy Cross. A historian with the Russian American Company reported in 1861 that there were six villages along the Innoko River. These villages were referred to collectively in the 1880 U.S. Census as the "Chageluk settlements." The site called Shageluk became a permanent settlement. Because this location on the Innoko River was prone to flooding, the village moved a few kilometers away to higher ground in 1966. Most residents are Alaska Native or part Native, mainly Deg Hit'an Athabascan, for whom traditional subsistence activities provide an important source of food. Employment includes work with the school and local government, and in seasonal construction. Though the community is not on the road system, it has a gravel airstrip and seaplane base for air carriers. From June through October, the Innoko River is ice-free. Shageluk is a checkpoint along the Iditarod Dogsled Race every other year.



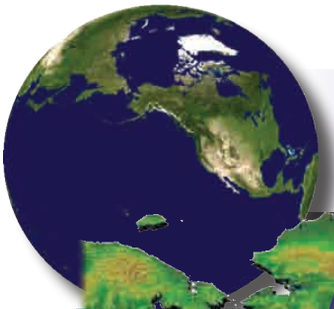


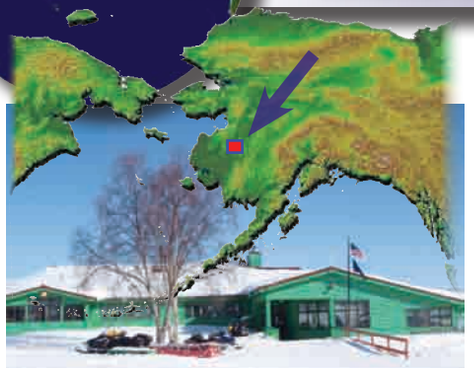
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

Location: 62.20° N, 159.77° W

Holy Cross

Iditarod Area School District





Student population: 49

Holy Cross, a village with 194 residents (2008 DCCED Certified Population), is located on the west bank of Ghost Creek Slough off the Yukon River, between Anvik and Russian Mission. People lived at this site in the 1840s, when Lt. Zagoskin, along with others exploring for the Russian American Company, traveled the Yukon River. Zagoskin reported the village name as Anilukhtakpak, with a population of 170. In 1880, the village name was reported as Askhomute, with a population of only 30. A Catholic mission was established here in the 1880s, and by 1899, a post office had opened, with the location name of Koserefsky. The community was permanently named Holy Cross in 1912, after the name of the mission. Ghost Creek Slough formed after the Yukon River changed its course in the 1930s. Most residents of Holy Cross are Alaska Native or part Native, mainly Ingalik Athabascan. Subsistence activities are important to the way of life here. There is some employment in commercial fishing. Holy Cross is not on the road system, but it has several kilometers of local roads. Air carriers use the gravel airstrip. Barges bring supplies up the Yukon River when it is ice-free from June through October.

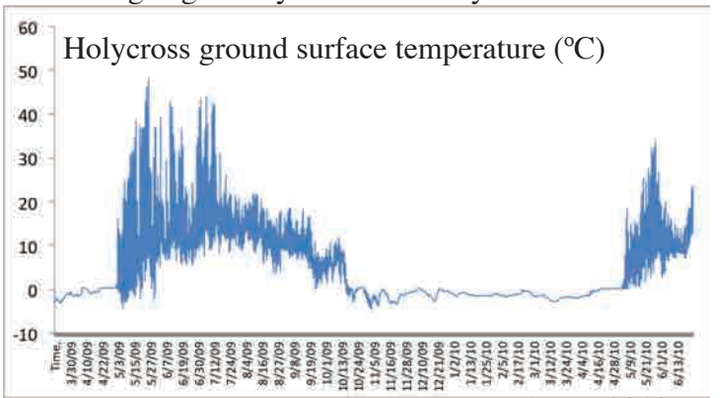
Key Facts (2009):

Annual mean ground temperature: 4.3°C

Freezing days: 174 days

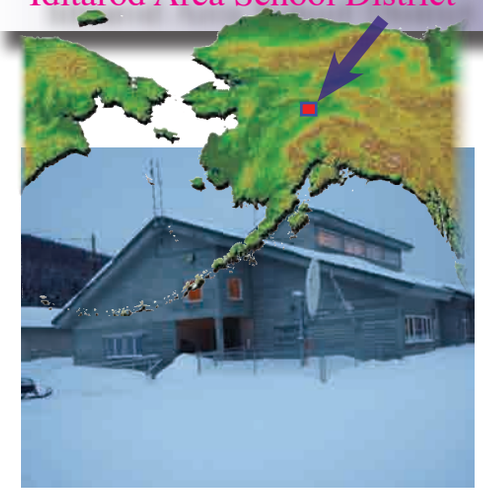
Freezing degree-days: 249 °C days

Thawing degree-days: 1800 °C days



Takotna

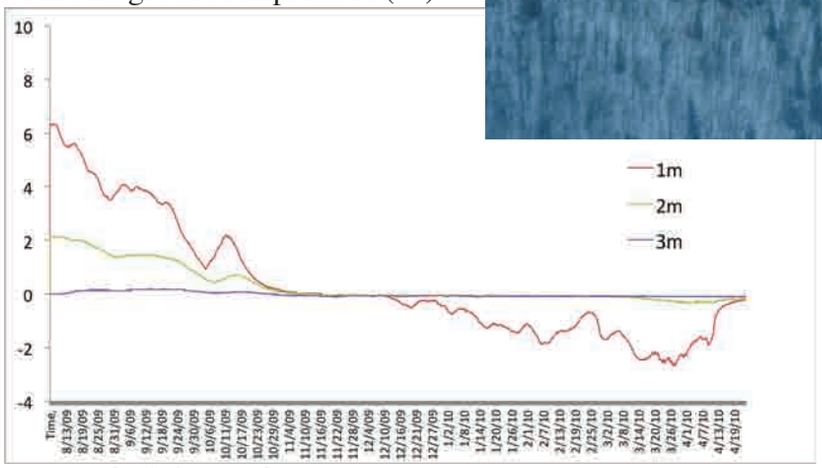
Iditarod Area School District



Student population: 12

Takotna, a village with 46 residents (2008 Estimated Population, not Certified), is located on the north bank of the Takotna River in the Kilbuck-Kuskokwim Mountains, west of McGrath. This location was as far as a small sternwheeler carrying supplies could travel upriver. Gold had been discovered in 1906 in the upper Innoko River region nearby, and miners needed supplies. Takotna became established where those supplies could be offloaded. By 1923, Takotna had stores, roadhouses, a post office, a radio station, its own newspaper, and an airstrip. Sometimes steamboats were unable to reach Takotna due to low water in the Takotna River, so in 1930, the Takotna-Sterling Landing road was built to the larger, deeper Kuskokwim River about 39 kilometers (24 miles) to the southeast. Over time, McGrath, which is located on the Kuskokwim River, grew more popular as a supply center. For about 30 years, until the 1980s, a White Alice communications site was operated at Tatalina Air Force Station, located southeast of Takotna. The gravel runway at the Air Force station is still available for use by air carriers, as is the community's gravel airstrip. Cargo shipped to Takotna is brought up the Kuskokwim River and offloaded at the Sterling Landing for transport to the community. Though Takotna is not on the road system, there are about 129 kilometers (80 miles) of roads that lead to mines, the Air Force station, and Sterling Landing. A winter trail leads to McGrath. Takotna is a checkpoint along the Iditarod Sled Dog Race trail.

Takotna ground temperature (ºC)



Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd°C days

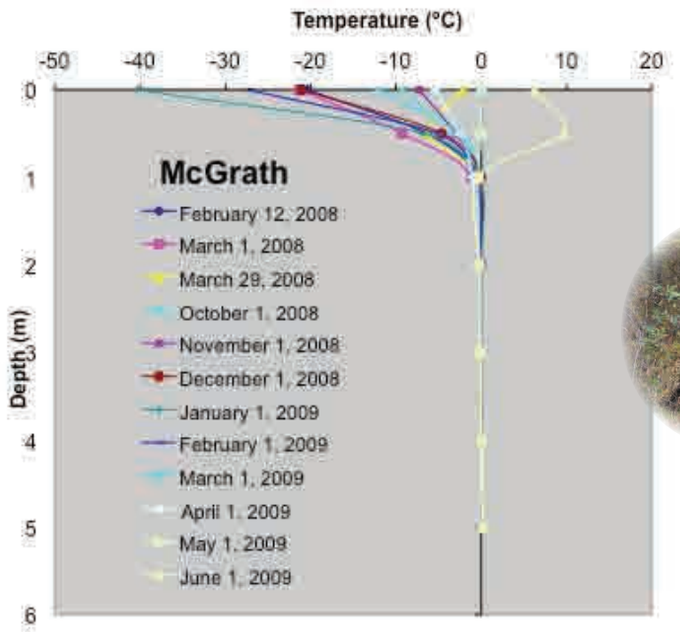
Location: 62.94° N, 155.55° W

McGrath

Iditarod Area School District

Student population: 127

McGrath, a village with 317 residents (2008 DCCED Certified Population), is located along the south bank of the Kuskokwim River, southwest of Nikolai and directly south of the confluence of the Takotna and Kuskokwim Rivers. Historically, this location was a seasonal Kuskokwim Athabascan village, where people from Nikolai, Telida, Big River, and Lake Minchumina met and traded. A trading post was built here in 1904, two years before gold was discovered in the Innoko district and at Ganes Creek. This point on the Kuskokwim River was the furthest that large riverboats could travel with passengers and supplies, which led to its development as a regional supply center for miners. The town of McGrath was officially established in 1907, named for Peter McGrath. The Iditarod Trail, which passed through McGrath, was used by many gold seekers heading for the Ophir gold districts; this traffic also contributed to McGrath's growth as a supply center until the 1920s, when mining declined. McGrath was originally situated on the north bank of the Kuskokwim, but a major flood in 1933 caused relocation of the village to the south bank. By the 1940s, the new site of McGrath had an airstrip, an FAA communications complex, and a school, in addition to rebuilt homes and a store. During World War II, McGrath was a refueling stop for planes as part of the Lend-Lease Program between the U.S. and Russia. McGrath's population is mixed, though the majority is Alaska Native or part Native. Subsistence activities remain important. McGrath serves as an Interior Alaska transportation, communications, and supply center, and there is a variety of employment opportunities. The community is not connected to the road system, but it has a paved runway for air transportation and a seaplane base on the Kuskokwim River. Barges deliver cargo when the river is ice-free, from June through October. McGrath is connected to the villages of Nikolai and Takotna by marked winter trails.



Key Facts (2008):
Annual mean ground temperature: 1.3°C
Freezing days: 219 days
Freezing degree-days: 865 °C days
Thawing degree-days: 1339 °C days

Schools Visited and Activities, 2005–2012

2005

9/30 Fairbanks Pearl Creek
11/30 Nome

2006

4/2 Barrow
5/1 Healy
9/20 Noatak
9/28 Glennallen
9/30 Circle
10/1 Nome
10/11 Beaver
11/1 Circle
11/2 Pearl Creek
8/30 Healy

2007

3/4 Manley H Spring
3/5 Tanana
3/7 Ruby
3/7 Galena
3/8 Koyukuk
3/8 Nulato
3/9 Kaltag
3/12 Shageluk
3/13 Holy Cross
3/14 Russian Mission
3/15 Marshall
3/16 St. Mary's
3/27 Arctic Village
3/28 Ft. Yukon
4/11 Kotzebue
4/12 Noatak
4/13 Selawik
4/23 Barrow
5/2 Beaver Creek
5/3 Destruction Bay
5/4 Whitehorse
5/7 Dawson
5/8 Faro
5/9 Ross River
5/24 Mongolia
5/26 Mongolia (Trej)
6/20 Tokyo
7/15 Kenny Lake
8/14 Lensk
9/17 Barrow
9/18 Wainwright
9/20 Healy
9/ 20 Cantwell
9/21 Manley
9/28 Cantwell/Anderson
9/29 GLOBE workshop
10/1 Dawson
10/2 Old Crow
10/3 Faro
10/5 Ross River
10/23 Kenny Lake
10/24 Northway
10/26 Randy Smith
11/9 Randy Smith
11/15 Pearl Creek
11/17 ACMP workshop
11/29 Delta Junction
11/30 Kenny Lake, Park
12/10 AGU outreach
12/10 IPY meeting
12/19 Delta Junction, Kenny Lake
12/20 Delta Junction

2008

1/4 CRREL Tunnel
1/17 Denali Park, Healy, Anderson, Nenana
1/26 GLOBE workshop
2/5 ACMP lecture
2/7 Tunnel filming
2/10 Alaska forum
2/11 Takotna, McGrath
2/14 Minto
2/18–19 Tunnel
2/21 Anaktuvuk Pass
3/14 Anvik
3/15 Shageluk
3/16 Emmonak
3/18 Kotlik
3/18 Stebbins
3/19 St. Michael
3/20 Unalakleet
3/21 Shaktoolik
3/22 Koyuk
3/23 Elim
3/24 Golovin
3/24 White Mountain
3/26 Teller
3/26 Brevig Mission
3/27 Wales
3/28 Shishmaref
3/29 Deering
4/7 Kotzebue
4/8 Selawik
4/9 Ambler
4/10 Shungnak
4/10 Kobuk
4/11 Ambler
4/11 Kiana
4/12 Noorvik
4/13 Kivalina
4/23 Fox tunnel
4/30 Venetie, Ft. Yukon (Arctic Village)
5/1 Stevens Village, (Beaver), Huslia, Hughes, Galena
5/2 Galena, Kaltag, Unalakleet
5/3 Koyuk, Golovin, Teller, Brevig Mission
5/4 Buckland, Noatak, Kiana
5/5 Nome, Savoonga
5/6 Gambell
5/9 West Valley High School, Polar Palooza
5/12 ICS Fairbanks
5/13 Eagle
6/9 GLOBE workshop
6/25–27 NICOP K12 summer session instructor
6/26 NICOP permafrost summer school
7/15 STEP teacher instructor Fox tunnel guide
7/23 STEP teacher instructor Fox tunnel guide
7/23 ARSC lecture
8/7 BSSD new teachers' orientation
8/7 Unalakleet
8/8 St. Michael, Stebbins
8/9 Shaktoolik
8/10 Elim
8/11 Brevig Mission, Teller
8/12 Nome, White Mountain (Council), Wales
8/13 Shishmaref
8/14 Noorvik, Kiana, Selawik, Buckland
8/15 Huslia
8/23 Eagle
8/26 Kaktovik
9/1 Homer
9/2 Kenai
9/2 Anchorage, Wasilla, Cantwell
9/12 Hatgal (Mongolia)
8/26–31 Anakutuk Pass, Ambler, Shungnak, Stevens Village, Venetie, Minto, Manley Hot Springs
9/15–24 McGrath, Shageluk, Anvik, Russian Mission, Marshall, St. Mary's, Kotlik, Emmonak
10/3 North Pole
10/4 GLOBE UAF workshop
10/6 Home school (IDEA, Deb Bennett)
10/8 Hutchison High School
10/13 Delta Junction
10/14 Valdez
10/15 McGrath, Igiugig
10/16 Bethel
10/17 Tuntutuliak, Platinum, Good News, Kwethluk
10/18 Tununak, Kasigluk-Akiuk
10/19 Kasigluk-Akula, Mekoryuk, Chuathbaluk
10/20 Nikolai
10/27 Badger Road Elementary
10/31 Joy Elementary
11/3 Valdez
11/4 Polaris K12
11/5 Chalkyitsik, Venetie
11/6 Joy
11/10 ACMP mentor lecture
11/14 Dot Lake, Tanacross, Tetlin, Tok
11/17 Dawson
11/18 Faro, Ross River
11/19 Carmacks, Whitehorse
11/20 Beaver Creek, Northway, Tok, Tanacross, Dot Lake, Delta Junction
11/25 Denali Park, Healy, Anderson
12/4 Bethel
12/8 Kenny lake
12/9 Valdez, Copper Center
12/10 Whittier, Anchorage (Aquarian)
12/12 Pearl Creek
12/15 Badger Road Elementary, North Pole
12/16 Salcha

2009

1/12 ACMP mentor lecture for BSSD
1/13 Two Rivers, Chena Hot Springs
1/15 Effie Kokrine Charter School
1/16 Randy Smith Middle School K7
1/22 Lunar Planetary Institute, Houston Texas
1/28 University Park Elementary
1/29 Cryoconn teachers workshop
1/30 Randy Smith K8
2/2 BSSD mentor lecture
2/11 Mahon Mountain, China
2/18 Napaskiak, Napakiak, Oscarville
2/19 Napaskiak, Napakiak, Oscarville, Eek
2/20 Eek, Quinhagak
2/21 Tuntutuliak
2/22 Kongiganak
2/23 Kwigillingok
2/24 Kipnuk, Chefornak
2/25 Nightmute
2/26 Tununak, Toksook Bay
2/28 Newtok
3/1 Kasigluk
3/2 Nunapitchuk
3/3 Atmautluk
3/13 Fairbanks Joy
3/17 Kwithluk, Akiak, Tuluksak, Aniak
3/18 Chuathbaluk, Holy Cross, Anvik
3/19 Grayling, Kaltag
3/20 Unalakleet
3/21 Shaktoolik, Koyuk
3/22 Buckland
3/24 Kotzebue
3/27 Fairbanks Barnett School
4/2 Pt. Hope
4/8 Barrow Middle School
4/16 Salcha school students visiting UAF
4/17 Delta Junction, Dot Lake, Tanacross, Tok, Mentasta Lake, Slana, Chistochina
4/18 Copper Center, Valdez
4/20 Tatitlik, Cordova, Chenega Bay
4/21 Port Heiden, Igiugig
4/22 Koliganek, Platinium
4/23 Bethel, Kalskag
4/24 Kaktovik
4/27 Pt. Lay, Shishmaref, Wales
4/28 Wales, Hooper Bay, Chevak
4/29 Kalskag, McGrath, Nikolai
5/2-4 St. Paul Island
5/5 Juneau
6/14–8/15 Finland, Mongol, Tibet
8/27 Hakodate Univ.
9/3 Barrow High School
9/3 Wainwright
9/4 Barrow Middle School
9/4 Nuiqsut
9/8 Allakaket
9/8 Tanana
9/11 U-Park, Anderson
9/15 Arctic Watershed Evolution Workshop, Healy, Cantwell
9/16 Seward, Whittier
9/17 Homer, Anchorage (Polaris K12)
9/18 Valdez, Copper Center
9/24–10/2 Kilimanjaro (8 African students)
10/15 Anchorage(Aquarian)
10/16–17 Juneau (Floyd Drysen)
10/18 Anchorage(Aquarian)
10/20 St. Mary's, Sheldon Point, Scammon Bay
10/21 Bethel, Eek
10/22 North Pole
10/25 Dot Lake, Tanacross, Tetlin, Beaver Creek
10/26 Haines, Mosquito Lake
10/27 Whitehorse, Carmacks
10/28 Pelly Crossing, Faro
10/29 Ross River
10/30 Watson Lake
10/31 Northway, Tok, Delta Junction, Salcha, North Pole
11/8 Field guide Arctic in Rapid Transition Art Initiation Workshop
11/10 U-Park
11/11 Joy Elementary
11/12 Begich Middle School/Denali Montessori
11/19 Joy
12/1 Joy, UAF planetary science
12/18 WISE

2010

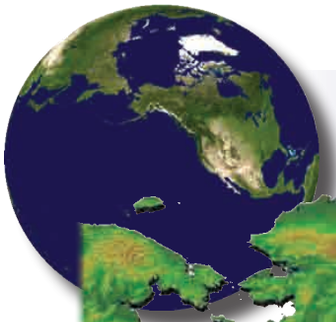
1/8 Cryoconn teachers workshop Chena Hot Springs
2/25 UAF, Joy
3/1 Valdez
3/2 Copper Center, Glacier View, Denali
3/3 Wasilla, Cantwell, Healy
3/4 Joy, Weller
3/11 Kotzebue science fair
3/12 Kotzebue
3/22 Randy Smith Middle School
3/23 Little Diomede
3/24 Wales, Pt. Hope
3/25 Pearl Creek
3/29 Joy
3/30 Kaktovik
3/31 Delta Junction, Valdez
4/1 Glacier View, Chugiak
4/2 Aquarian, Begich, Denali, Polaris K12, Wasilla, Healy, Anderson
4/6 Kivalina
4/7 Kotzebue
4/16 Begich
4/19 Chenega Bay, Tatitlek, Cordova
4/20 Shageluk
4/21 Kasigluk, Nightmute
4/22 Bethel, Crooked Creek, Sleetmute, Koliganek, New Stuyahok
4/23 Iguigig, McGrath, Takotna
4/27 U-Park
4/29 Fox tunnel for Cordova High School
4/30 North Pole Middle School
5/4 Valdez
5/5 Kenny Lake
5/6 Slana, Mentasta Lake, Tanacross, Dot Lake
5/28 GLOBE workshop
6/8 IPA Oslo science conferences
6/10–13 Spain
6/28 GLOBE workshop
7/8–9 St. Paul
8/23–9/2 Peru
9/6 Healy, Denali NP, Cantwell, Seward, Whittier
9/7 Polaris K12, Begich, Palmer, Glacier View
9/8 Valdez, Delta Junction
9/14 Pt. Hope
9/15 Kotzebue
9/16 U-Park, Weller, Pearl Creek
9/17 Randy Smith, Joy
9/21–10/1 Kilimanjaro
10/11 Valdez
10/15 Nenana students in Fox tunnel
10/19 Watershed
10/26 Watershed
11/13 Chugach SD in service
12/13 Fairbanks Joy
12/16 Wainwright
12/17 Barrow, Nuiqsut

2011

1/7 Anderson, Wasilla, Begich
1/8 Seward
1/9 Anderson
1/13 Weller
2/11 Nenana
3/6 Anderson, Healy, Cantwell, Wasilla
3/7 Begich, Aquarian, Polaris K12, Denali, Palmer
3/23 Valdez
3/24 Copper Center
4/5 Little Diomede
4/8 Raven Home school (Fox)
4/14 Pt. Lay, Pt. Hope, Kivalina, Kotzebue
4/20 Fairbanks, Joy
4/21 RAP
4/26 UNIT
4/29 Kodiak
5/2 Tetlin, Dot Lake
5/3 Mosquito Lake, Haines public lecture
5/4 Haines
5/6 Sitka
5/7 Angoon
5/9 Petersburg
5/10 Thorne Bay
5/11 Coffman Cove, Naukati
5/12 Kasaan, Hollis, Craig, Klawock
5/13 Petersburg
5/14 Juneau, Hoonah, Tenakee Hot Spring
5/15 Sitka
5/18 Hyder
6/28 Sitka
7/9 Yukon Wildlife Reserve
7/10 Watson Lake
7/11 Skagway, Haines
7/21 Dutch Harbor, Unalaska
7/23 Akutan
7/24 Cold Bay, False Pass
7/25 Sand Point, King Bay
7/26 Chignik Bay
7/27 Kodiak
7/29 Weller, U-Park
7/31 Two Rivers
8/9 Salcha
8/11 Wasilla, Chugiak
8/12 UNIS Fox tunnel tour
8/23 Fort Greely, Kenny Lake
8/24 Whittier, Seward, Kenai
8/25 Homer
8/30 Fairbanks Joy
8/31 Kaktovik
9/8 Nightmute, Hooper Bay, Scammon Bay, St. Mary's Grayling, Bethel
9/7 Kasigluk, Quinhagak, Platinum, Goodnews Bay, Eek
9/8 Sleetmute, Crooked Creek, Koliganek, New Stayahuk
9/9 King Salmon, Naknek
9/10 Iliamna
9/11 Corvova, Chenega Bay
9/14 Mars polar science conference field excursion
9/15 Nordale
9/20 North Pole
9/23 Anderson
9/24 Math and science workshop field trip
10/7 Kenny Lake
10/11 Tanana, Allakaket
10/12 Joy
10/14 Nenana High at Fox tunnel
10/20 Cordova
10/21 Yakutat
10/25 Fairbanks Pearl Creek Elementary
10/29 Adak
11/28–30 Eastern Hokkaido schools
12/5 AGU
12/15 Eagle
12/21 UNIS Fox tunnel tour

2012

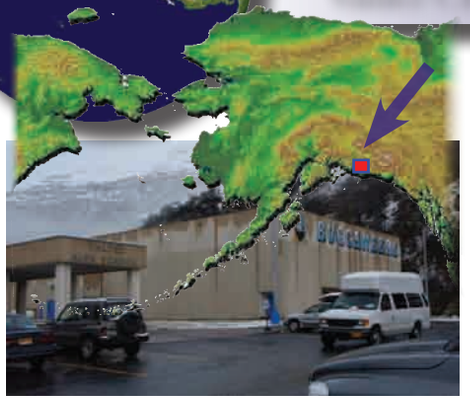
1/17 Fairbanks Pearl Creek
1/18 Kenny Lake
1/18 Valdez
1/19 Palmer High
1/19 Anchorage Denali
1/23 McNeil Canyon Elementary, Homer
1/24 Voznesenka Homer
2/3 St. Paul Island schools permafrost tunnel tour
2/15 Valdez
2/23 Kotzebue
3/5-11 Eastern Hokkaido schools
3/13 Suwa High School permafrost tunnel tour
3/30 Longyearbyen
4/4–11 Yamal, Russian schools
4/17 Weller
4/21–23 IPY Montreal
4/26 Anderson, Healy
4/27 Polaris K12
5/1 Thorne Bay
5/2 Coffman Cove, Naukati, Hollis, Craig
5/3 Kasaan
5/5 Ketchikan
5/6 Petersburg
5/7 Juneau
5/8 Sitka
5/21 Whitehorse
5/22 Carmacks, Pelly Crossing
5/23 Dawson
5/24 Watson Lake
5/25 Hyder
5/26 Skagway
5/27 Haines, Mosquito Lake
6/5 GLOBE Workshop
6/30 Novy Urengoi, Russia
7/15 Nerungli, Russia
7/22 Technical Institute (branch) of the North-Eastern Federal University Russia
8/15 YFSD & YKSD teacher in service
8/18 Fox tunnel open house
8/19 Fox tunnel open house
8/28 Naknek
8/30 Homer, Kackmak Selo
8/31 Kaktovik
9/3 Valdez
11/16 Joy



Location:61.14° N, 146.36° W

Valdez

Valdez City Schools



Student population: 866

Valdez, a city with 4,498 residents (2008 DCCED Certified Population), is located on the north shore of Port Valdez in Prince William Sound. The people who lived in the Prince William Sound area originally were Chugach. Spanish explorers sailed into the sound in 1790, naming this port after a celebrated Spanish naval officer. Valdez is located near the end of a deep-water, ice-free fjord, making it an excellent port. This feature of the location led to the town's development beginning in 1898 with the gold rush. Valdez served as a route for gold prospectors heading to the Eagle mining district, and soon developed into a supply center for local gold miners. In the early 1900s, the U.S. Army constructed a sled and wagon road that linked Fort Liscum in Valdez to Fort Egbert in Eagle. About twenty years later, the Alaska Road Commission connected this road to Fairbanks. From Valdez, roads lead also to Anchorage and the Canadian border. As the terminus for the trans-Alaska oil pipeline, Valdez experienced rapid development in the 1970s during construction of the terminal, the pipeline, and cargo transportation facilities. Valdez was the center for cleanup efforts following the Exxon Valdez oil spill in 1989. There is an airport in Valdez and a seaplane base, a small harbor for commercial fishing boats and recreational boats, and a large floating concrete dock. Valdez is on the Alaska Marine Highway system.

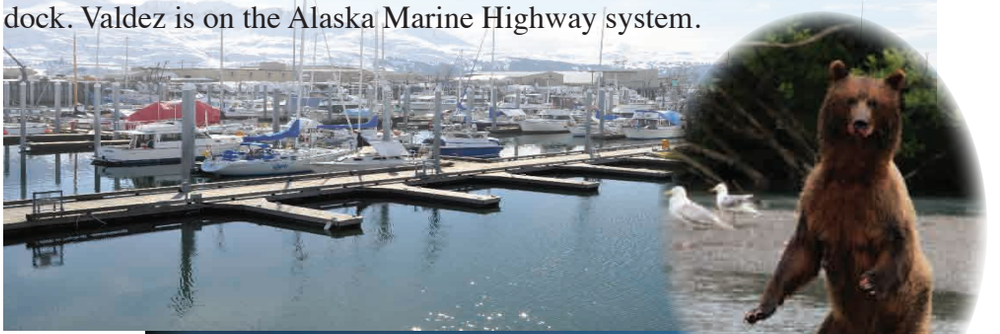
Key Facts:

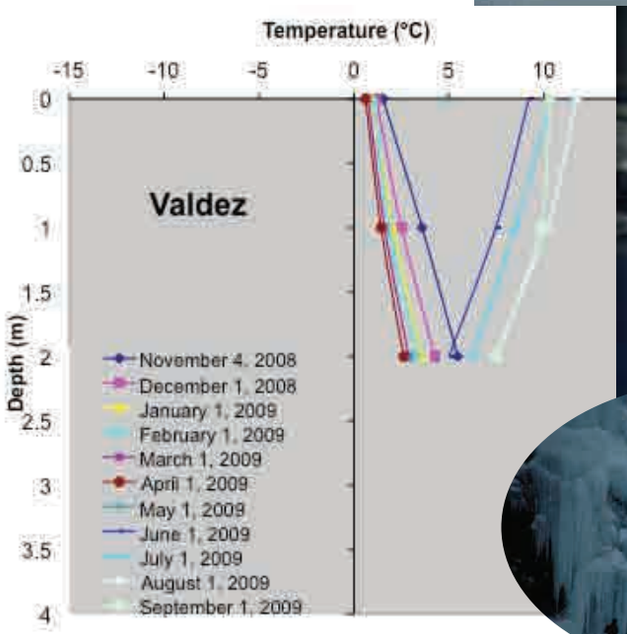
Annual mean ground temperature: nd°C

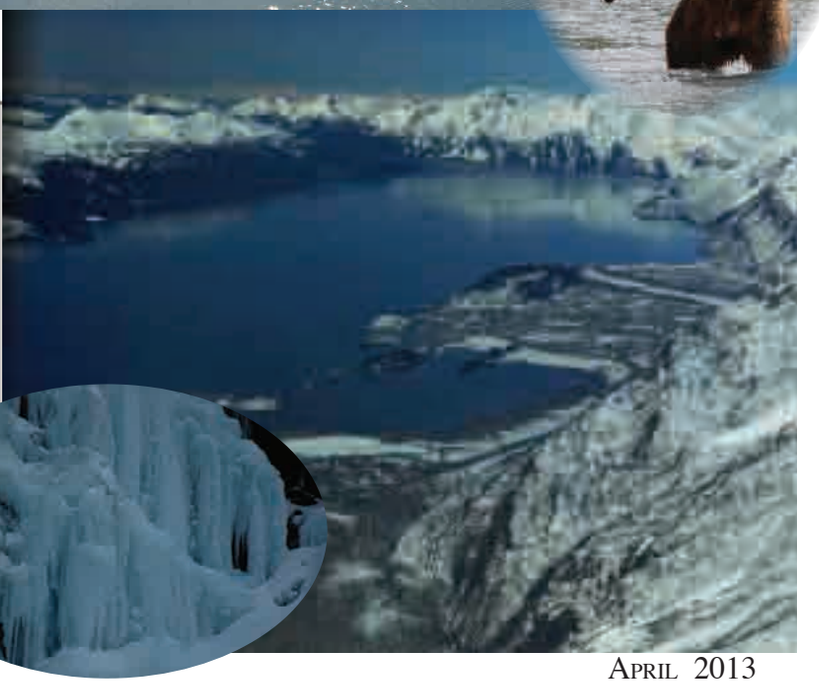
Freezing days: nd days

Freezing degree-days: nd °C days

Thawing degree-days: nd °C days

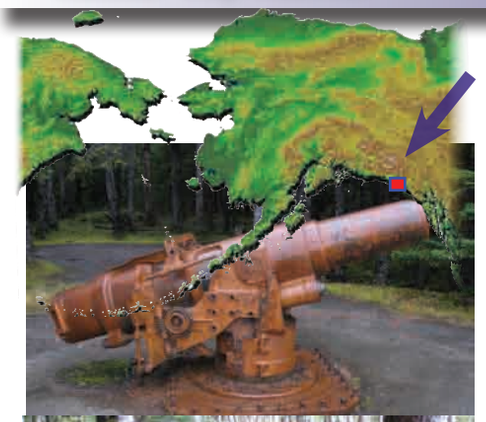






Yakutat

Yakutat City Schools



Student population: 108

Incorporated as a non-unified Home Rule Borough on September 22, 1992, Yakutat was previously a city in the Skagway-Yakutat-Angoon Census Area. The name is Tlingit, Yaakwdáat ("the place where canoes rest") but it originally derives from an Eyak name, diya'quda't, and was influenced by the Tlingit word yaakw ("canoe, boat"). As of the 2011 DCCED certified estimate, the population was 656.

Key Facts:

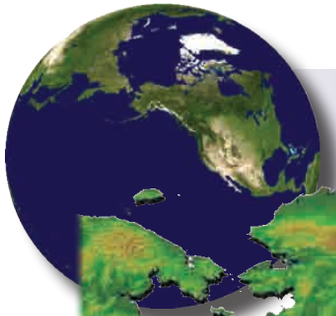
Annual mean ground temperature: nd°C

Freezing days: nd days

Freezing degree-days: nd °C days

Thawing degree-days: nd °C days

PWS

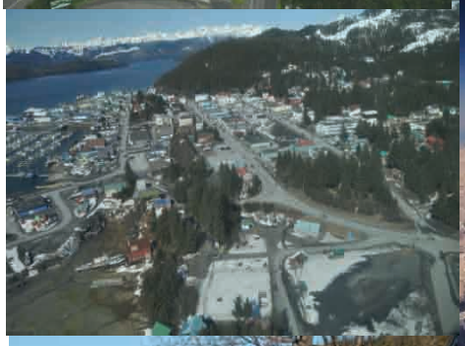


Cordova

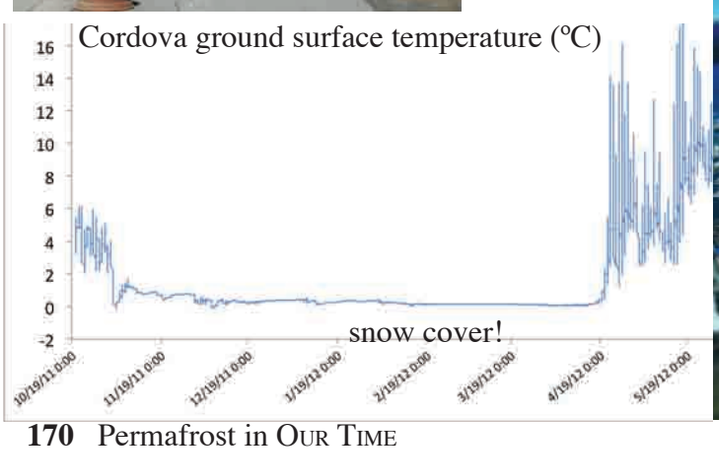
Cordova City Schools

Student population: 373

Cordova, a community with 2,161 residents (2008 DCCED Certified Population), is located on the southeastern side of Prince William Sound in Orca Inlet. The town is 84 kilometers (52 miles) southeast of Valdez by air. Historically, the area around Cordova was inhabited by Alutiiq and Eyak with neighboring Athabascan and Tlingit. In 1790, Spanish explorer Don Salvador Fidalgo gave the name Puerto Cordova to the body of water that is today called Orca Inlet. Cordova (so named in 1906) grew as a town following an oil discovery further southeast at Katalla in 1902. The southern terminus for the Copper River and Northwestern Railroad was located in Cordova in the early 1900s, along with an ocean shipping port, to transport copper ore from the Kennecott Mine, located inland. The Katalla oil field and the Bonanza-Kennecott Mines operated into the 1930s, after which fishing developed as Cordova's economic base. Employment opportunities here include work in commercial fishing and fish processing, and services that support both; and work in the school, in health services, transportation, and city and state government. Cordova is not on the road system. Aside from local roads, one road leads out of town, east to the Copper River Delta. This road also leads to the airport, which serves regularly scheduled flights, including jets. Barge and state ferry service is available year-round.



Key Facts (2011):
Annual mean ground temperature: nd°C
Freezing days: 0 days
Freezing degree-days: 0 °C days
Thawing degree-days: nd °C days



Home of the trans-Alaska pipeline, Alaska has been the setting for a few epic engineering battles rendered against nature. The Million Dollar Bridge, standing almost intact on the lower Copper River, is a reminder of another improbable Alaska construction project. Completed in 1910, the Million Dollar Bridge was the crux of the Copper River and Northwestern Railway, built to carry copper oar 196 miles from Kennicott to Cordova. Along that route were some of the greatest obstacles Alaska offers-steep canyons, rivers, hurricane-force winds, mosquitoes, and dozens of glaciers.

Copper River

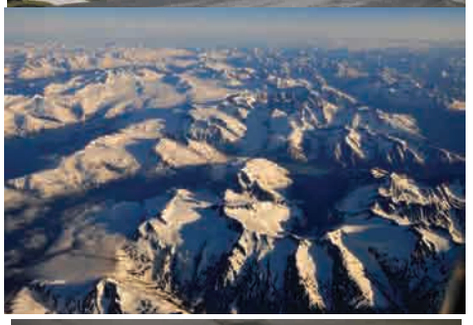
Geologists found that the glaciers had fused during the past several centuries, and the leader of a U.S. Army expedition up the Copper River in 1885 reported that the nose of Miles Glacier was then about 120 yards from the site of the bridge. By 1908, both glaciers had receded to provide a gap of about three miles. Soon after construction of the Million Dollar Bridge (which cost $1.4 million to build), the glaciers threatened the railroad.

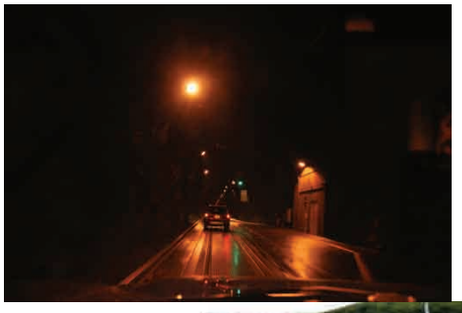
In August 1910, two glaciologists from the National Geographic Society studied the sudden advances of both Miles and Childs glaciers. A northern lobe of Childs Glacier began creeping toward the bridge in June, and by August it was moving eight feet per day. On August 17th, the 200-foot face of the glacier was 1,624 feet away from the bridge. Childs Glacier did not engulf the bridge, but the glacier crept to within 1,475 feet in June 1911. Childs and Miles glaciers have since retreated, sparing the Million Dollar Bridge, which served the railway from 1910 until 1938, when low copper prices forced the shutdown of the Copper River and Northwestern Railway. The bridge survived nature's whims until March 27, 1964, when the Good Friday Earthquake knocked the northernmost span from its concrete piling.

Location: 60.77° N, 148.69° W

Whittier

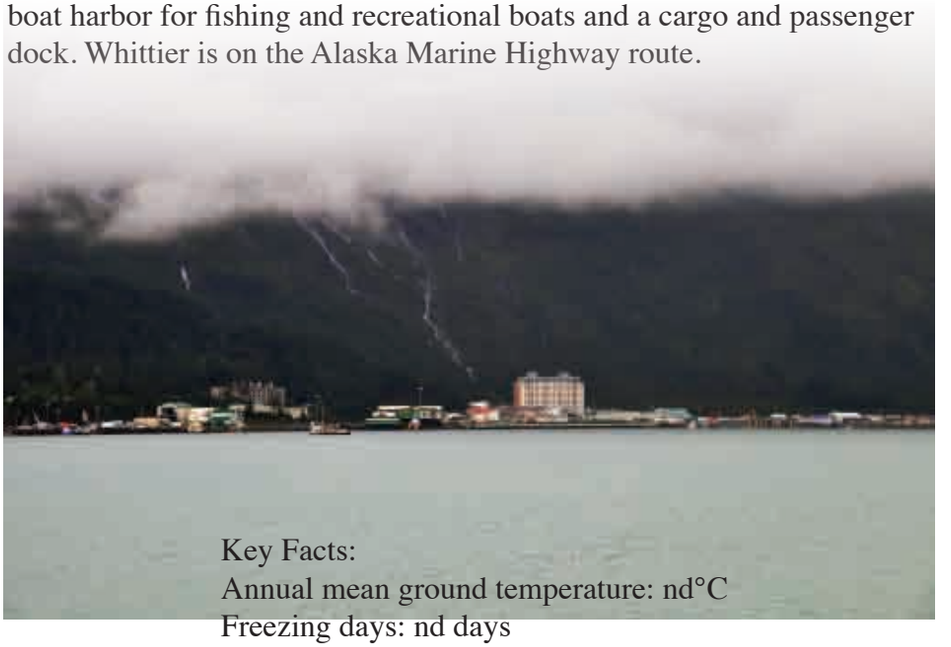
Chugach School District





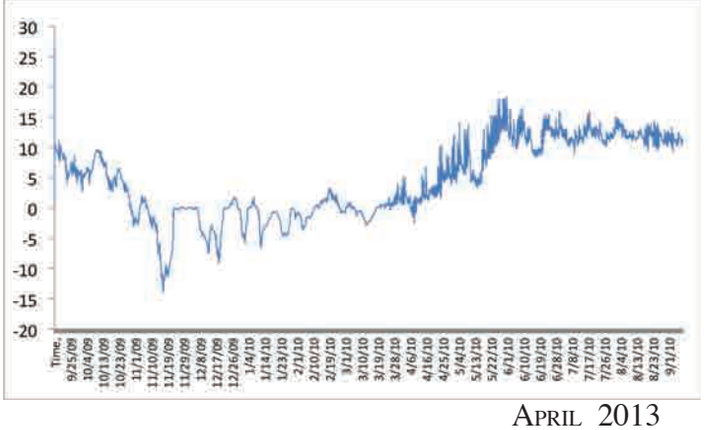
Student population: 35

Whittier, a town with 161 residents (2008 DCCED Certified Population), is located on the northeast shore of the Kenai Peninsula, at the head of Passage Canal in the western part of Prince William Sound. Historically, this is home to the Chugach people. A glacier located nearby was named for John Greenleaf Whittier, an American poet. The U.S. Coast and Geodetic Survey published this name in 1915. During World War II, the U.S. Army built a port and railroad terminus at Whittier for moving fuel, supplies, and military troups into Alaska. The railroad connects Whittier to the Seward Highway at Portage. Whittier was an active army facility until 1960, and buildings related to the military's presence remain. Whittier's population is mixed. Employment includes work with the school, local government, and tourism, and in local services. A road connects Whittier to the state's road system, and a gravel airstrip accommodates chartered air carriers. Whittier's port is ice-free. The town has a small boat harbor for fishing and recreational boats and a cargo and passenger dock. Whittier is on the Alaska Marine Highway route.



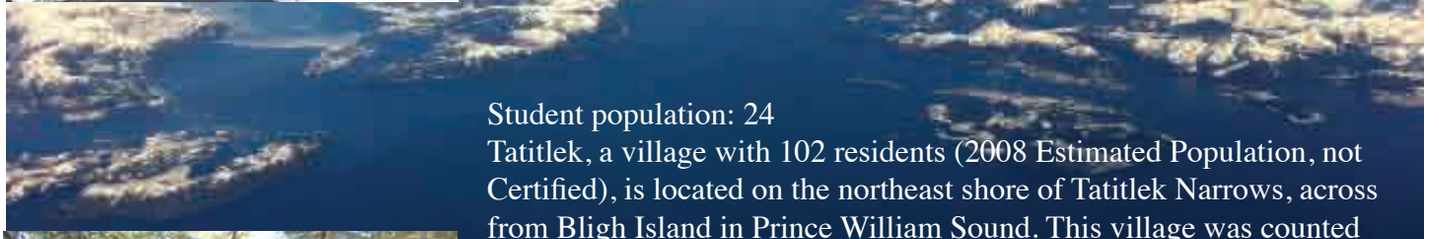
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Single-lane tunnel to Whittier, Alaska



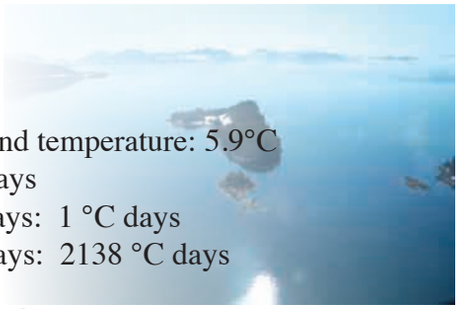
Tatitlek

Chugach School District



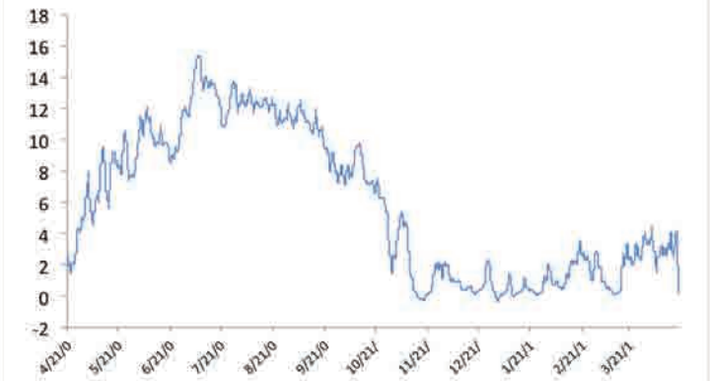
Student population: 24

Tatitlek, a village with 102 residents (2008 Estimated Population, not Certified), is located on the northeast shore of Tatitlek Narrows, across from Bligh Island in Prince William Sound. This village was counted in the 1880 U.S. Census, though it moved from its original location in Gladhaugh Bay to its present site around 1900. A post office opened here in 1946. Following the 1964 Good Friday earthquake and tsunami, many people that lived in Chenega, a village across the Sound that was destroyed, moved to Tatitlek. Most residents of Tatitlek are Alaska Native or part Native, mainly Alutiiq. Traditional subsistence practices are important in this community. Employment includes work in fish processing, oyster farming, and commercial fishing. Air carriers to Tatitlek use either a lighted gravel airstrip or a seaplane landing area. Boat travel is the predominant form of transportation.



Key Facts (2009):
Annual mean ground temperature: 5.9°C
Freezing days: 8 days
Freezing degree-days: 1 °C days
Thawing degree-days: 2138 °C days

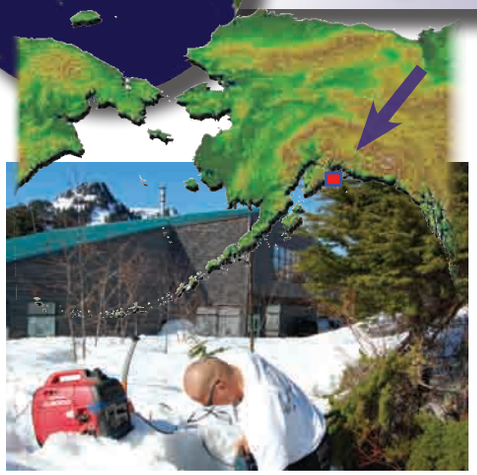
Tatitlek ground surface temperature (ºC)



Location: 60.07° N, 148.01° W

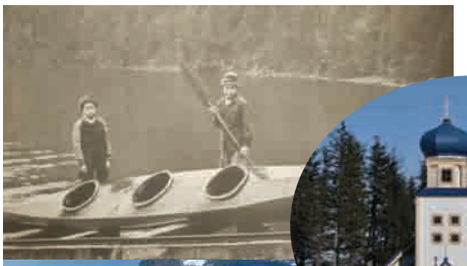
Chenaga Bay

Chugach School District

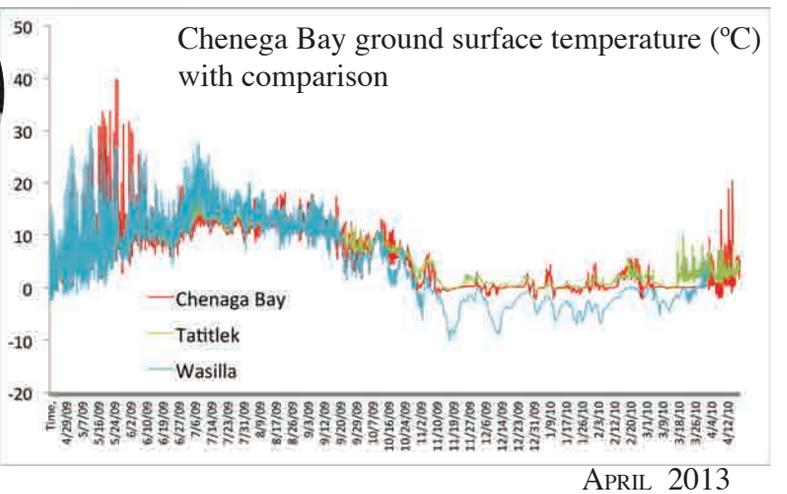


Student population: 19

Chenega Bay, a village with 76 residents (2008 Estimated Population, not Certified), is located at Crab Bay on Evans Island in Prince William Sound. At the time of the 1880 Census, this Alutiiq village was located on the southern end of Chenega Island. A post office was opened in 1946. The tsunamis that followed the 1964 earthquake destroyed the village of Chenega Bay, and killed more than half its residents. The village was reestablished on Evans Island in 1984, with the construction of homes, a church, a school, and community buildings. Most residents in Chenega Bay are Alaska Native or part Native, mainly Alutiiq. Subsistence activities are important here. Some residents fish commercially and there is a small oyster farm in operation, but generally employment is limited. Chenega Bay is accessible by air and sea; it has a gravel runway, floatplane landing area, and small-boat harbor and dock.

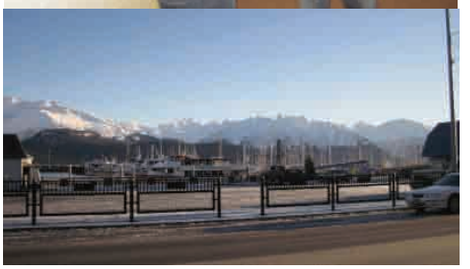


Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

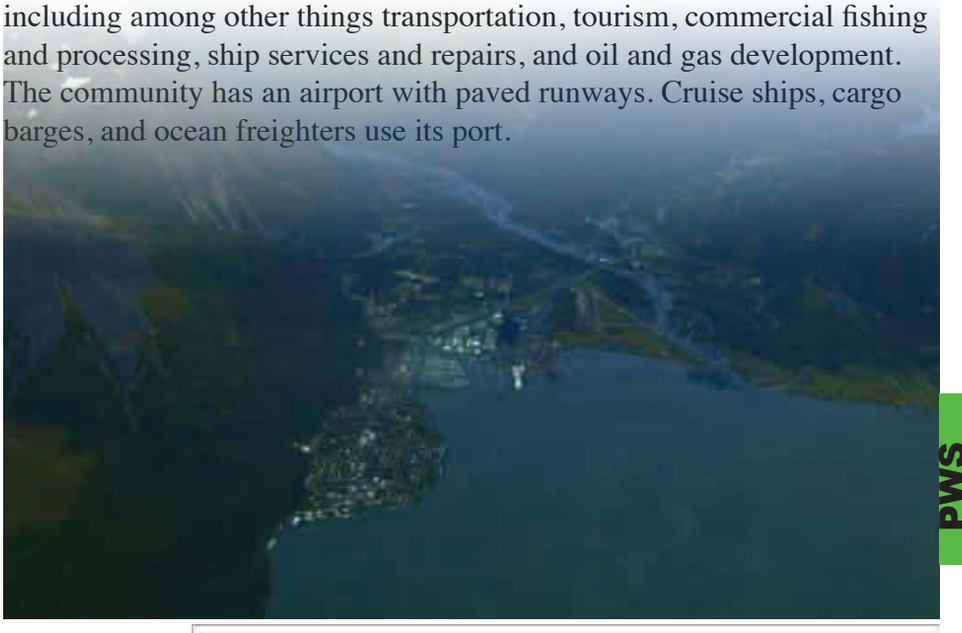


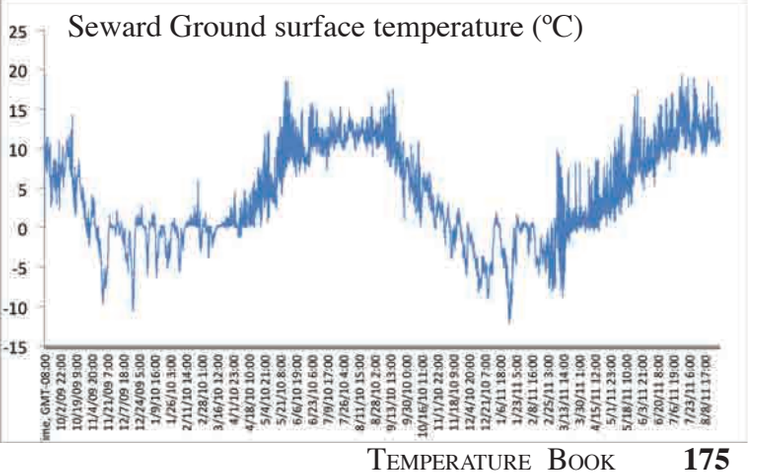
Seward

Kenai Peninsula Borough School District



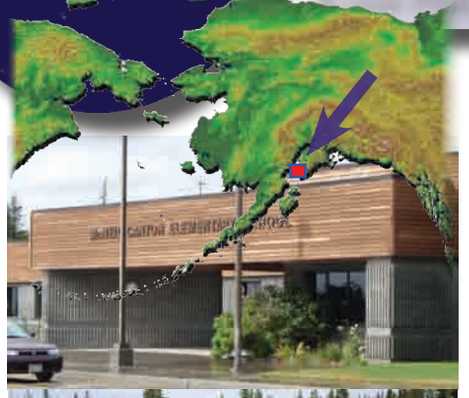
Seward, Alaska
Student population: 594
Seward, a town with 2,619 residents (2008 DCCED Certified Population), is located at the head of Resurrection Bay on the east coast of the Kenai Peninsula, 201 kilometers (125 miles) south of Anchorage by road. The people who lived here before Russian contact were Alutiiq-speaking Unegkurmiut. Russian fur traders, exploring the coast of Alaska in the late 1700s, found sheltered water in Resurrection Bay and named it after a religious day. The town is named for William Seward, U.S. Secretary of State from 1861–1869, who figured importantly in the 1867 purchase of Alaska from Russia. In 1903, construction began on the Alaska Central Railroad, a railway that would connect Seward with Interior Alaska. The project went bankrupt after four years, but the U.S. government purchased the railway, completing the Alaska Railroad in 1923. With its ice-free harbor, Seward developed as an ocean terminus and supply center. The town suffered considerable damage caused by tsunamis following the 1964 Good Friday earthquake. Seward's economy today is diverse, including among other things transportation, tourism, commercial fishing and processing, ship services and repairs, and oil and gas development. The community has an airport with paved runways. Cruise ships, cargo barges, and ocean freighters use its port.





Key Facts (2009):
Annual mean ground temperature: 4.4°C
Freezing days: 87 days
Freezing degree-days: 187 °C days
Thawing degree-days: 1811 °C days

www.uaf.edu/permafrost



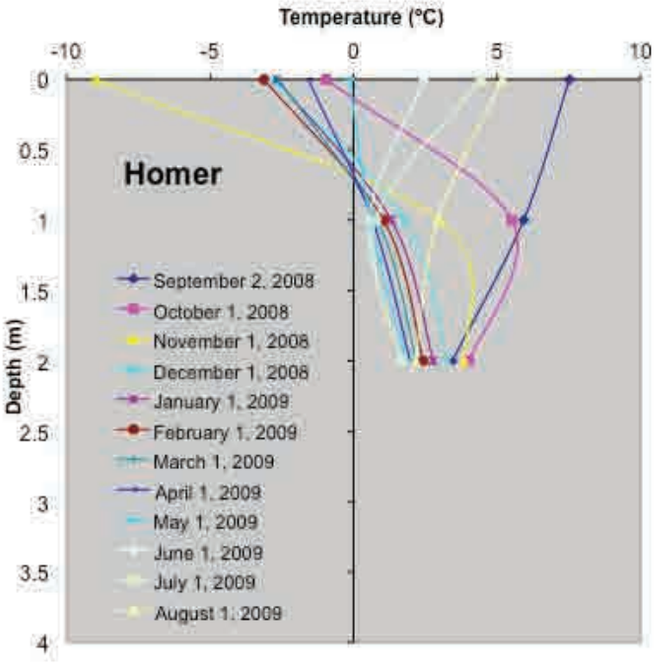
Location:59.78° N, 151.18° W

Homer -McNeil Canyon Elementary School-

Kenai Peninsula Borough School District

Student population: 1,425

Homer, a town with 5,390 residents (2008 DCCED Certified Population), is located on the north shore of Kachemak Bay on the southwestern edge of the Kenai Peninsula. The town is a 365-kilometer (227-mile) drive south of Anchorage on the Sterling Highway. For thousands of years, the area around Homer has been inhabited by the Kenaitze. The U.S. Geological Survey arrived in Homer in 1895 to study the area's coal and gold resources. A year later, Homer Pennock, after whom the community is named, arrived, with an interest in mining beach sands for gold. He constructed living quarters for his 50 employees on a spit of land, now called the Homer Spit, which extends nearly 8 kilometers (5 miles) into Katchemak Bay. By 1899, coal was being mined near Homer, and development increased with a dock and a post office, and a railroad that carried coal to the end of the Spit. Coal mining continued until World War I. Settlers moved into the area in the 1930s and 1940s to homestead and work in the canneries. Fishing and fish processing continue to be important economic sources in Homer. The area attracts artists, recreationists, and tourists, some of whom arrive on the many cruise ships that visit here each summer. Homer has an airport with a paved airstrip and scheduled air service. In addition, the community is on the Alaska Marine Highway system, with regularly scheduled ferry service.

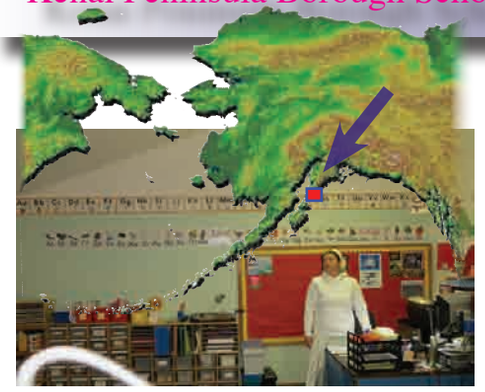


Key Facts (2010):
Annual mean ground temperature: 2.4°C
Freezing days: 186 days
Freezing degree-days: 340 °C days
Thawing degree-days: 1212 °C days

Location: 59.79° N, 151.07° W

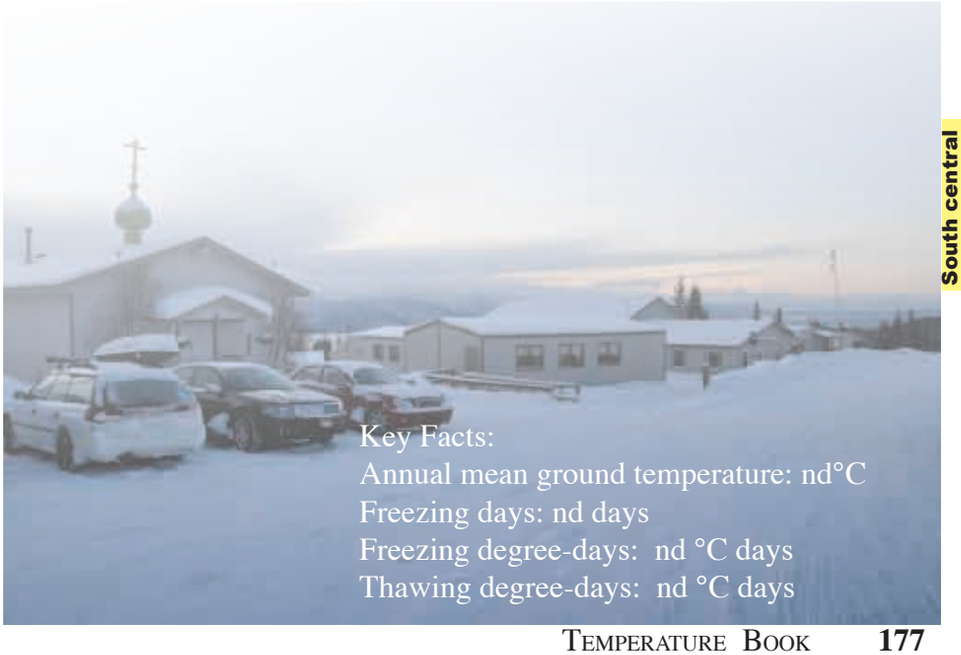
Voznesenka/Kachemak Selo

Kenai Peninsula Borough School District



Voznesenka, a Russian name that means "Ascension," is a community of 40 families situated about 40 kilometers (25 miles) east of Homer on a bluff above Kachemak Bay. The neighboring village of Kachemak Selo is beside the bay, accessible from Voznesenka by foot trail or ATV. Residents of these communities are members of the Old Believers branch of the Russian Orthodox Church. The local language is Russian, and the community's dress code reflects the residents' ethnicity. Voznesenka has a community church and a public school.

History:
Old Believers split from the Russian Orthodox Church in the 17th century when Patriarch Nikon ordered a number of reforms to Russian Orthodoxy. Many members left Russia or moved to the Siberian taiga, where they could pass the old rites down to their children in peace. However, the Bolshevik Revolution of 1917 forced many of the remaining Old Believers out of Russia for good, as the Soviets threatened their religious practices and collective farms threatened the community's livelihood.
About 300 Old Believers left Siberia in 1945 to take up residence in Manchuria, China. When that country fell to communism, the group sought a new home. Several South American countries took in the Old Believers. In Brazil, the government did not interfere with their religion, but many of the families found it difficult to make a living. Old Believers next moved to the United States, establishing themselves primarily in Woodburn, Oregon, in the early 1960s. One of the members discovered that government land was available in the Kenai Peninsula area of Alaska, where fishing was reputed to be outstanding. The first Old Believer settlers on the Kenai Peninsula received a grant from the Tolstoy Foundation in New York and purchased 640 acres of land on the peninsula in 1967.



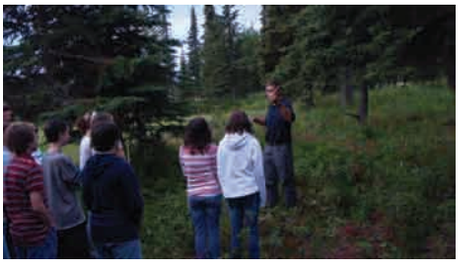
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

South central

Location: 60.56° N, 151.21° W

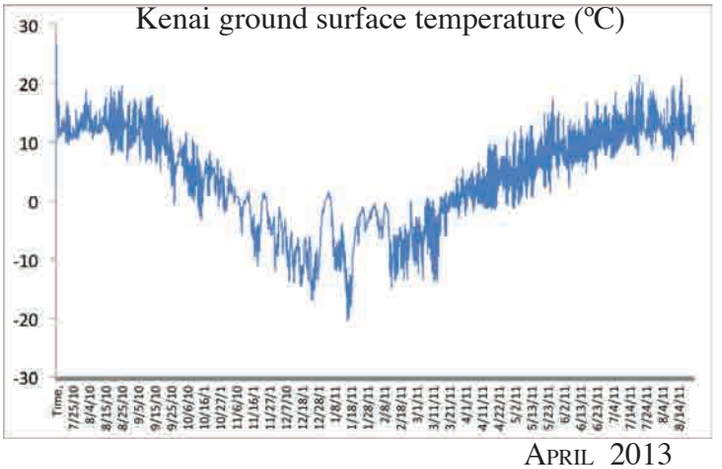
Kenai

Kenai Peninsula Borough School District



Kenai, Alaska
Student population: 1,830
Kenai, a city with 7,134 residents (2008 DCCED Certified Population), is located on the west coast of the Kenai Peninsula, bordering Cook Inlet. The community is a 249-kilometer (155-mile) drive southwest of Anchorage. Before Russian fur traders arrived at this location in 1741, it was the site of a Dena'ina Athabascan village, called Shk'ituk't. The Russian traders called the people living here Kenaitze, or Kenai people. Over the next one hundred years, the Russians established a trading post for fur and fish, and a Russian Orthodox church. Fishing was Kenai's main commercial activity through the 1920s. Further development occurred when the area was opened to homesteading in 1940. A dirt road connected Kenai to Anchorage by 1951. It is this road—the Sterling Highway—and the Kenai Spur Highway that lead to the community. With the discovery of oil northeast of Kenai and offshore in Cook Inlet, Kenai has grown as a service and supply center for oil and natural gas drilling and exploration in Cook Inlet. The Kenai River, which flows through the community, is a popular sport fishing location.

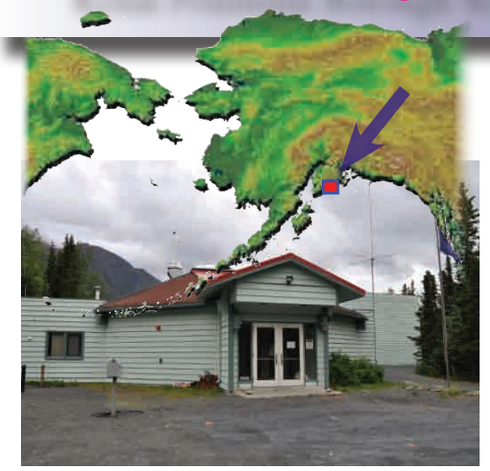
Key Facts (2010):
Annual mean ground temperature: 2.7°C
Freezing days: 234 days
Freezing degree-days: 826 °C days
Thawing degree-days: 1818 °C days



Location: 60.50° N, 149.42° W

Cooper Landing/Moose Pass/Ninilchik

Kenai Peninsula Borough School District



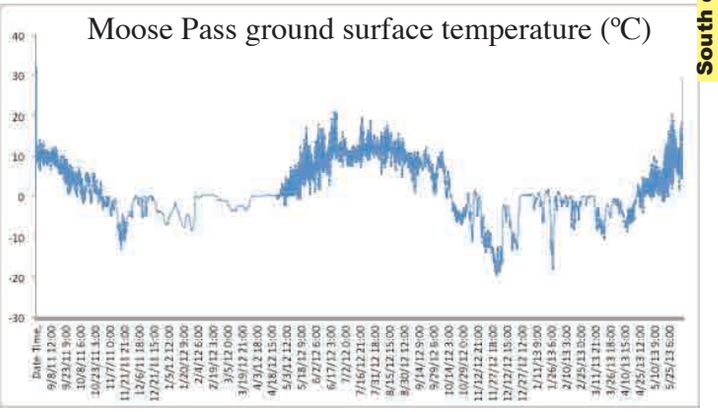
Cooper Landing is a census-designated place (CDP) in Kenai Peninsula Borough, Alaska, United States, about 100 miles (160 km) south of Anchorage, at the confluence of Kenai Lake and Kenai River. The town was first settled in the 19th century by gold and mineral prospectors, and has become a popular Summer tourist destination thanks to its scenic wilderness location and proximity to the world-class salmon fishery of the Kenai River and Russian River. As of the 2010 census, the population in Cooper Landing was 289.

Moose Pass is an unincorporated community of just over two hundred people on the Kenai Peninsula, Alaska. It is a census-designated place (CDP) in Kenai Peninsula Borough, Alaska, United States. At the 2010 census the population was 219.

Ninilchik (Russian: Нинилчик) is a census-designated place (CDP) in Kenai Peninsula Borough, Alaska, United States. At the 2010 census the population was 883.

Key Facts (Moose Pass 2011):
Annual mean ground temperature: 2.7°C
Freezing days: available
Freezing degree-days: available
Thawing degree-days: available

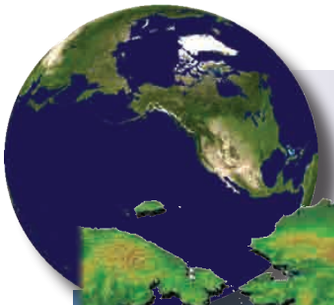
Moose Pass ground surface temperature (°C)

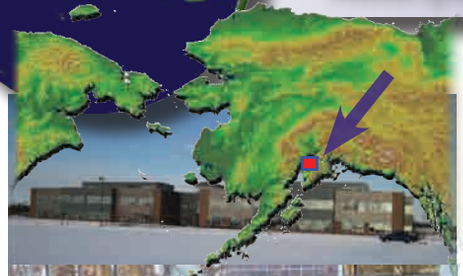


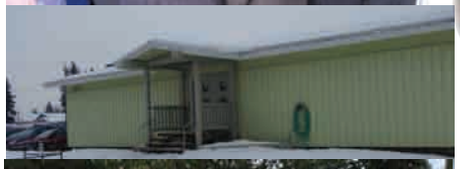
South central

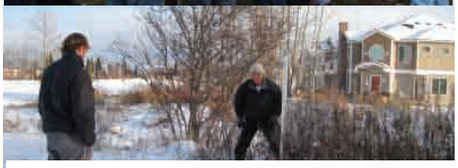
Anchorage

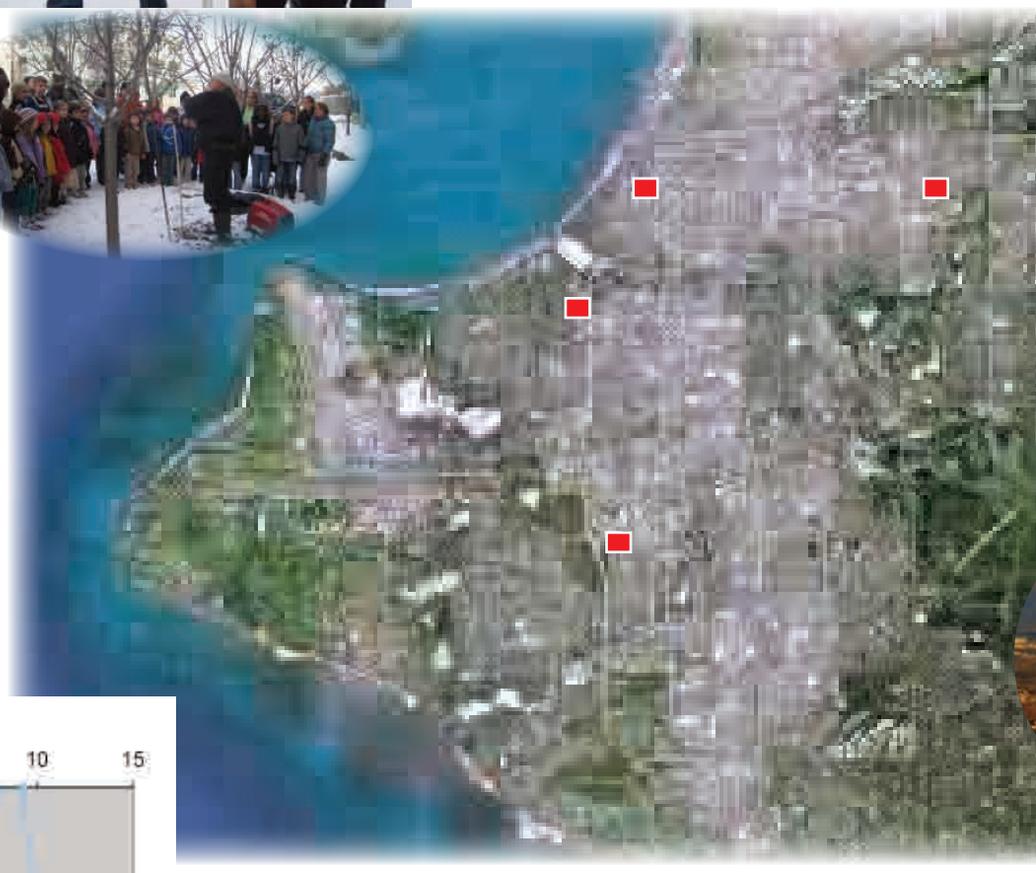
Municipality of Anchorage School District

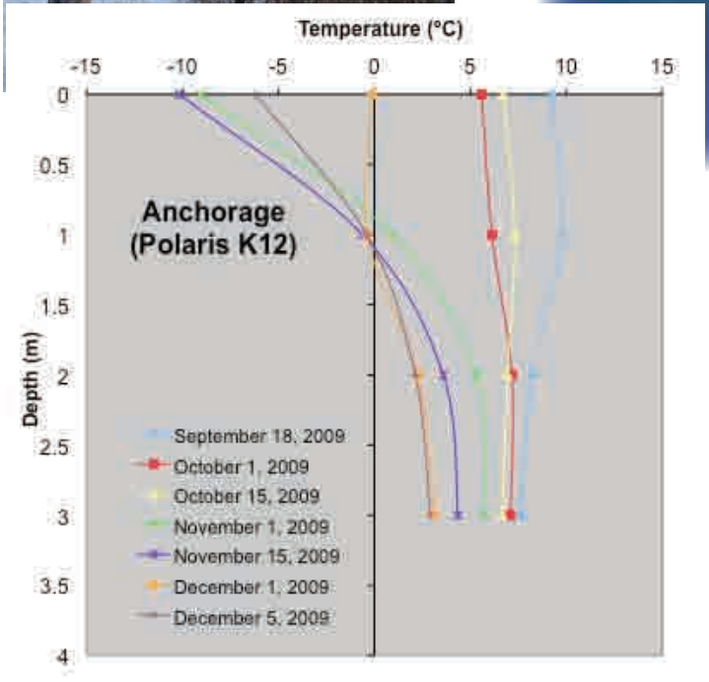




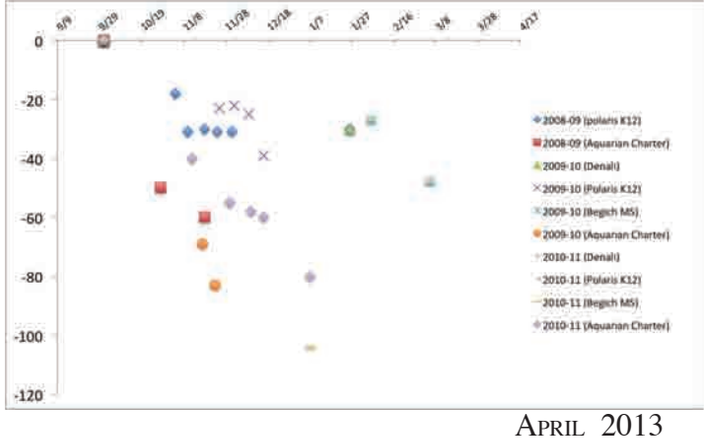








3 years frost tube results from Anchorage schools

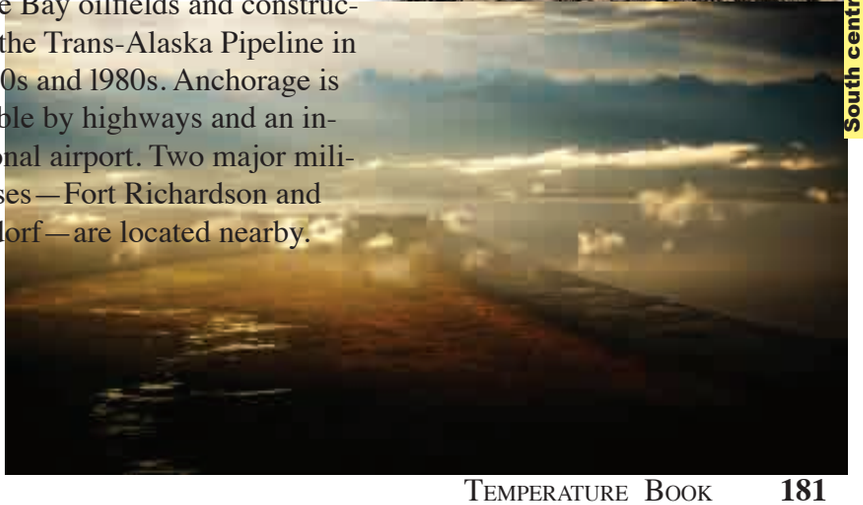


Location: 61.16° N, 149.85° W

Student population: 48,837

Anchorage, the largest city in Alaska with a population of 284,994 (2008 DCCED Certified Population), is located at the head of Cook Inlet in southcentral Alaska. Dena'ina Athabascan (Dena'ina meaning "the people") are the original inhabitants of the area surrounding Anchorage. British explorer Captain James Cook, for whom Cook Inlet is named, explored and mapped the southern Alaska coast in 1778. Following the discovery of gold in Alaska in the late 1800s, including that in nearby Turnagain Arm, Anchorage began to grow in population and develop.

In 1915, construction began on a federal railroad that would connect Seward with Fairbanks via Anchorage to take advantage of the coalfields and gold discoveries in Interior Alaska. Thousands of people arrived in Anchorage, the midpoint headquarters of railroad construction, looking for jobs. A land auction was held in 1915, and 655 lots were sold. In 1920, the City of Anchorage was incorporated. The growth of Anchorage was assisted by the military presence in Alaska and government construction, with roads, airports, and harbors being built in various locations in the territory between 1939 and 1957. Though the Good Friday earthquake caused a great deal of destruction to Anchorage in 1964, the city recovered and continued its growth as the state's center of commerce with the development of the Prudhoe Bay oilfields and construction of the Trans-Alaska Pipeline in the 1970s and 1980s. Anchorage is accessible by highways and an international airport. Two major military bases—Fort Richardson and Elmendorf—are located nearby.

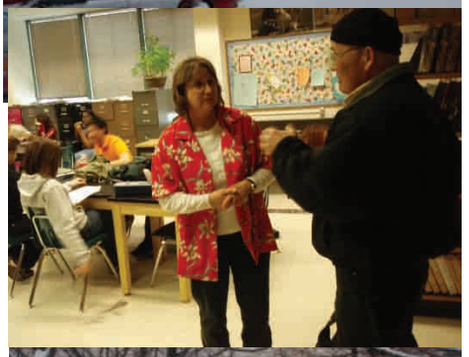


Key Facts (2009) Polaris K12:
Annual mean ground temperature: 2.8°C
Freezing days: 151 days
Freezing degree-days: 993 °C days
Thawing degree-days: 2010 °C days

Location: 61.38° N, 149.54° W

Chugiak

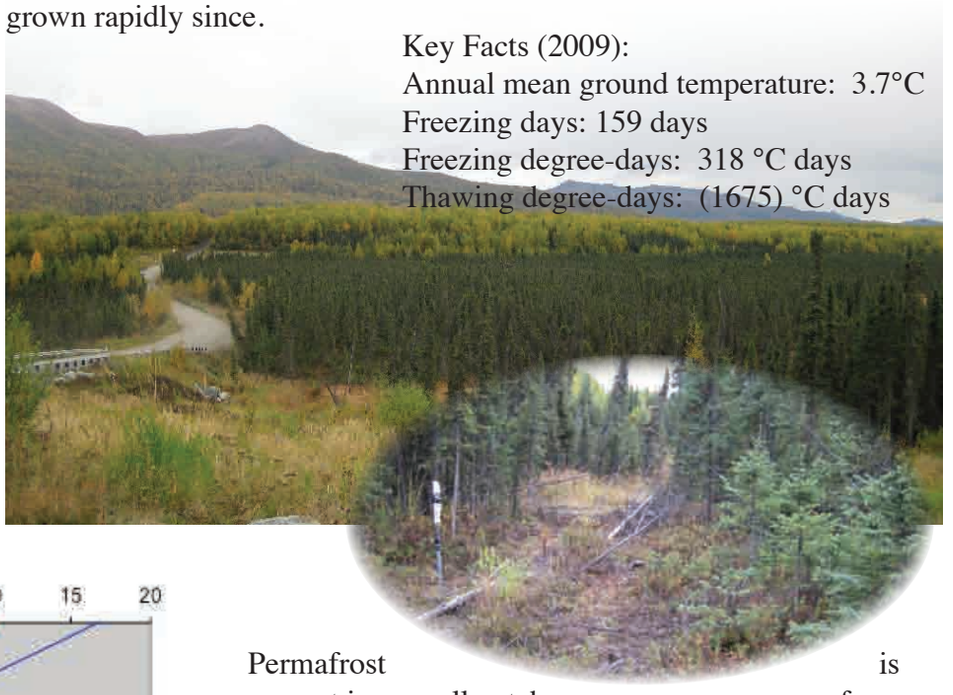
Municipality of Anchorage School District

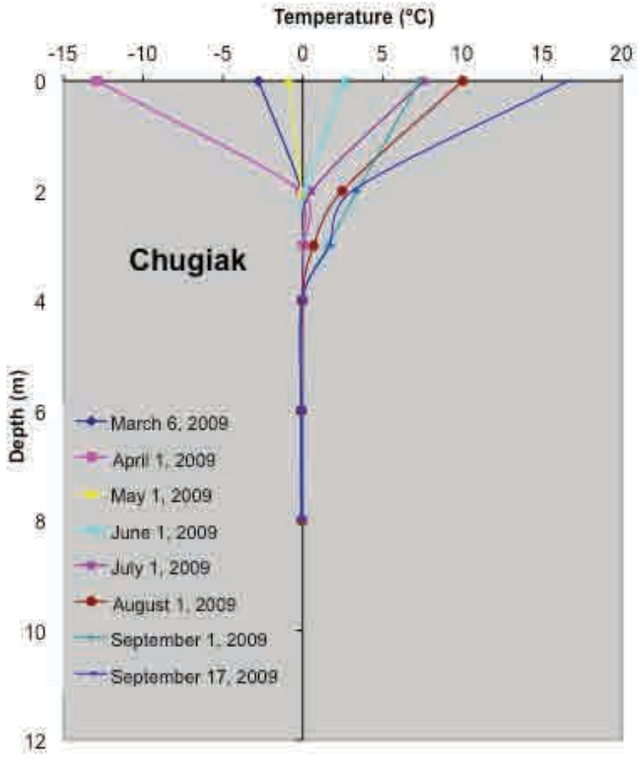


Student population: 2,310

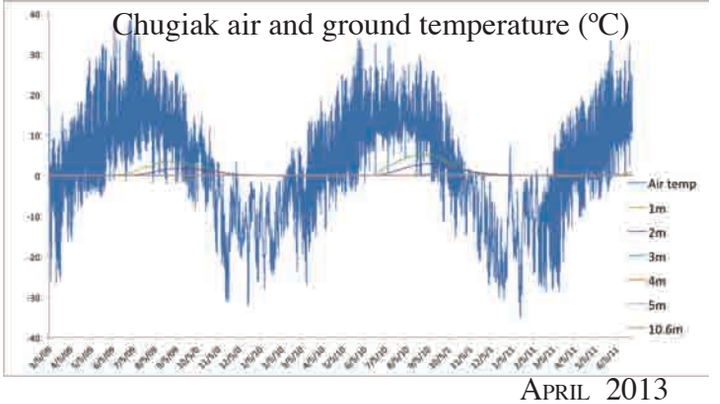
Chugiak, an unincorporated community of about 7,000 residents (Wikipedia) in the Municipality of Anchorage, lies 32 kilometers northeast of Anchorage, just beyond Eagle River along the Glenn Highway. The name Chugiak is a Dena'ina name that means "place of many places" (Wikipedia). Dena'ina (meaning "the people") are Athabascans, the original inhabitants of this region. During World War II, two military bases were built outside Anchorage; they are now combined and called Joint Base Elmendorf-Richardson. In the 1950s, following military service at these bases, many former military personnel and their families settled in the surrounding area, helping to develop the Chugiak community, which has grown rapidly since.

Key Facts (2009):
Annual mean ground temperature: 3.7°C
Freezing days: 159 days
Freezing degree-days: 318 °C days
Thawing degree-days: (1675) °C days





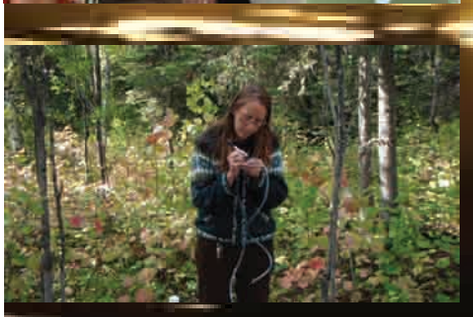
Permafrost is present in a small patch of spruce forest just north of the school. Chugiak is the southernmost permafrost monitoring site along the highway system. In all of Alaska, counting all monitoring sites, the southern-most permafrost is found at Naknek near King Salmon.



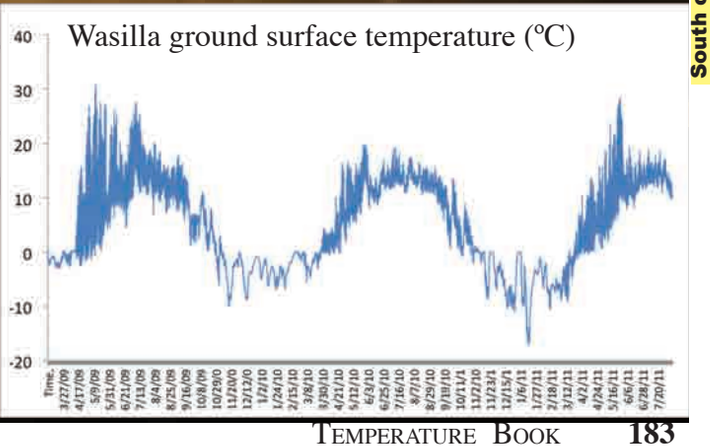
Wasilla

Matanuska Susitna Borough School District

Student population: 6,700 (population numbers suspect)
Wasilla, a city with 7,176 residents (2008 DCCED Certified Population), is located 69 kilometers (43 miles) north of Anchorage, along the George Parks Highway, between Wasilla and Lucille Lakes. The city is named after Dena'ina Athabascan Chief Wasilla. The city of Wasilla grew from a townsite that had been established in 1917 near the Alaska Railroad route. Through World War II, this location served as a supply base for regional gold and coal mining. In the 1930s, the Matanuska-Susitna Valley, in which Wasilla lies, was settled by homesteaders. Construction of the George Parks Highway, which was completed in the early 1970s, has provided an easy commute for residents of Anchorage and Wasilla. It is estimated that about one-third of Wasilla residents work in Anchorage. Wasilla has a diverse economy. Aside from a variety of government and professional services, there are retail stores and businesses related to tourism, agriculture, wood products, and steel and concrete products. The community has an airport with scheduled commuter and air taxi services, and there are three lakes nearby for floatplane use.



Key Facts (2009):
Annual mean ground temperature: 4.4°C
Freezing days: 141 days
Freezing degree-days: 426 °C days
Thawing degree-days: 2034 °C days

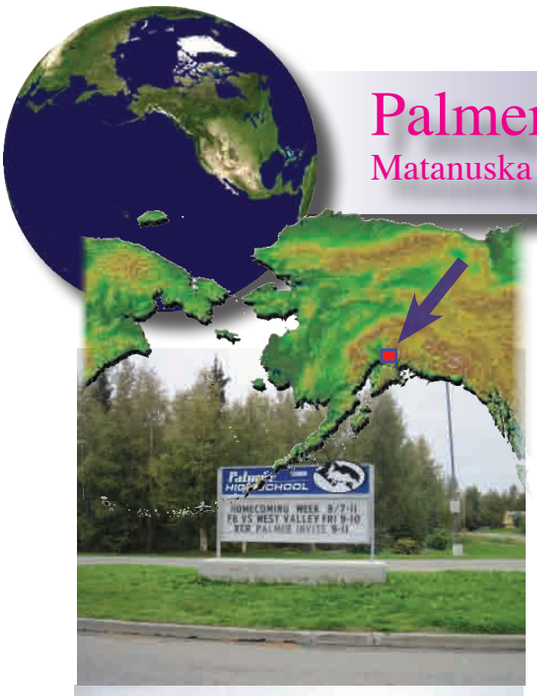


South central

Location: 61.61° N, 149.14° W

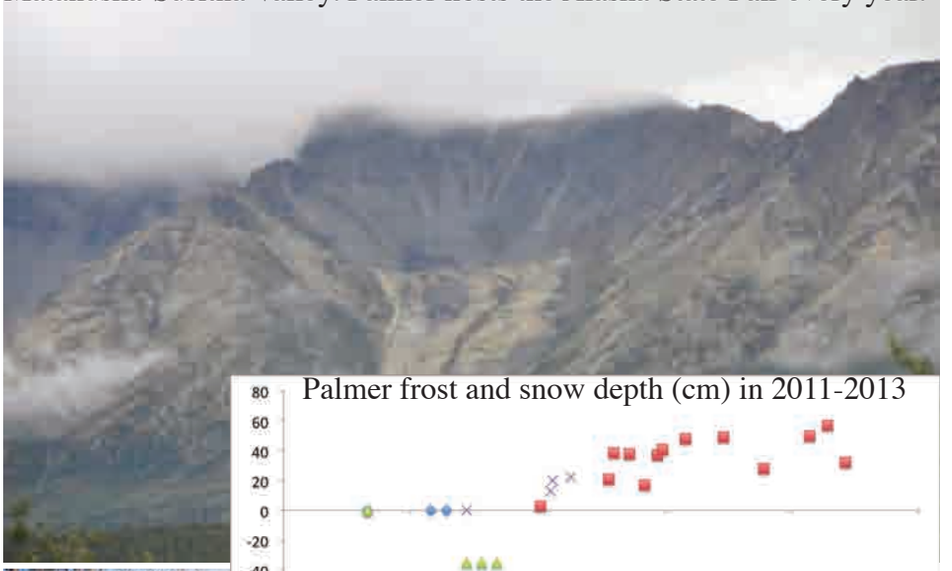
Palmer

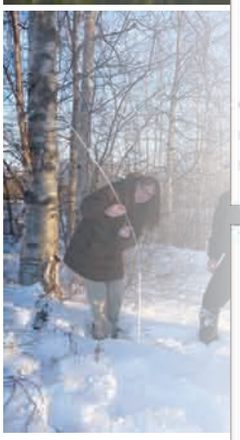
Matanuska Susitna Borough School District



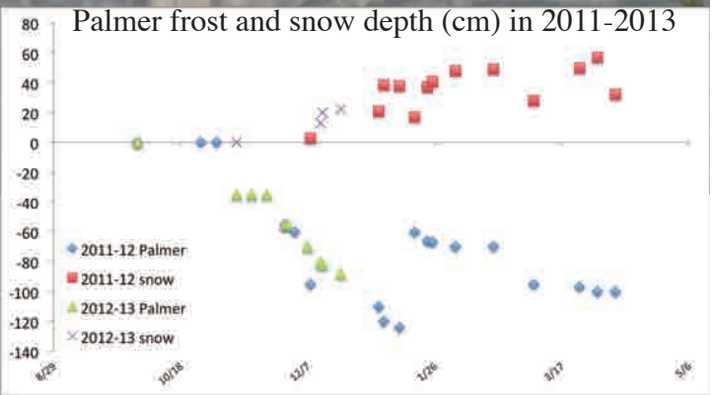
Student population: 2,726

Palmer, a city with 5,937 residents (2010 U.S. Census), is located in the Matanuska Valley, about 68 kilometers (42 miles) northeast of Anchorage. Ahtna and Dena'ina Athabascans are the original inhabitants of this area. George Palmer, for whom the town is named, moved here in 1875 and established a trading post. By 1916, a rail line led to Palmer from Anchorage. An agricultural colony created near Palmer in 1935 as part of the U.S. government's New Deal to help Americans recover from the Depression encouraged development here, as 203 families -moved to the valley from the Lower 48- prepared to farm. A city was formed by 1951. Palmer is on the state highway system, and has a municipal airport. Residents of Palmer either commute to Anchorage for employment or work in the many retail and service businesses and government offices in the Matanuska-Susitna Valley. Palmer hosts the Alaska State Fair every year.

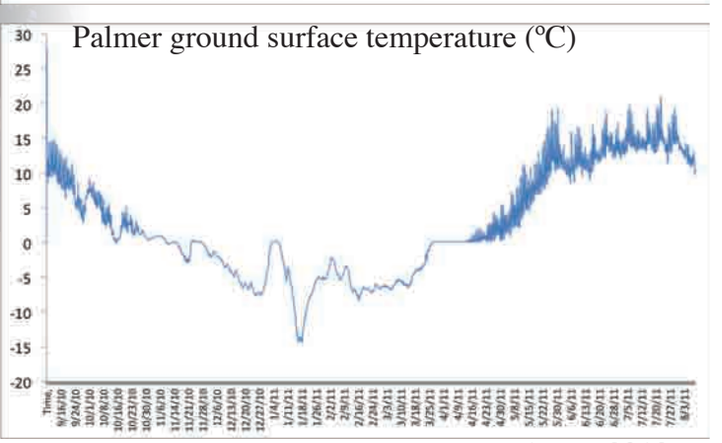




Palmer frost and snow depth (cm) in 2011-2013



Palmer ground surface temperature (°C)



Key Facts:

Annual mean ground temperature: nd°C

Freezing days: nd days

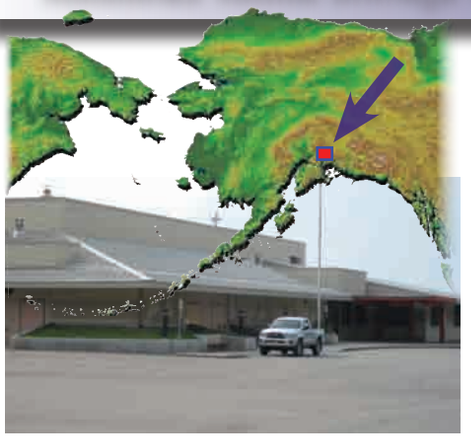
Freezing degree-days: nd °C days

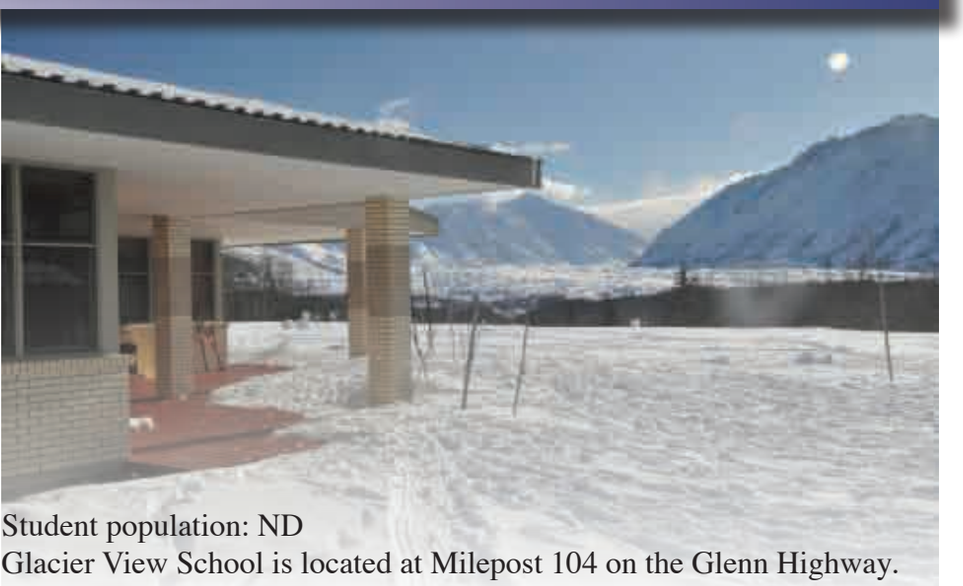
Thawing degree-days: nd °C days

Location: 61.79° N, 147.73° W

Glacier View -Matanuska-

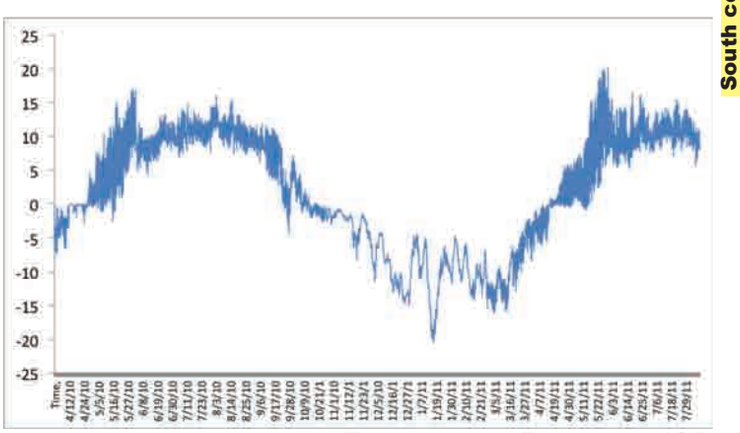
Matanuska Susitna Borough School District



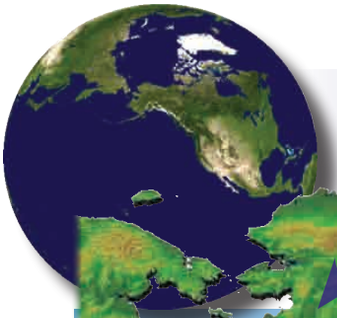


Student population: ND

Glacier View School is located at Milepost 104 on the Glenn Highway. Students in Kindergarten through Grade 12 who live between Chickaloon (at Milepost 76) and Mendeltna (at Milepost 154) of the Glenn Highway attend this school. The Talkeetna Mountains are to the north; the Chugach Mountains are to the south. Athabascans are the indigenous people of this area. Historically, Chickaloon was a center of trade for Ahtna and Dena'ina Athabascans; the village was once the site of a primary fishing camp used by villagers. The village name is derived from the name of Chief Chiklu, the area's last Dena'ina chief. Mendeltna was a stopping point along a trail used by Athabascans traveling from Lake Tyone to Tazlina Lake. Nelchina lies between Chickaloon and Mendeltna; it is a highway community, also. In the late 1800s, gold prospectors entered the Mendeltna area after gold was discovered in creeks in the Chugach Mountains. A vein of high-quality coal, discovered by an army exploration party in 1898, is what drew outside interest to Chickaloon. From 1915 to 1922, the U.S. Navy contributed to a coal-mining boom in the Chickaloon River drainage. Chickaloon was opened to homesteading in 1958. Nelchina developed as a mining settlement. Employment includes work in businesses that serve residents and travelers, guiding for recreational activities, and air taxi services for fly-in fishing and mountaineering.



Key Facts (2010):
Annual mean ground temperature: 0.1°C
Freezing days: 192 days
Freezing degree-days: 1374 °C days
Thawing degree-days: 1403 °C days
www.uaf.edu/permafrost

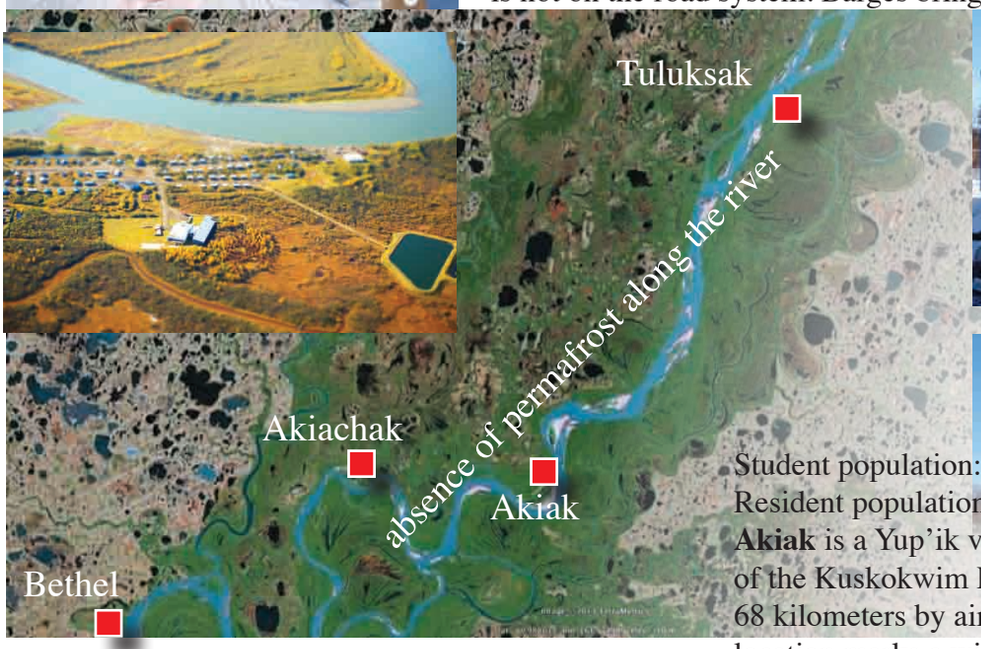


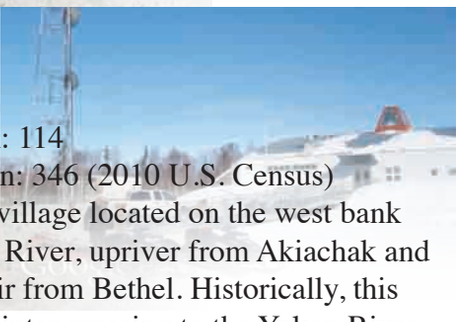
Location: 61.10° N, 160.95° W

Tuluksak/ Akiak/ Akiakchak

Yupitt School District

Student population: 142
Resident population: 373 (2010 U.S. Census)
Tuluksak is a Yup'ik village located on the south bank of the Tuluksak River, near its confluence with the Kuskokwim River. Tuluksak is northeast of Akiak and 56 kilometers from Bethel. Residents of Tuluksak rely on a subsistence way of life for their livelihood: hunting, fishing, and gathering. Employment possibilities include work in services, the school, and village government. Commercial fishing provides seasonal employment. Tuluksak has a state-owned gravel airstrip and year-round air transportation. Residents travel by boat, snow machine, and ATV, as Tuluksak is not on the road system. Barges bring supplies during the summer.



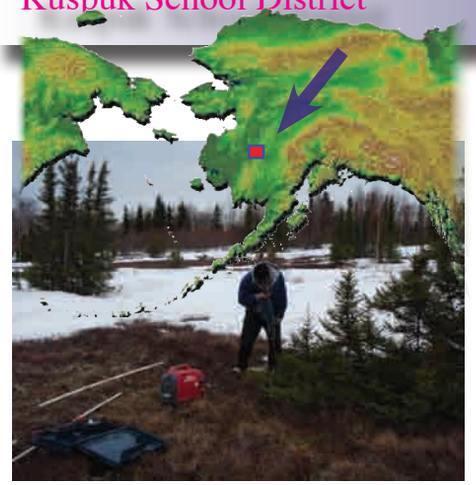


Student population: 197
Resident population: 627 (2010 U.S. Census)
Akiachak is a Yup'ik village located along the west bank of the Kuskokwim River, about 29 kilometers northeast of Bethel. The community has a strong traditional culture. The location of Akiachak was a historic seasonal subsistence site for the Yup'ik before settlement; it is counted in the 1890 U.S. Census as "Akiakchagamiut." Most residents live a subsistence way of life. Some year-round employment is available in education and public services; seasonal employment includes commercial fishing, construction, and BLM firefighting. Akiachak is not on the road system, but has a state-owned gravel airstrip and public seaplane facility. Residents use boats, snowmachines, and ATVs for transportation. A winter trail connects Akiachak and Bethel. Fuel and supplies are barged to the village during the summer.

Student population: 114
Resident population: 346 (2010 U.S. Census)
Akiak is a Yup'ik village located on the west bank of the Kuskokwim River, upriver from Akiachak and 68 kilometers by air from Bethel. Historically, this location marks a winter crossing to the Yukon River basin; the Yup'ik named it Akiak, meaning "the other side." By the 1920s, a post office and a U.S. Public Health Service hospital had located here. Residents rely on fishing, hunting, and gathering for their livelihood. Those with year-round employment work at the school, for the village, or in public service. Seasonal employment includes commercial fishing and BLM firefighting. Akiak has a state-owned gravel runway for air transportation. Snow machines, ATVs, and boats are used for travel to nearby villages, since this community is not on the road system.

Kalskag

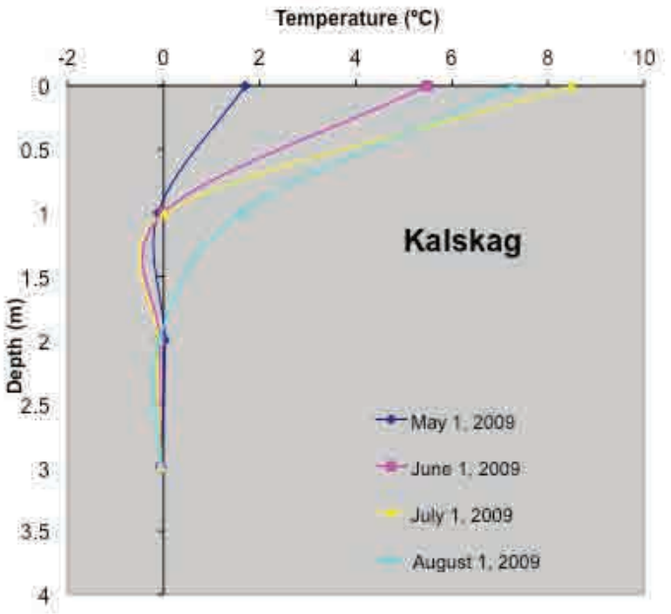
Kuspuk School District

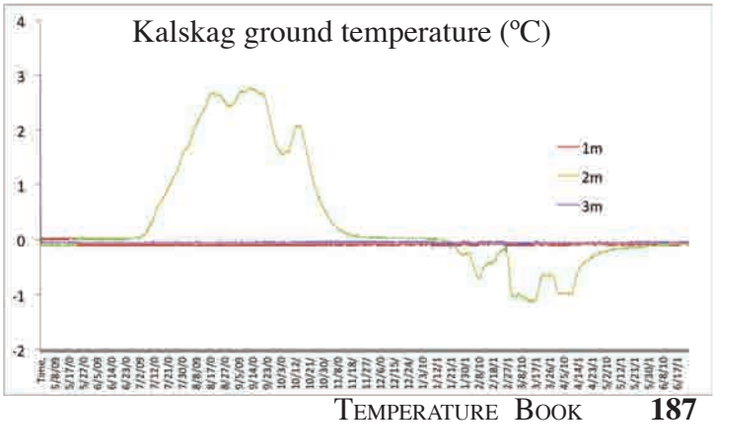


Student population: 122

Kalskag is the name for two locations on the north bank of the Kuskokwim River. Lower Kalskag, with 256 residents, is 3 kilometers (2 miles) downriver from Upper Kalskag, with 235 residents (both population figures based on 2008 DCCED Certified Population). The indigenous people of this area are Yup'ik, and both sites, historically, were used as fish camps. The fish camp upriver was called Kessiglik. In 1898, a Russian family of ten moved there and settled. Residents of Kalthagamute joined them around 1900. The BIA built a government school in what is now Upper Kalskag in 1930, which attracted families from nearby villages. This location had a general store, post office, coffee shop, and barge company by 1940. Reindeer, which had been introduced to the area, were being managed and herded by the community. Kalskag had members of both the Russian Orthodox and the Catholic faiths. Due to religious differences, members of the Russian Orthodox church moved downriver to the Lower Kalskag fish camp site in the 1930s, which is when year-round settlement began there. By 1969, Lower Kalskag had a school, post office, sawmill, and power plant. Most residents in both villages are Alaska Native or part Native, mainly Yup'ik. Traditional subsistence practices are important to their way of life. Employment includes work with the school, local government, and clinic, and seasonally, commercial fishing and firefighting. A gravel road connects Lower and Upper Kalskag, and the two communities share a gravel airstrip. Barges bring fuel and supplies on the Kuskokwim River, which is ice-free from mid-June through October. Winter trails connect both villages with the neighboring communities of Russian Mission and Aniak.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days





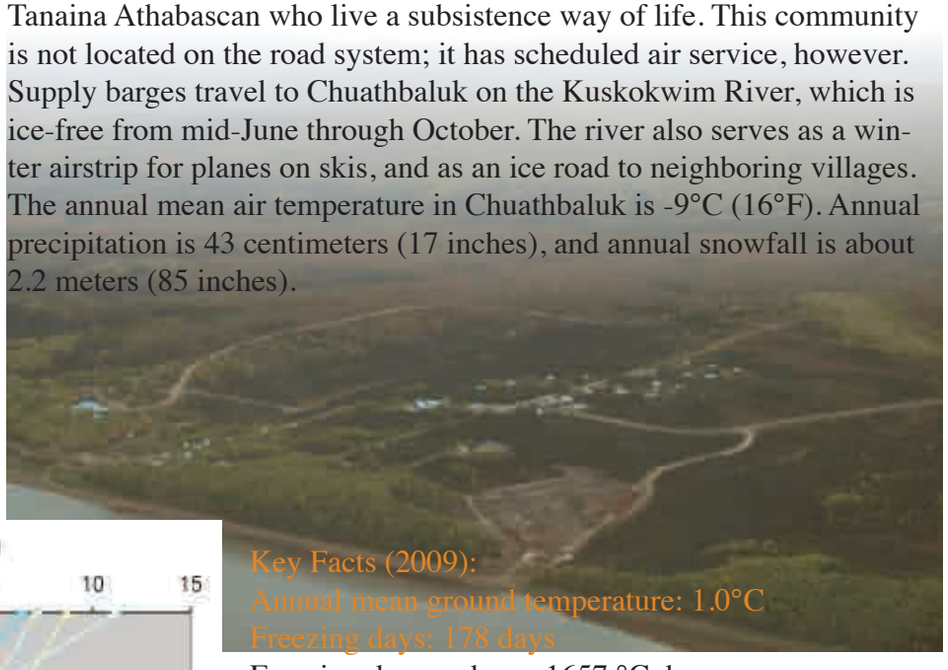
Location: 61.57° N, 159.25° W

Chuathbaluk

Kuspuk School District

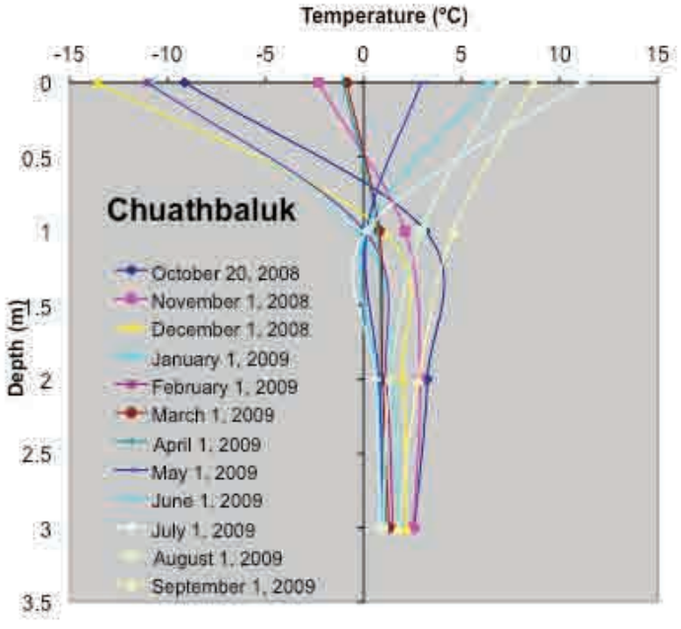
Student population: 31

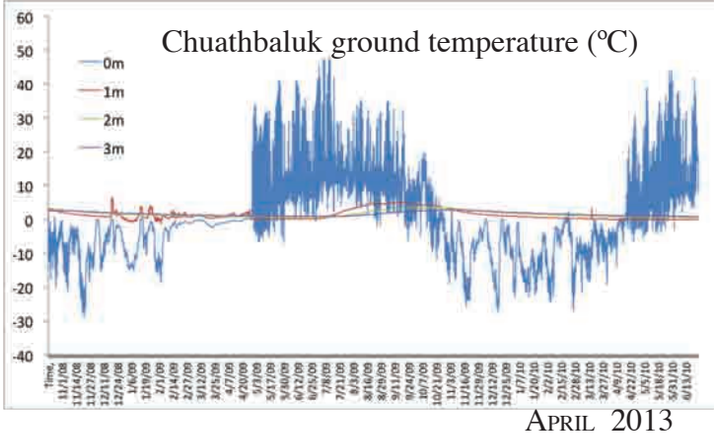
Chuathbaluk, a village with 111 residents (2008 DCCED Certified Population) located in the Kilbuk-Kuskokwim Mountains, is situated on the north bank of the Kuskokwim River, 18 kilometers (11 miles) upriver from Aniak. In the mid-1800s, this site was a summer fish camp of Ingalik. The Russian Orthodox Church, in 1894, built the St. Sergius Mission here, which attracted Kukuktuk residents from downriver. The influenza epidemic of 1900 killed many villagers, and by 1929, the site was largely deserted. The mission was resettled in 1954 by a family from Crow Village, and individuals from Aniak and Crooked Creek moved to the area. The village has had other names, including Chukbak, St. Sergius Mission, Kuskokwim Russian Mission, and Little Russian Mission, but in the 1960s, it was permanently named Chuathbaluk, a name derived from the Yup'ik word curapalek ("the hills where the big blueberries grow"). The majority of residents are Alaska Native or part Native, mainly Yup'ik and Tanaina Athabascan who live a subsistence way of life. This community is not located on the road system; it has scheduled air service, however. Supply barges travel to Chuathbaluk on the Kuskokwim River, which is ice-free from mid-June through October. The river also serves as a winter airstrip for planes on skis, and as an ice road to neighboring villages. The annual mean air temperature in Chuathbaluk is -9°C (16°F). Annual precipitation is 43 centimeters (17 inches), and annual snowfall is about 2.2 meters (85 inches).



Key Facts (2009):
Annual mean ground temperature: 1.0°C
Freezing days: 178 days

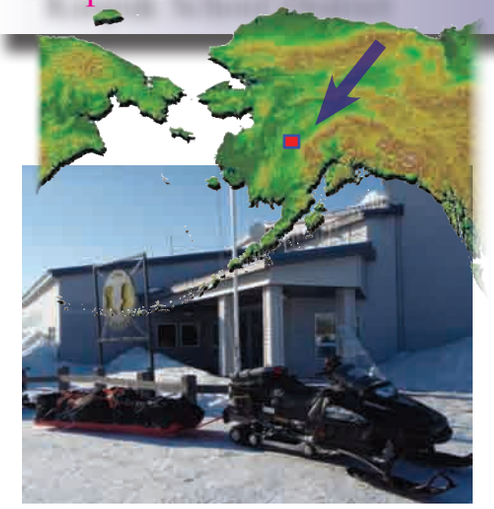
Freezing degree-days: 1657 °C days
Thawing degree-days: 2015 °C days





Aniak

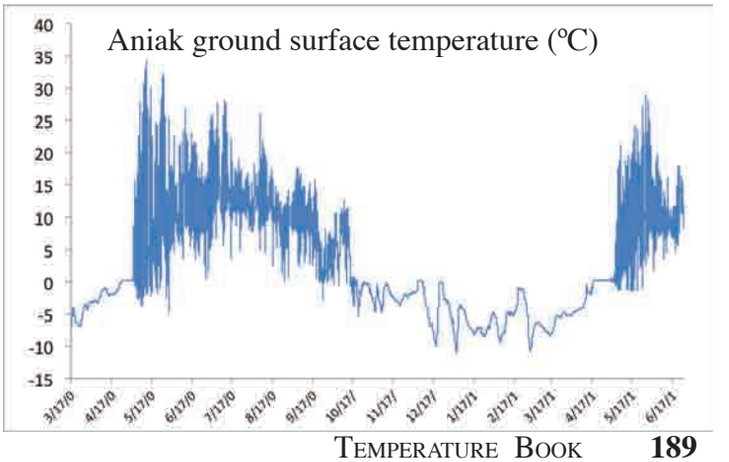
Kuspuk School District



Student population: 113

Aniak, a village with 494 residents (2008 DCCED Certified Population), is located on the south bank of the Kuskokwim River at the head of Aniak Slough, near the mouth of the Aniak River. The village of Chuathbaluk is upriver on the Kuskokwim, and Bethel is 148 kilometers (92 miles) southwest by air. Yup'ik, who lived in this area originally, named the location Aniak, which means "the place where it comes out," referring to the Aniak River that flows into the Kuskokwim River. Gold seekers traveled the Kuskokwim River during the placer gold rush of 1900–1901. When a homesteader settled here in 1914, the site appeared abandoned. A store and post office were opened. The Native community was reestablished when Willie Pete and Sam Simeon moved with their families to Aniak from Ohagamuit. Gold was discovered near Aniak in 1932. By 1939, the village had both a school and an airfield. A White Alice radar-relay station was constructed in 1956. Most residents in Aniak are Alaska Native or part Native, mainly Yup'ik and Tanaina Athabascan. Subsistence activities are important to the people living here. Employment includes work with the school, government, health clinic, and stores. Aniak is a service hub for surrounding villages. The community has a state-owned airport with a lighted paved runway, and air service year-round. The Kuskokwim River is ice-free from mid-June through October, allowing barge delivery of fuel and supplies. Though there is no road connection to neighboring villages, there are trails, including a marked winter trail to Kalskag.

Key Facts (2009):
Annual mean ground temperature: 0.2°C
Freezing days: 187 days
Freezing degree-days: 1898 °C days
Thawing degree-days: 1800 °C days



Location: 61.87° N, 158.13° W

Stony River/ Sleetmute/ Crooked Creek

Kuspuk School District

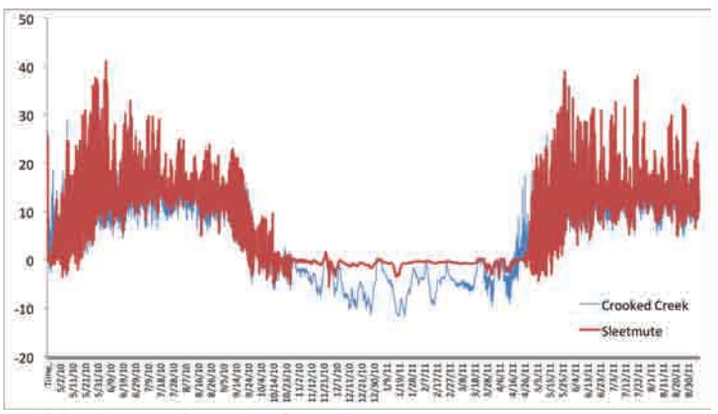
Crooked Creek:
community population: 103 (2011 Alaska Dept. of Labor Estimate) school enrollment: 26 (Johnnie John Sr. School)

Stony River:
community population: 46 (2011 Alaska Dept. of Labor Estimate)
school enrollment: 10 (Gusty Michael School) United States. The population was 61 at the 2000 census.

Sleetmute:
community population: 93 (2011 Alaska Dept. of Labor estimate)
school enrollment: 16 (Jack Egnaty Sr. School)

Key Facts (2010) Sleetmute:
Annual mean ground temperature: 4.7°C
Freezing days: 177 days
Freezing degree-days: 153 °C days
Thawing degree-days: 1857 °C days

Crooked Creek & Sleetmute ground temperature (ºC)



Key Facts (2010) Crooked Creek:
Annual mean ground temperature: 2.1°C
Freezing days: 192 days
Freezing degree-days: 814 °C days
Thawing degree-days: 1565 °C days

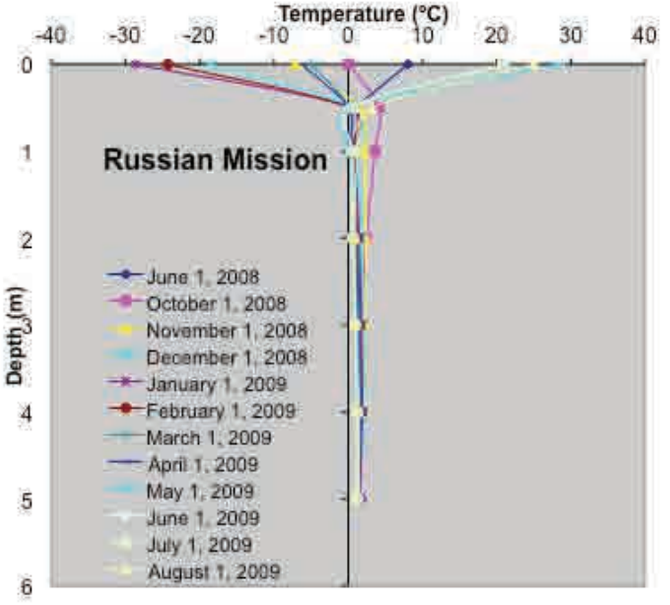
Russian Mission

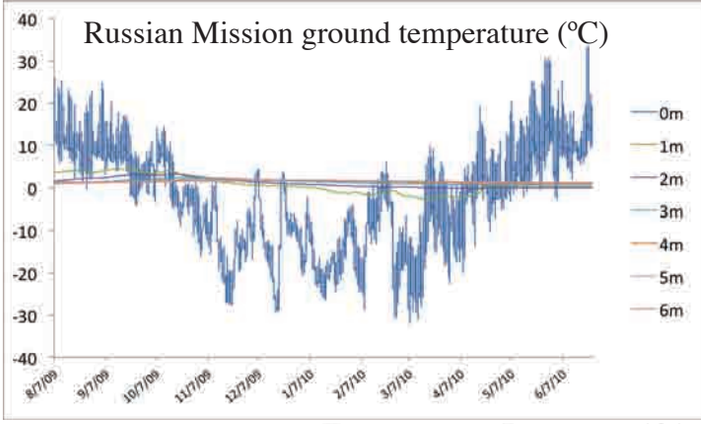
Lower Yukon School District

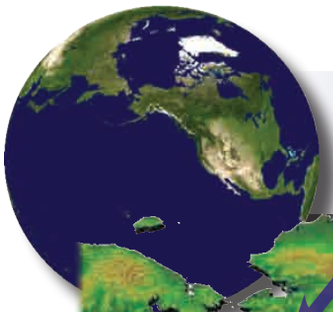
Student population: 116

Russian Mission, also known as Iqurmiut, is a village with 362 residents (2008 DCCED Certified Population), located on the west bank of the Yukon River between Marshall and Holy Cross. When first designated a fur-trading post by the Russian American Company in 1837, this site was a Yup'ik settlement called Ikogmiut, meaning "people of the point." In 1857, the Russian Orthodox church established its first Interior Alaska mission here. The village name—Russian Mission—became official in 1900. Most residents are Alaska Native or part Native, mainly Yup'ik. Subsistence practices are predominant. Employment includes work with the school, in local businesses, commercial fishing, firefighting, and construction. Russian Mission has a gravel airstrip and seaplane landing area, with scheduled daily flights. The community mainly relies on air carriers to bring light goods and mail. Boats and barges travel the Lower Yukon River from mid-June through October, when it is ice-free. Russian Mission is connected to Kalskag by a marked winter trail.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days







Location: 61.88° N, 162.08° W

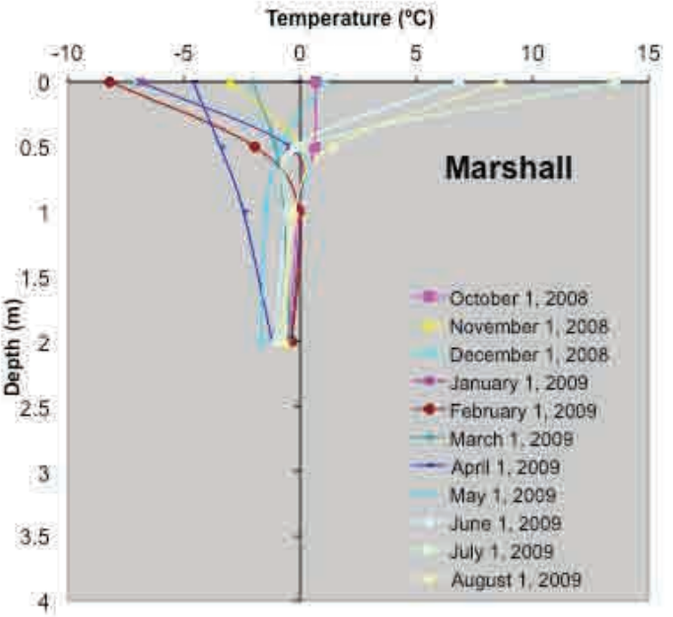
Marshall

Lower Yukon School District

Student population: 139

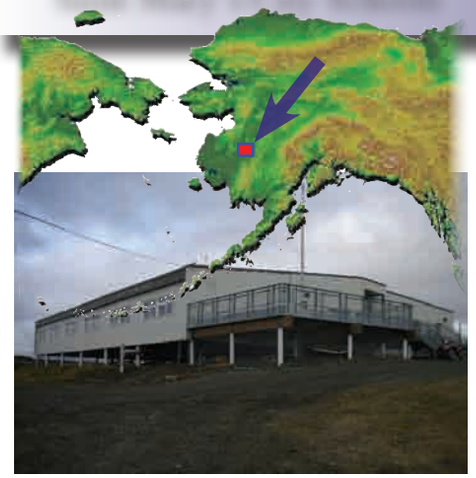
Marshall, a village with 417 residents (2008 DCCED Certified Population), is located on the north bank of Polte Slough, downriver from Russian Mission, on the east bank of the Yukon River. This site's original name was Uglovaia, as reported by an expedition that traveled through the area in 1880. When gold was discovered in 1913 in nearby Wilson Creek, the village's location on the Yukon River became a convenient landing spot for riverboats supplying the placer mining camp that developed. A post office was opened in 1915. Miners called the site Fortuna Ledge, after the name of a child born at the camp, but this name was later changed to Marshall, after the vice president of President Woodrow Wilson's administration. For a time, Marshall was called Marshall's Landing, but the name became Marshall officially in 1984. The majority of the residents in Marshall are Alaska Native or part Native, mainly Yup'ik. Subsistence activities are important to the way of life here. Employment is mainly seasonal, including jobs related to commercial fishing and firefighting. Marshall is not on the road system, but has a gravel airstrip for air transportation. Supplies are barged to Marshall during summer. Many residents travel the river by boat between mid-June and October, when the lower Yukon is ice-free. Travel is also done by snow machine and dog team.

Key Facts (2008):
Annual mean ground temperature: 1.7°C
Freezing days: 204 days
Freezing degree-days: 838 °C days
Thawing degree-days: 1460 °C days



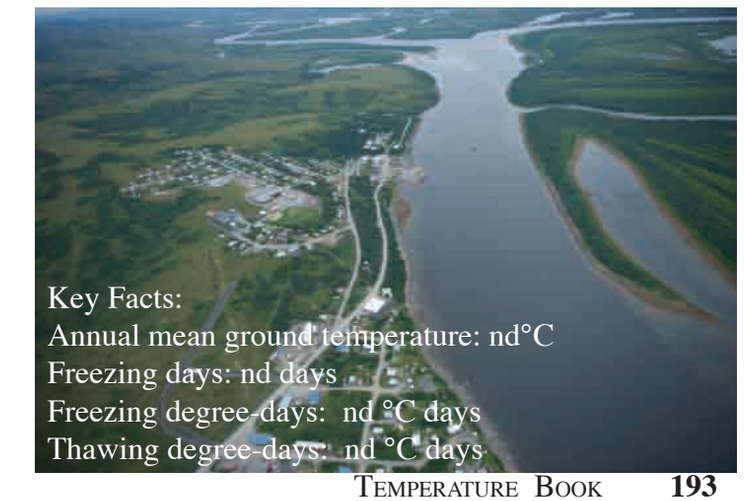
Saint Mary's

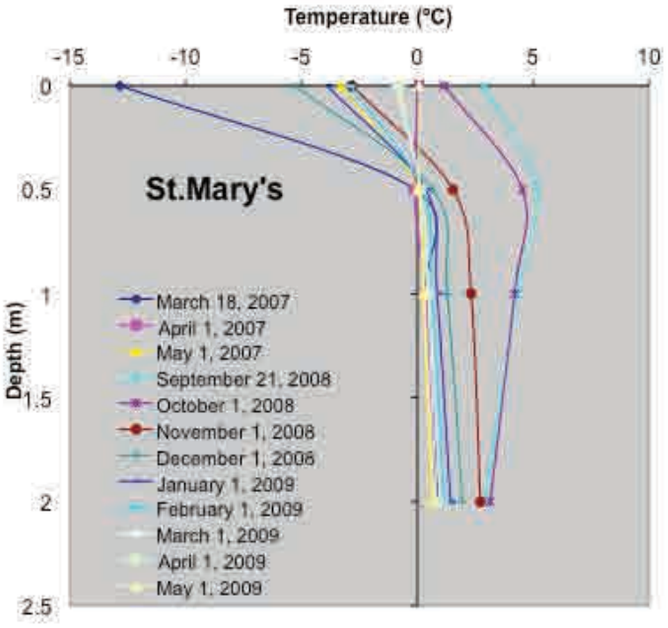
Saint Mary's City Schools



Student population: 178

Saint Mary's, also known as Algaaciq, is a village with 549 residents (2008 DCCED Certified Population), located on the north bank of the Andreafsky River, 8 kilometers (5 miles) upriver from its confluence with the Lower Yukon River. The village of Andreafsky nearby is included in Saint Mary's. In 1899, years before Saint Mary's was established, the Northern Commercial Company had set up a supply depot and winter headquarters at Andreafsky, which also was the site of a Russian Orthodox church. Saint Mary's was established in 1948, when villagers in Akulurak, downriver on the Yukon, decided to relocate because of silting problems in the river. The Jesuit mission, built in Akulurak in 1903 to educate and care for children orphaned by the 1900–01 flu epidemic, was also relocated to Saint Mary's. Homes and a school were built, and by the 1960s, several Yup'ik families had settled in the area. Most residents are Alaska Native or part Native, mainly Yup'ik, for whom subsistence activities are important. Employment includes work in local stores and commercial fishing. The community has a gravel runway with a cross-wind strip that allows year-round air transportation. Barges travel the Yukon and Andreafsky Rivers during ice-free months, generally from June to October. Saint Mary's is connected to Andreafsky, Pitka's Point, and Mountain Village by a road, maintained only during summer; the road becomes a snow machine trail in winter.





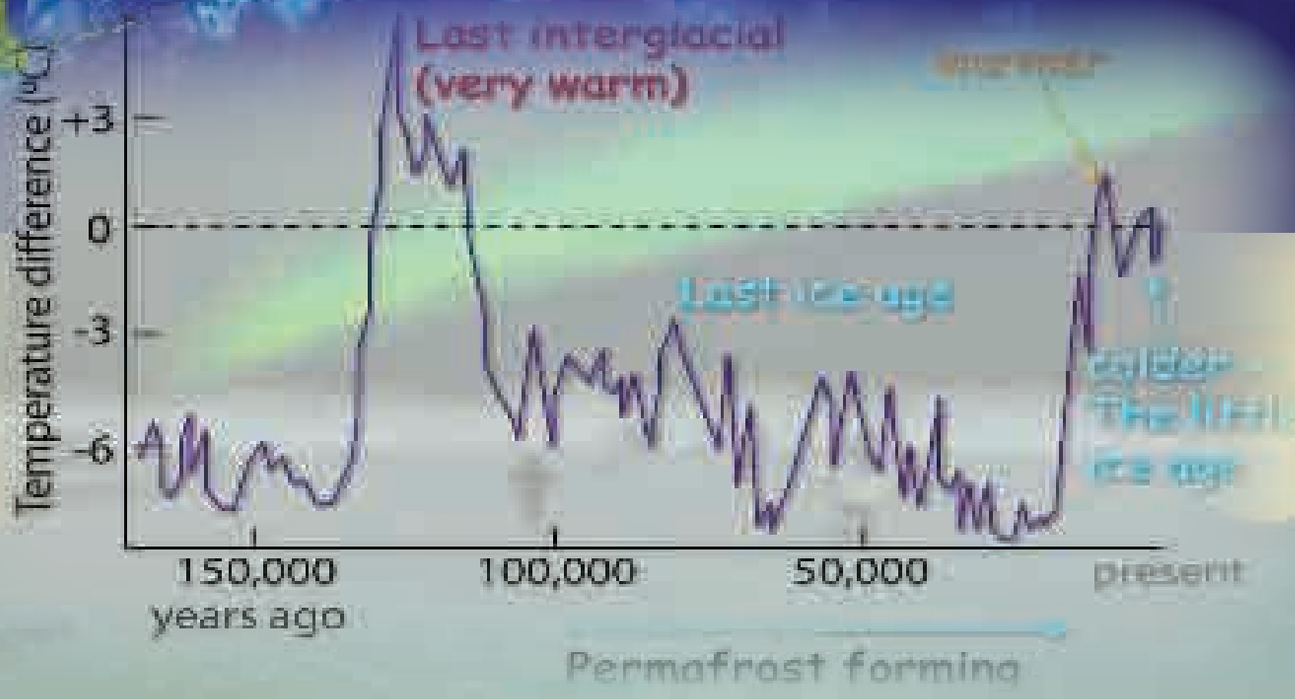
Climate never stays the same !

One hundred and forty thousand years ago the climate was changing and the newly emerging humans, the homo sapiens, were first fighting for survival in Africa. Limited resources forced them to be on the move, always searching for new country where life would be easier. Some groups even left Africa in their quest for a better life, moving to lands that had never seen humans.

Most of the permafrost was formed during the last ice age. Thicker permafrost formed in places that were unglaciated during the last ice age Because the ground surface was exposed to the cold air all the time instead of being insulated by the glaicers.

During this period, the last ice age, Earth was colder than today. Sea level was much lower than today, because so much of Earth's water was on land, frozen in glaciers.

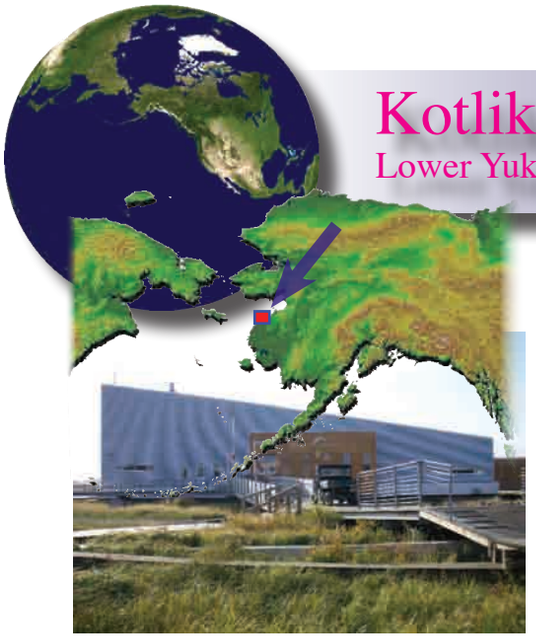
Siberia and Alaska were one, connected by the Bering Land Bridge. The people of this place, Beringia, hunted the largest ice-age mammal, the mammoth.



A huge change began about 10,000 years ago, when the earth started to get warmer. Glacial ice melted, swelling the seas. Sea level rose, drowning the Bering Land Bridge.

About 500 years ago, the climate changed yet again. In this "Little Ice Age," the planet got colder, cold enough that the ocean froze in some places. The Bering Sea was coated with ice during winter.

"Permafrost melting" is incorrect terminology, the result of a misinterpretation of the physical process of permafrost degradation. "Melting" describes a physical phase change during a temperature increase when a solid substance is transformed into a liquid state. Hence, the term "permafrost melting" suggests the transition of solidly frozen permafrost terrain into a liquid.



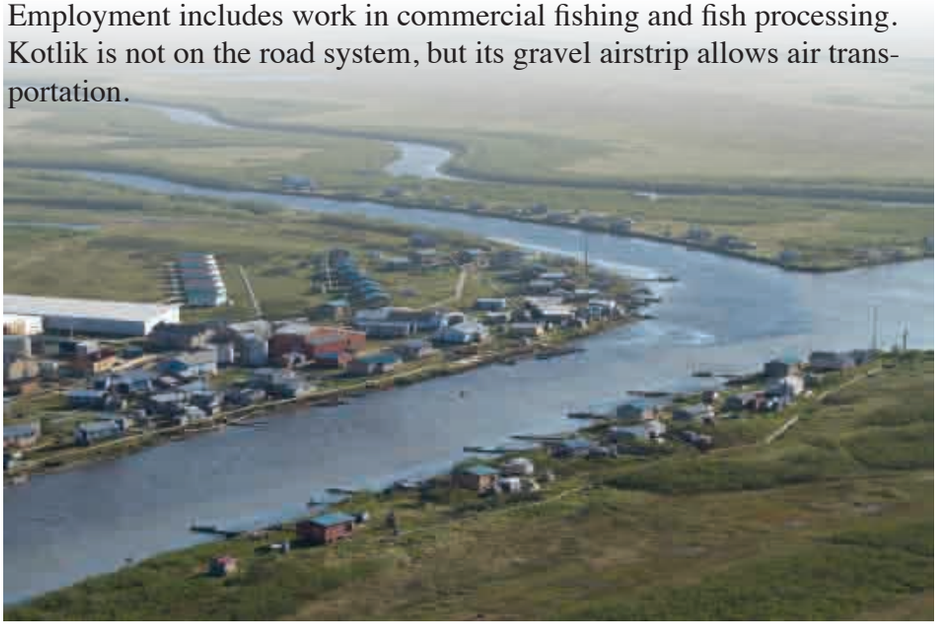
Location: 63.03° N, 163.55° W

Kotlik

Lower Yukon School District

Student population: 193

Kotlik, a village with 610 residents (2008 DCCED Certified Population), is located on Kotlik Slough, southwest of Saint Michael in the Yukon-Kuskokwim Delta. After a BIA school was built at Kotlik in the mid-1960s, residents from four nearby villages settled there. Kotlik Slough provides easy access for riverboats and barges. This feature led to Kotlik's development as a port and commercial center on the lower Yukon River. Most residents here are Alaska Native or part Native, mainly Yup'ik. Subsistence activities are important to their way of life. Many descendants of Russian traders who settled in the area after 1867 are included in this community's population. Kotlik's economy is seasonal. Employment includes work in commercial fishing and fish processing. Kotlik is not on the road system, but its gravel airstrip allows air transportation.



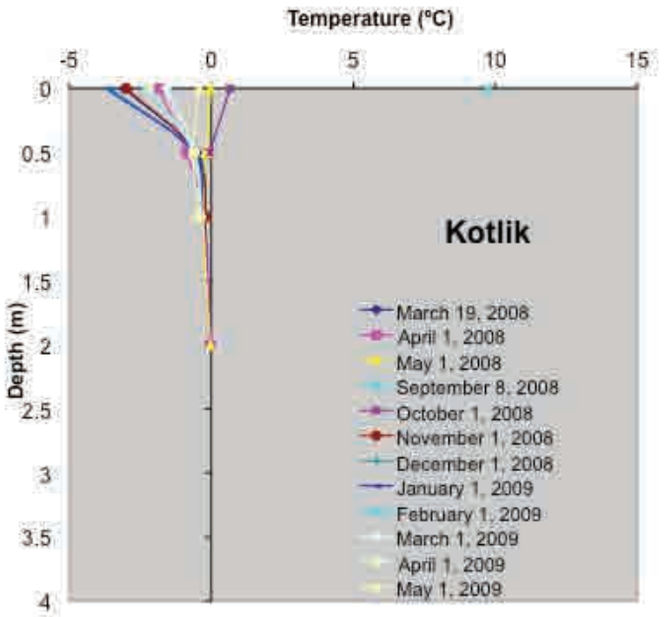
Key Facts:

Annual mean ground temperature: nd°C

Freezing days: nd days

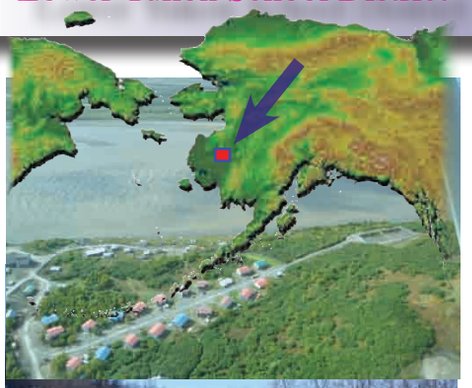
Freezing degree-days: nd °C days

Thawing degree-days: nd °C days



Pilot Station, Mountain Village

Lower Yukon School District



Mountain Village

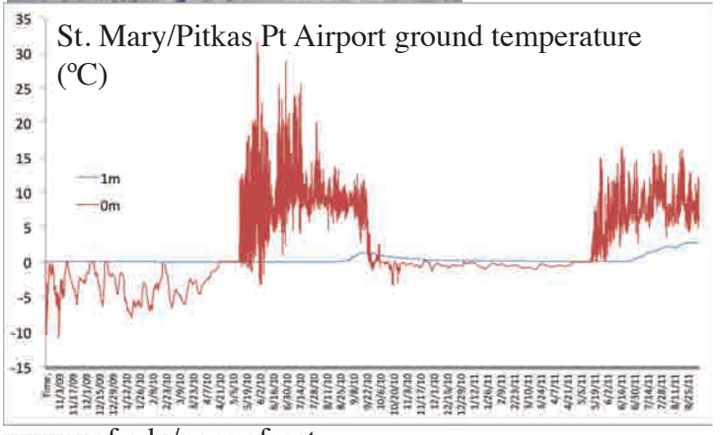
Student population: 242, Resident population: 813 (2010 U.S. Census)

Mountain Village, also known as Asa'carsarmiut, is located on the north bank of the Yukon River, downriver from St. Mary's. This Yup'ik village was a traditional summer fish camp, before permanent settlement began, after construction of a general store in 1908. By 1923, a post office and missionary school had opened. Mountain Village is the headquarters for the Lower Yukon School District. Some residents work at the school. Residents also commercial fish and trap, and work in government offices and the Native corporation. Subsistence activities provide an important source of food. Mountain Village is connected to St. Mary's and points between by a summer road. Otherwise, the village is accessible by air and river.

Pilot Station

Student population: 172, Resident population: 568 (2010 U.S. Census)

Pilot Station is located on the northwest bank of the Yukon River, upriver from St. Mary's. This Yup'ik village was named by riverboat pilots in the early 1900s, who traveled the Yukon River, using the site as a checkpoint. The local school and government are sources of year-round employment. Commercial fishing, trapping, and BLM firefighting provide seasonal employment. Subsistence activities are part of the way of life here, providing an important source of foods. The village is not on the road system, but is accessible by air and river.

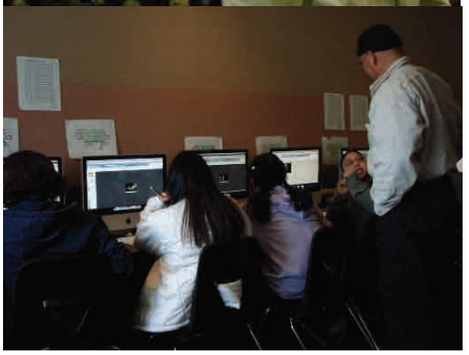


Key Facts (2010):
Annual mean ground temperature: 2.0°C
Freezing days: 205 days
Freezing degree-days: 830 °C days
Thawing degree-days: 1543 °C days

Location: 62.78° N, 164.56° W

Emmonak

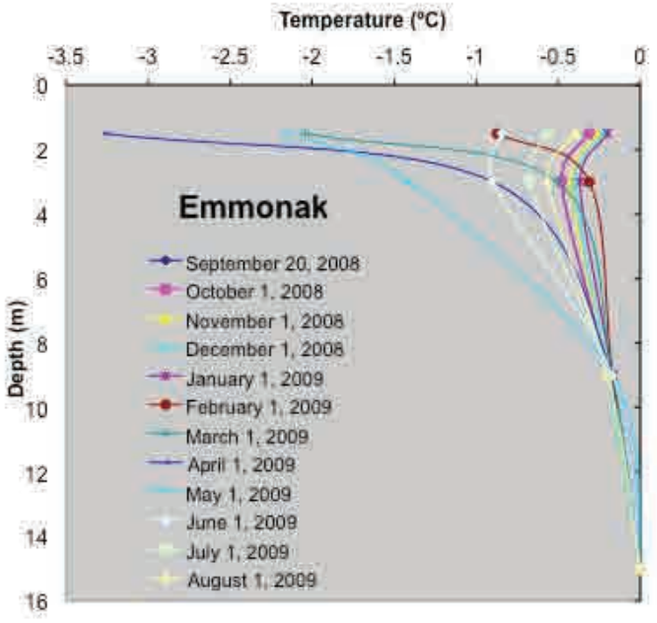
Lower Yukon School District



Student population: 236

Emmonak, a village with 794 residents (2008 DCCED Certified Population), is located near the mouth of the Yukon River on the north bank of Kwiguk Pass, 16 kilometers (10 miles) inland of the Bering Sea. The original settlement was further south; it was called Kwiguk, a Yupik word meaning "big stream." Residents called themselves Kuigpagmuit, meaning "people from the Yukon River." At Kwiguk, the community had a post office by 1920. Commercial fishing developed as an industry, and a cannery was built.

In 1964, the cannery was destroyed by a flood. Soon after, because of repeated problems with flooding and erosion, the residents of Kwiguk moved their village inland and renamed it Emmonak, which means "blackfish." Most residents of Emmonak are Alaska Native or part Native, mainly Yup'ik. Subsistence activities are important to the way of life here; traveling to fish camps during summer is common. Commercial fishing and processing provide seasonal employment. Emmonak is not on the road system, but winter snowmachine trails lead to the neighboring villages of Kotlik, Alakanuk, and Nunam Iqua. The community has a gravel airstrip for air transportation. The Yukon River, an important transportation route, is ice-free from June through September.



Key Facts:

Annual mean ground temperature: nd°C

Freezing days: nd days

Freezing degree-days: nd °C days

Thawing degree-days: nd °C days

Location: 62.52° N, 164.84° W

Nunam Iqua, Alakanuk

Lower Yukon School District

Student population: 67

Nunam Iqua, formerly called Sheldon Point, is a village with 207 residents (2008 DCCED Certified Population). The village lies 15 kilometers (9 miles) southwest of the village of Alakanuk, on a south fork of the Yukon River in the Yukon-Kuskokwim Delta. The indigenous people in this region are Yup'ik. Nunam Iqua, a Yup'ik name meaning "end of the tundra," was a summer fish camp, historically. In the late 1930s and early 1940s, a man named Sheldon owned and operated a fish saltery at this location. When the village was formed as a "city" in 1974, it was recorded as the City of Sheldon Point. Residents changed the name to Nunam Iqua twenty-five years later. Most residents here are Alaska Native or part Native, mainly Yup'ik. Traditional subsistence practices are important to them. The economic base of the community is commercial fishing, though employment is possible with the school, government agencies, and private businesses. The community has a gravel airstrip, and there are two floatplane landing sites nearby. Barges can access Nunam Iqua when the Bering Sea is ice-free, between mid-June and the end of October.

Southwest

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Location: 61.52° N, 166.13° W

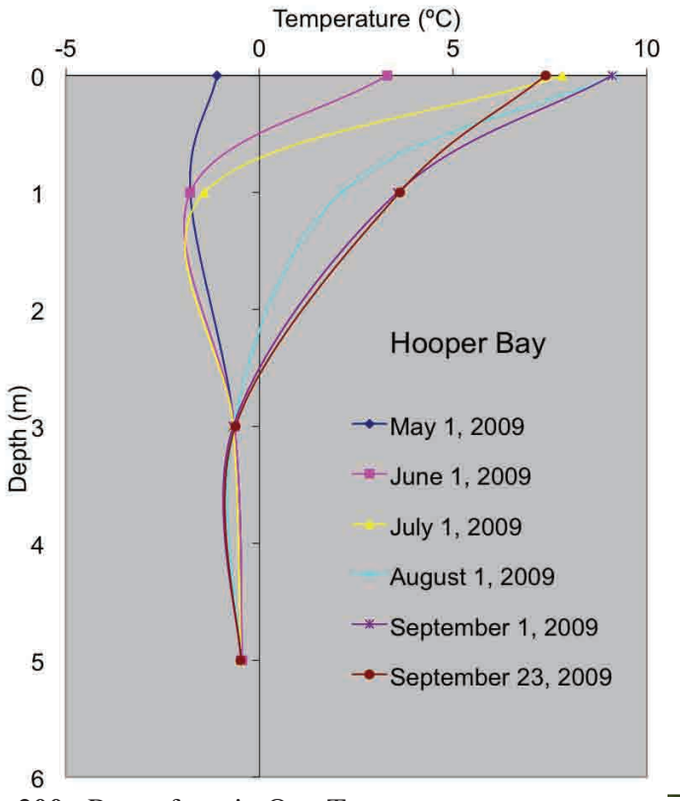
Hooper Bay

Lower Yukon School District

Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

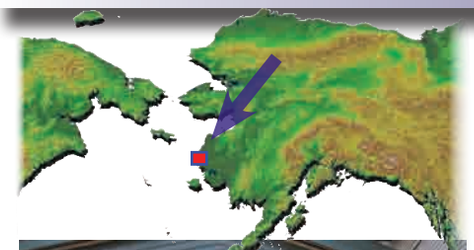
Student population: 414

Hooper Bay, also known as Naparyarmiut, is a community with 1,160 residents (2008 DCCED Certified Population) located on the Yukon-Kuskokwim Delta 40 kilometers (25 miles) south of Scammon Bay. Naparyarmiut means "stake village people" in the language of the Yup'ik, the indigenous people of this area. The community has two sections: an older, more developed site in the hills, and a newer section in the lowlands. The U.S. Signal Service recorded settlement here in 1878. When a post office was opened at this village in 1934, it was named Hooper Bay. Most residents are Alaska Native or part Native, mainly Yup'ik. Subsistence practices are important to the livelihood of the people living here. Employment, which is largely seasonal in Hooper Bay, includes commercial fishing, fire fighting, and work with the school. Grass baskets and ivory artwork are produced and sold by some of the residents. Hooper Bay is not on the road system, but winter trails connect it with the neighboring villages of Scammon Bay, Chevak, and Paimiut. Air carriers use the community's paved runway, and barges, traveling the Bering Sea, bring fuel and supplies when the sea is ice-free, usually from late June through October.



Scammon Bay

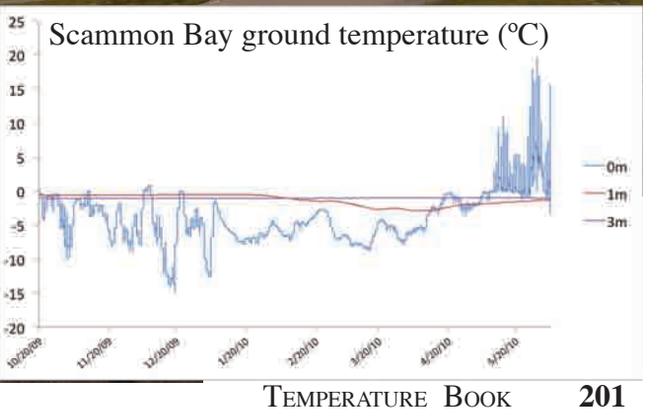
Lower Yukon School District



Student population: 236

Scammon Bay, a village with 533 residents (2008 DCCED Certified Population), is located on the south bank of the Kun River, about 2 kilometers (1 mile) from the Bering Sea. The indigenous people of this location are Yup'ik, who called their village Mariak and called themselves Mariagamiut. The bay that the Kun River flows into was named after a marine chief with the Western Union Telegraph Expedition, in the area in the late 1800s. When a post office opened in 1951, it was given the name Scammon Bay. Most residents here are Alaska Native or part Native, mainly Yup'ik. Traditional subsistence practices are important to the way of life here. Employment includes seasonal work in commercial fishing, firefighting, and construction. Some residents sell handicrafts. The community has a gravel airstrip and a seaplane base. Supplies arrive by barge when the Bering Sea is ice-free, from mid-June through October. Though not on the road system, Scammon Bay is connected by winter trails to the neighboring villages of Hooper Bay and Chevak.

Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



Southwest

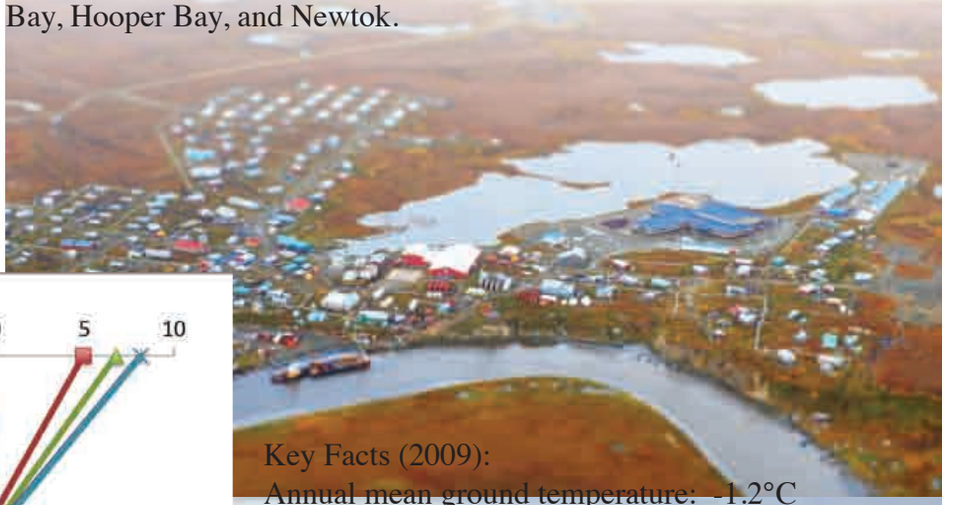
Location: 61.54° N, 165.60° W

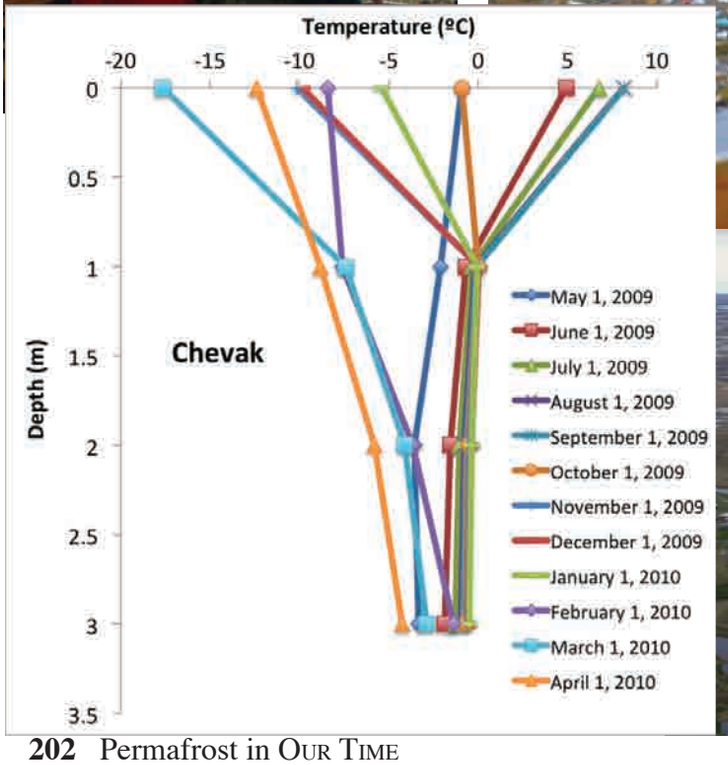
Chevak

Kashunamiut School District

Student population: 317

Chevak, a village with 922 residents (2008 DCCED Certified Population), is located in the Yukon-Kuskokwim Delta. The village is situated on the north bank of the Ninglikfak River, east of Hooper Bay. This area has been inhabited for thousands of years. The present location of the village is referred to as New Chevak. Before 1948, villagers had lived at Old Chevak, several kilometers further east, on the north bank of the Keoklevik River, but that location was abandoned because of flooding. The meaning of Chevak is "a connecting slough," which describes where Old Chevak was situated. A post office opened in the community in 1951. Most residents in Chevak are Alaska Native or part Native, mainly Cup'ik. Subsistence activities are important here. Summer employment includes construction work, BLM firefighting, and commercial fishing. The community is not on the road system, but is accessible by air and river; it has a gravel airstrip and a barge landing at the river. Ice on the Ninglikfak River begins to break up in June, and the river remains ice-free until the end of October. During this time, float planes land on the Chevak Lake or Ninglikfak River, and villagers travel the river in skiffs. Winter trails connect Chevak to the neighboring villages of Scammon Bay, Hooper Bay, and Newtok.





Key Facts (2009):

Annual mean ground temperature: -1.2°C

Freezing days: 197 days

Freezing degree-days: 1814 °C days

Thawing degree-days: 1371 °C days

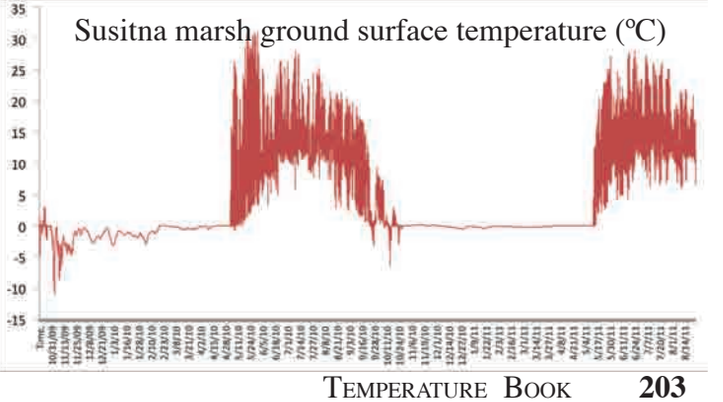
Susitna Vally/ Talkeetna/ Willow

Matanuska Susitna Borough School District

Student population: ND

Susitna Valley Junior/Senior High School is located at Milepost 98 of the George Parks Highway. Students in Grade 7 to 12, living north of Willow to Trapper Creek, including Talkeetna, attend this school. Dena'ina Athabascans are the indigenous people here. The Susitna River, which in the Dena'ina language means "sand river," is a major local geographic feature. Gold discoveries in the Susitna River are what drew gold prospectors here in the early 1900s. Talkeetna, which had a trading post by 1896, became a riverboat steamer station for supplies brought for trappers and miners. Trapper Creek was along the route to Cache Creek, where gold was discovered in 1906. The Alaska Railroad, which passes through Talkeetna, brought employment, construction camps, and more settlement when it was built. Construction of the railway contributed to settlement of a community called Y, a developed area along the highway between Willow and Talkeetna, including Montana Creek and Sunshine. Homesteading opportunities drew many people to the area after 1948, as did construction of the George Parks Highway and land disposals. The population of this area is diverse. Businesses provide supplies and services for residents and travelers, as well as guiding, and fishing and flightseeing trips. Talkeetna has a paved runway and a gravel airstrip, and there are other airstrips in the vicinity.

Key Facts (2010):
Annual mean ground temperature: 4.5°C
Freezing days: 153 days
Freezing degree-days: 33°C days
Thawing degree-days: 1777 °C days



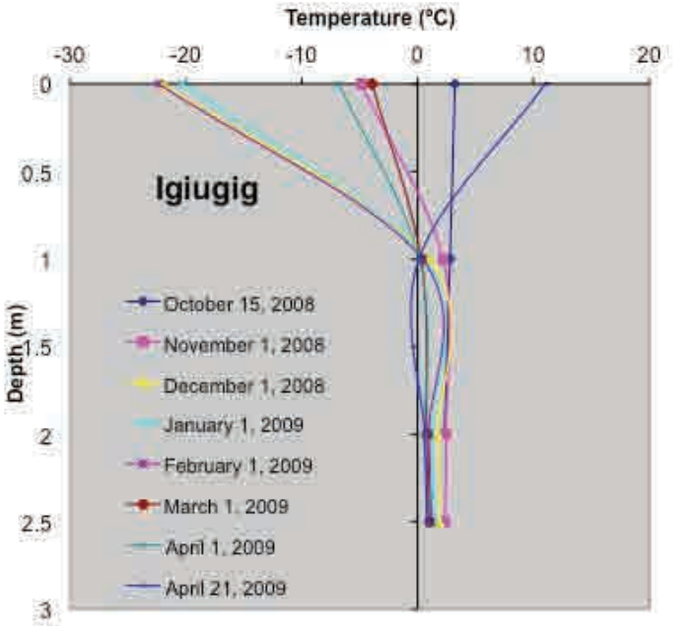
Location: 59.31° N, 155.92° W

Igiugig

Lake & Peninsula Borough School District

Student population: 16

Igiugig, a village with 40 residents (2008 Estimated Population, not Certified), is located on the south shore of the Kvichak River, which flows from Iliamna Lake to Bristol Bay. This location was used by Kiatagmuit as a summer fish camp, until they settled here permanently in the early 1900s. As Igiugig grew, people from a Branch River village joined the settlement. Most residents in Igiugig are Alaska Native or part Native, mainly Alutiiq. Subsistence practices are important to the way of life here. Employment includes work related to fishing. Some residents commercial fish; others travel to Naknek each summer to work in canneries. Igiugig is not on the road system, but chartered flights provide air transportation, using its gravel runway. In the fall, barges from Naknek or Dillingham bring supplies.



Key Facts (2009):

Annual mean ground temperature: 3.0°C

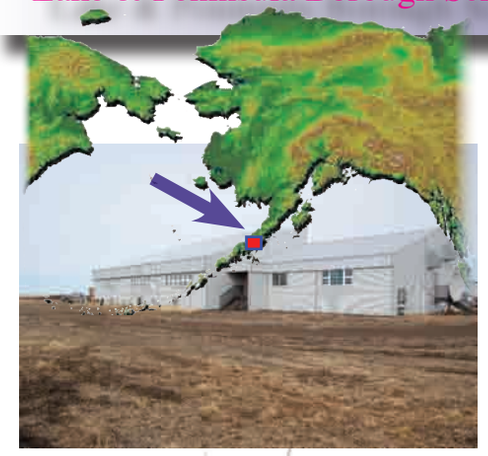
Freezing days: 150 days

Freezing degree-days: 593 °C days

Thawing degree-days: 1693 °C days

Port Heiden, Chignik

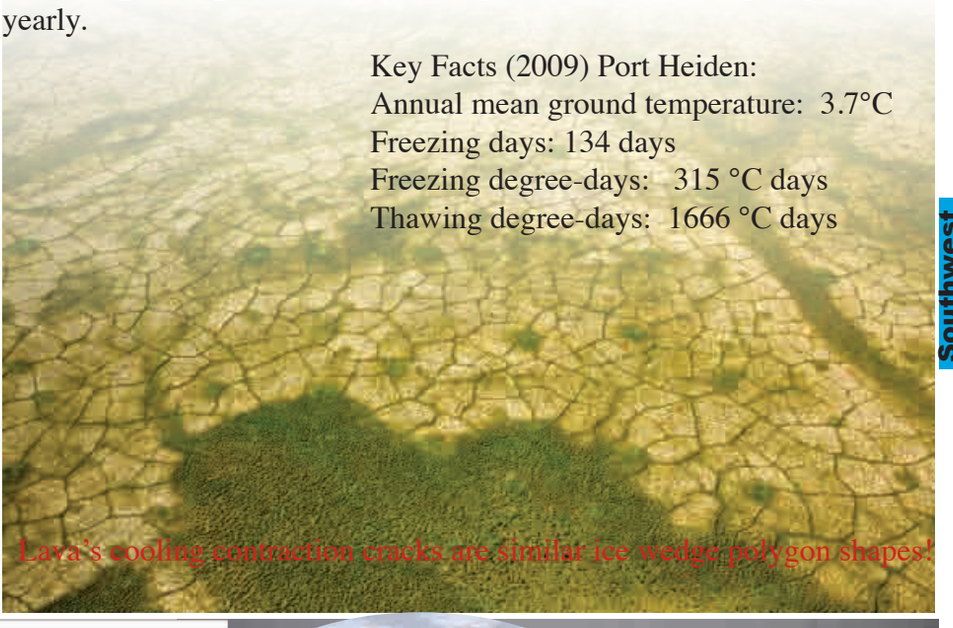
Lake & Peninsula Borough School District



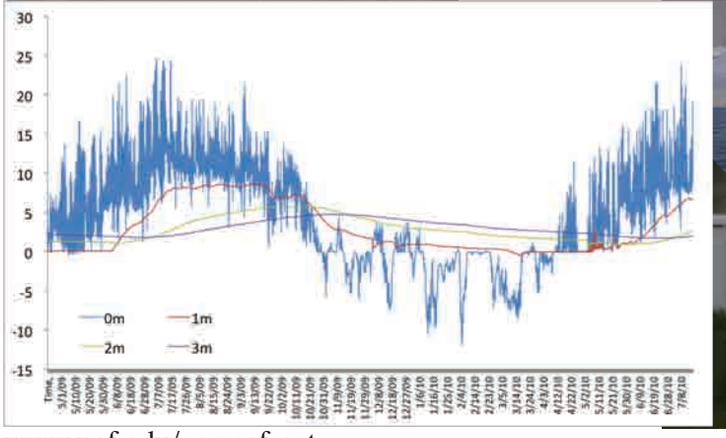
Student population: 27

Port Heiden, also known as Meshik, is a village with 90 residents (2008 DCCED Certified Population) located at the mouth of the Meshik River on the north side of the Alaska Peninsula. Meshik was the name of this village before influenza epidemics struck in the early 1900s, forcing residents to move to other villages. The U.S. Army established Fort Morrow at this location during World War II. About 5,000 military personnel were stationed here while the base was active; it closed following the war. In the early 1950s, a school opened at Port Heiden, attracting families from surrounding villages. When storm waves eroded the coastline by the old town site, villagers moved the community further inland. Port Heiden has a mixed population, but most residents are Alaska Native or part Native, mainly Alutiiq, for whom traditional subsistence practices are important. Employment includes work in government offices and commercial fishing. The community has an airport with a lighted gravel runway and a lighted gravel crosswind runway. Aircraft as large as a Boeing 737 can land here. Flights heading to the Pacific side of the Alaska Peninsula use the airstrips as a point of transfer. Barges from Seattle bring cargo twice yearly.

Key Facts (2009) Port Heiden:
Annual mean ground temperature: 3.7°C
Freezing days: 134 days
Freezing degree-days: 315 °C days
Thawing degree-days: 1666 °C days



Lava's cooling contraction cracks are similar ice wedge polygon shapes!



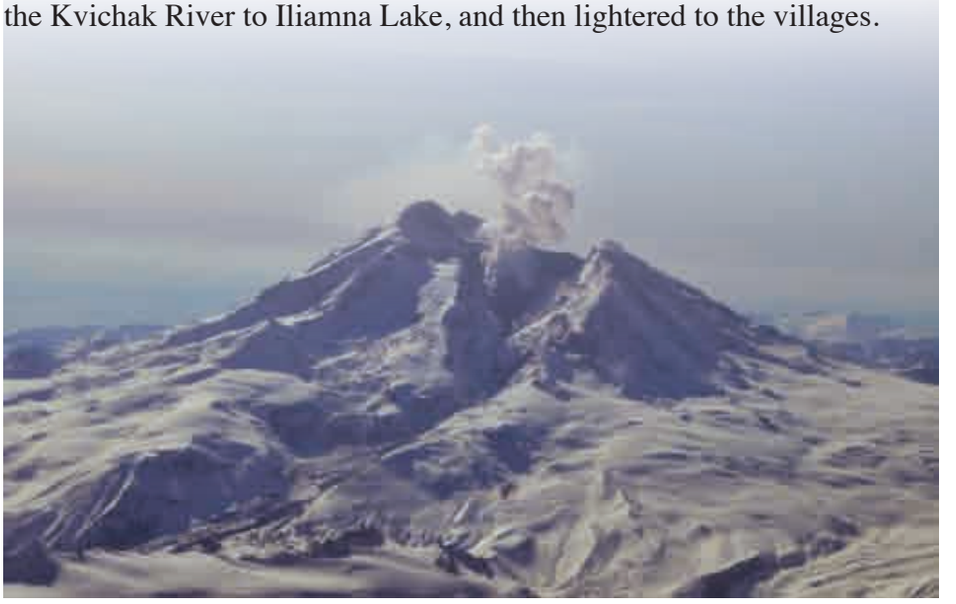
Location: 59.72° N, 154.90° W

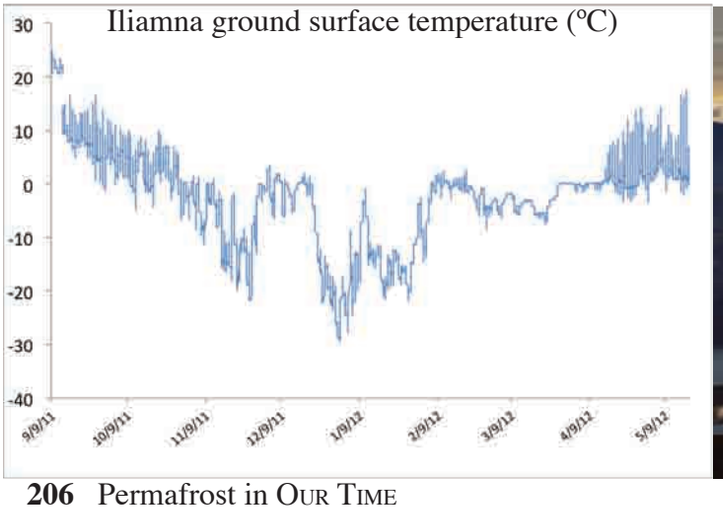
Newhalen/ Iliamna

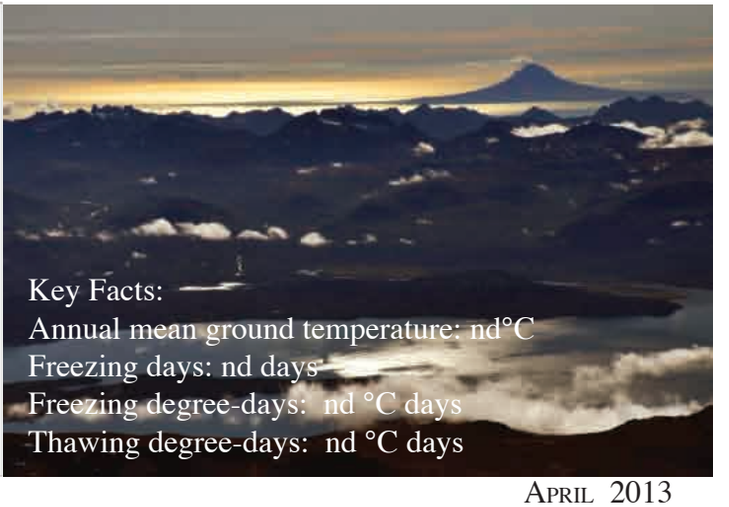
Southwest Region School District

Student population: 77

Iliamna and Newhalen, with a combined population of 299 (2010 U.S. Census), are located on the north shore of Iliamna Lake. Newhalen is south of Iliamna, at the mouth of the Newhalen River. Athabascans and Yup'ik Eskimo are the original inhabitants of this area. Athabascans settled at Iliamna, and Yup'ik settled at Newhalen. Fish and game are plentiful here. Since the 1930s, this bounty has attracted the development of fishing and hunting lodges, bringing thousands of people to Lake Iliamna every summer to fish. Employment is largely seasonal—commercial fishing and tourism—and many residents rely on subsistence activities for their livelihood. The two villages share one local school, located in Newhalen, and two state-owned gravel airstrips. Though not on the state road system, Iliamna and Newhalen are connected by a 13-kilometer gravel road. Bulk supplies are barged from the coast at Kvichak Bay, up the Kvichak River to Iliamna Lake, and then lightered to the villages.







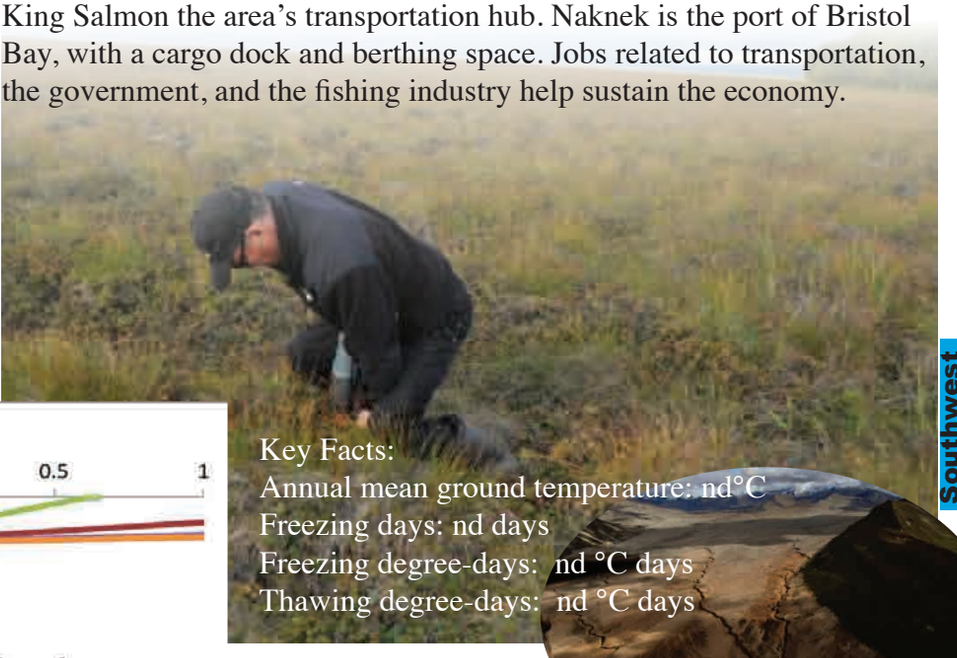
Location: 58.73° N, 156.81° W

King Salmon/ Naknek/ Dellingham

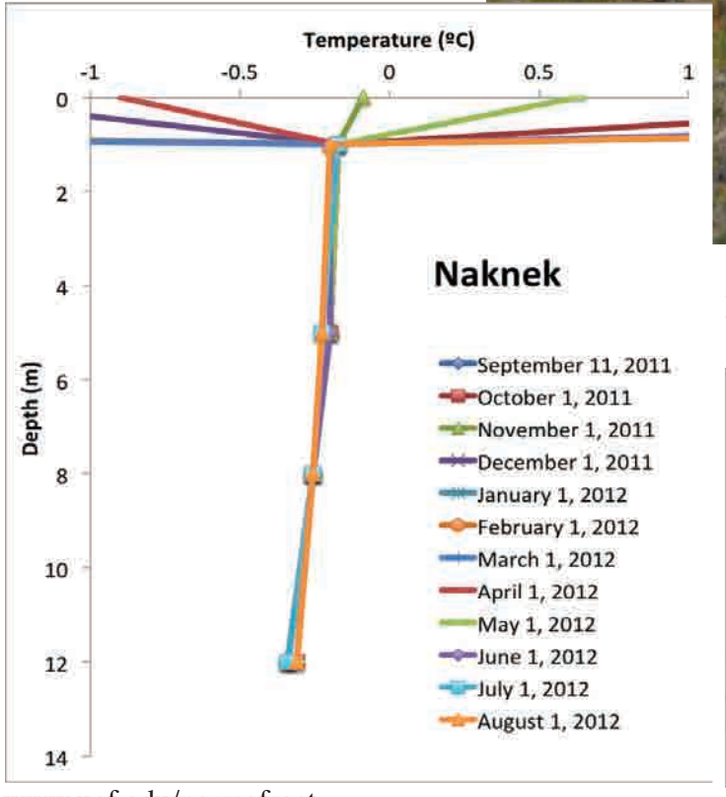
Southwest Region School District

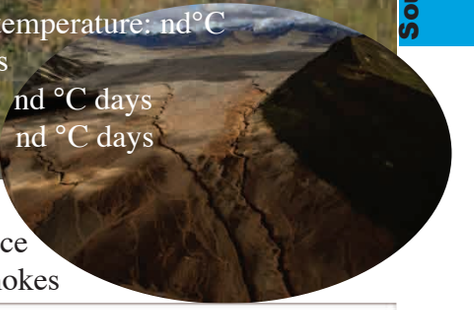
Student population: 180, Resident population: 918

Naknek and King Salmon are located on the north bank of the Naknek River. This river flows into Kvichak Bay, which opens into Bristol Bay, an area known for its red salmon fishery. Naknek is near the mouth of the river, and King Salmon is 24 kilometers upriver; they are connected by road. Yup'ik and Athabascans have lived in this region for thousands of years. Noting settlement at Naknek in 1821, Russians later built a fort nearby and began fur trapping. In 1890, a salmon cannery was built in Naknek, one of twelve that were built in the Bristol Bay area within the next ten years. World War II brought construction of a U.S. Air Force base at King Salmon. Since 1993, the base has been inactive, but its facilities are maintained and house borough and state government offices, and support occasional military activities. The military-built runway now has public use; it accommodates jet service to and from Anchorage, making King Salmon the area's transportation hub. Naknek is the port of Bristol Bay, with a cargo dock and berthing space. Jobs related to transportation, the government, and the fishing industry help sustain the economy.

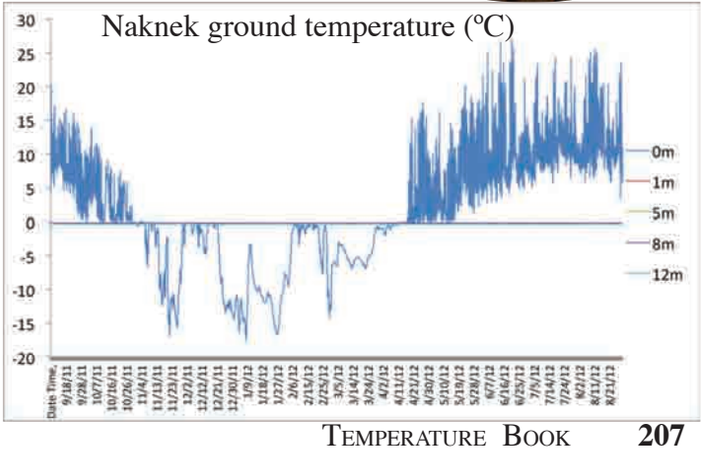


Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days





New permafrost site since 1912! Valley of 10K smokes



Southwest

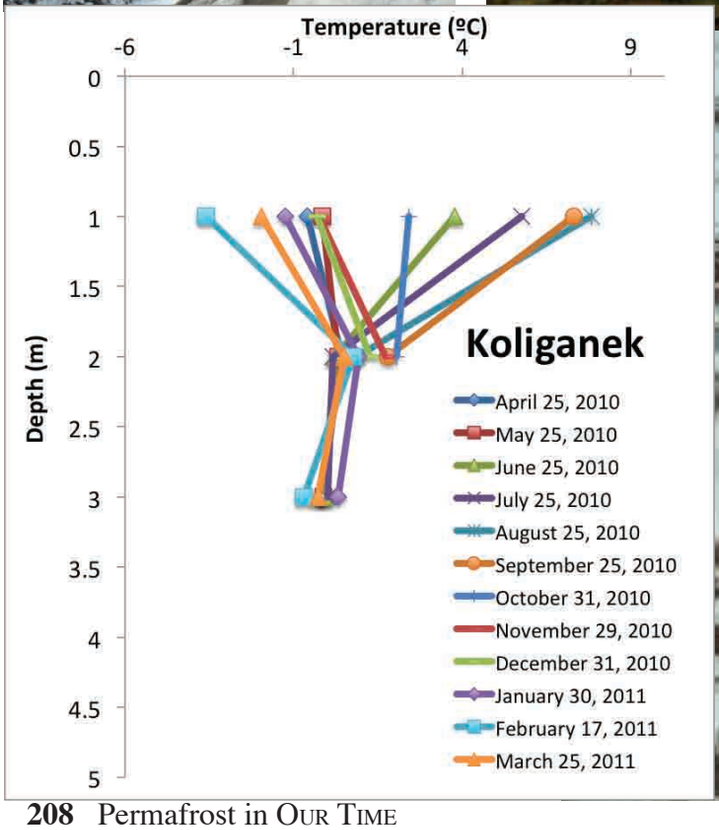
Location: 59.73° N, 157.29° W

Koliganek

Southwest Region School District

Student population: 50

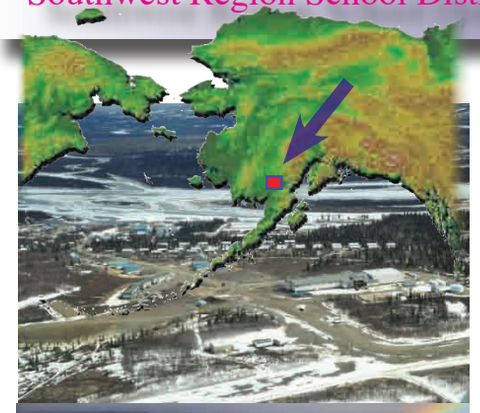
Koliganek, a village with 174 residents (2008 Estimated Population, not Certified), is located on the south bank of the Nushagak River, 105 kilometers (65 miles) northeast of Dillingham. The indigenous people of this area are Yup'ik. Since its recording in the 1880 U.S. Census, the village has relocated further downriver. Most residents in Koliganek are Alaska Native or part Native, mainly Yup'ik, for whom subsistence practices are important. Employment includes work with the school and village organization, in businesses, transportation, and services, and commercial fishing. Though Koliganek is not on the road system, it has a runway for air transportation. Supplies are brought upriver by barge from Dillingham.



Key Facts (2009):
Annual mean ground temperature: 2.3°C
Freezing days: 163 days
Freezing degree-days: 866 °C days
Thawing degree-days: 1708 °C days

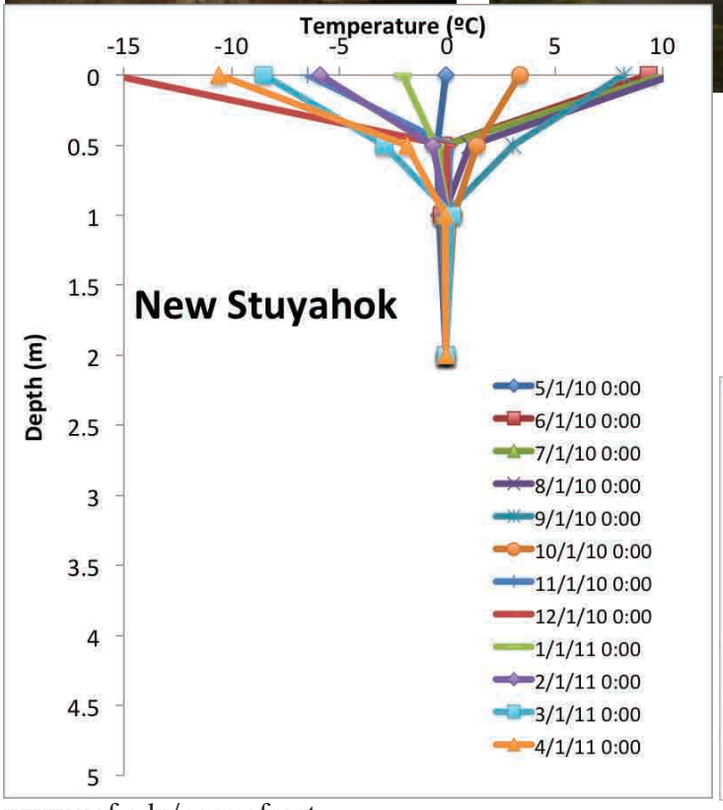
New Stuyahok

Southwest Region School District

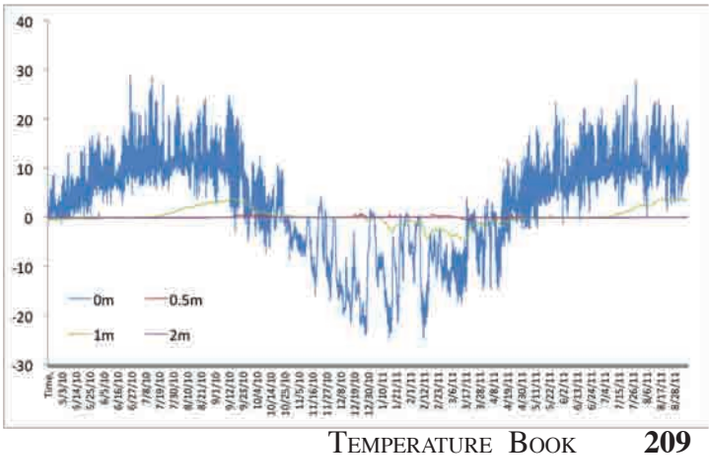


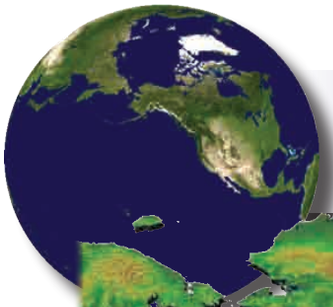
Student population: 146

New Stuyahok, a village with 491 residents (2008 DCCED Certified Population), is located on the west bank of the Nushagak River, about 84 kilometers (52 miles) northeast of Dillingham. The meaning of Stuyahok is "going downriver place," descriptive of the village's present location, since former locations have been further upriver. At one of the upriver locations in the 1920s and 1930s, villagers herded reindeer for the U.S. Government, though that practice ended as the herd size dwindled. New Stuyahok had a school and a post office by 1961. Most residents are Alaska Native or part Native, mainly Yup'ik. Subsistence practices provide an important source of food. Employment is primarily through commercial fishing, with the salmon fishery being especially significant. New Stuyahok has a lighted gravel airstrip, used by regularly scheduled and chartered air carriers out of Dillingham. Supplies are lightered upriver on the Nushagak when it is ice-free from June through mid-November.



Key Facts (2010):
Annual mean ground temperature: 0.3°C
Freezing days: 171 days
Freezing degree-days: 1467 °C days
Thawing degree-days: 1558 °C days

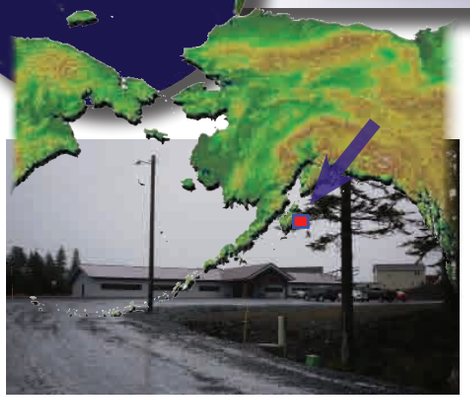




Location: 57.81° N, 152.36° W

Kodiak

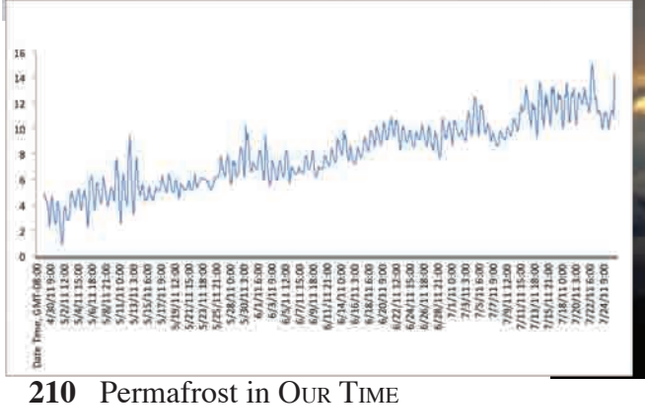
Kodiak Island Borough School District



Student population: 2,310

Kodiak, a city with 6,130 residents (2010 U.S. Census), is located at the northeast end of Kodiak Island, about 406 kilometers south of Anchorage by air. Evidence indicates that people have lived on the island for at least 8,000 years. Sugpiaqs were living here at the time that Russian explorers first arrived in 1763. Years later, Russian fur traders established a settlement near present-day Kodiak City, bringing their culture and influence, which remained after the U.S. purchased Alaska from Russia in 1867. With the opening of a fish cannery in 1882, commercial fishing began as an industry, and fishing, along with seafood processing, remains important to the local economy and character of the local culture. During World War II, the U.S. Navy and Army located military bases near Kodiak, and the military has had a presence since. Today, the U.S. Coast Guard occupies the military base, and its members and families form a major portion of the community's population. For the islands around it, Kodiak is a center for medical, transportation, and other services, retail businesses, governmental offices, and education, including a campus of the University of Alaska Anchorage. The University of Alaska Fairbanks Fishery Industrial Technology Center is on Near Island, which is connected to Kodiak by a bridge. The Alaska Marine Highway route includes Kodiak, and the local airport supports daily commercial air service, including jets. Kodiak has a floatplane base, and is the homeport for hundreds of fishing vessels.

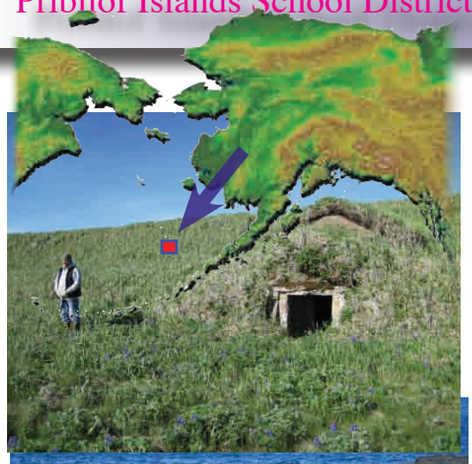
Key Facts:
Annual mean ground temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



Location: 57.12° N, 170.28° W

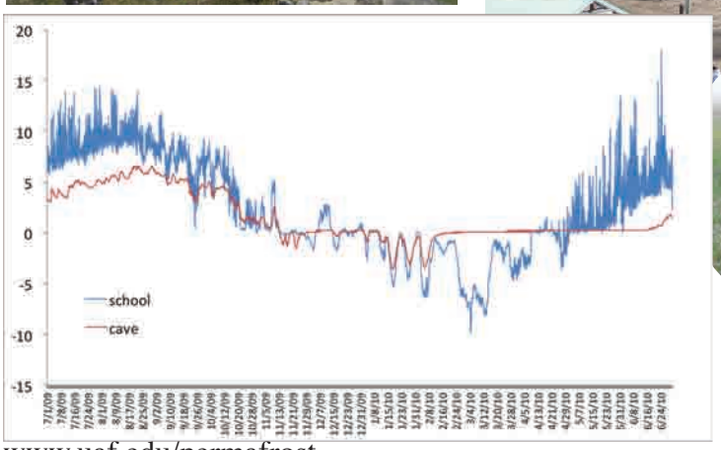
Saint Paul

Pribilof Islands School District



Student population: 96

Saint Paul, a village with 450 residents (2008 DCCED Certified Population), is located near the southern tip of Saint Paul Island, one of the Pribilof Islands in the Bering Sea. Saint Paul Island lies about 386 kilometers (240 miles) north of the Aleutian Islands. These islands are breeding grounds for the northern fur seal. Russian fur traders encountered the islands in 1786 and 1787, naming the group after their navigator Gavriil Pribylov. The Russian American Company returned to the islands in 1788 with Aleuts from Siberia, Atka, and Unalaska who were forced to travel to the islands and hunt the northern fur seal for the company. Present-day residents of Saint Paul are descendants of these Aleut hunters. The lives of the Pribilof Aleuts have been intertwined with the northern fur seal for both commercial and subsistence purposes, first during Russian ownership of Alaska and, after 1867, during U.S. ownership of Alaska. By 1910, the practices of private companies awarded seal-hunting leases by the U.S. government had contributed to overharvest of the northern fur seal. The Fur Seal Act enacted by Congress gave management of the northern fur seal to the U.S. Bureau of Fisheries. Work opportunities decreased for the Pribilof Aleuts, affecting their income. During World War II, residents of Saint Paul were evacuated to Funter Bay on Admiralty Island in Southeast Alaska, where living conditions and treatment were poor. In 1983, amendments to the Fur Seal Act ended federal presence on Saint Paul Island and government control of commercial seal harvests, giving management responsibility of the northern fur seal to local entities. Commercial harvesting of the fur seal ended at Saint Paul in 1985. Most residents of Saint Paul Island are Alaska Native or part Native, mainly Aleuts. The harbor at Saint Paul provides a port for the Central Bering Sea fishing fleet; processing facilities for seafood are located there. Fur seal rookeries and many species of nesting sea birds attract tourists every year. Saint Paul has a paved runway, with regularly scheduled air service. Supplies are delivered by ship.



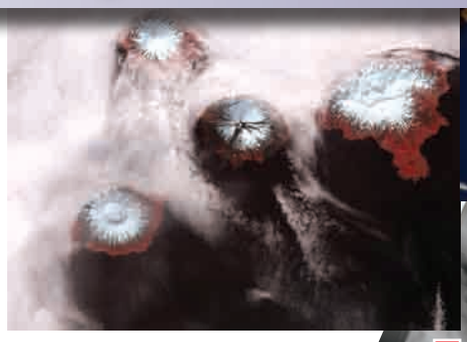
Key Facts (2009):
Annual mean ground temperature: -1.6°C
Freezing days: 197 days
Freezing degree-days: 2158 °C days
Thawing degree-days: 1590 °C days

Akutan, False Pass, Cold Bay, King Cove,

Aleutians East Borough School District

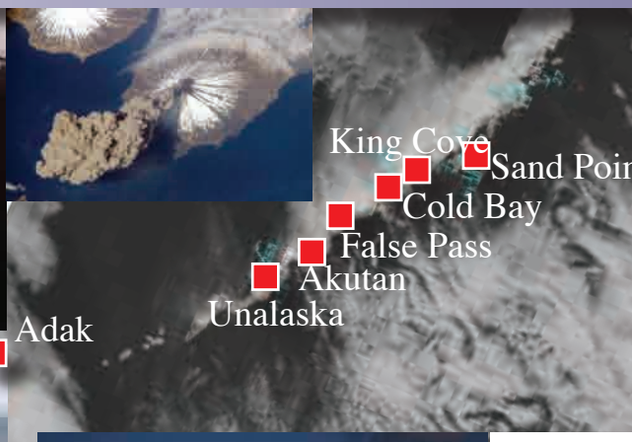
Student population: 8, Resident population: 1,027 (2010 U.S. Census)

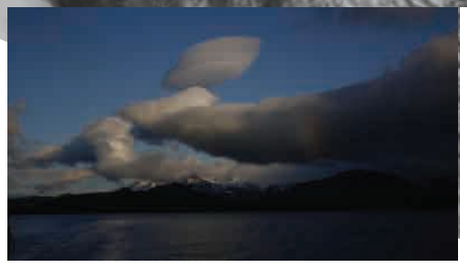
Akutan is located on Akutan Island. Unangans lived on Akutan Island when the Western Fur and Trading Company established a port for fur storage and trading in 1878. That same year, a Russian Orthodox church and school were located here. In the early 1900s, a whale processing station operated nearby. Akutan residents were evacuated by the U.S. government in 1942 over concern of an enemy attack during World War II. Afterward, residents returned, though some did not. Akutan's economy is built on commercial fish processing. Travel to and from the village is possible by floatplane and boat, and by ferry May through October.



Student population: 13
Resident population: 108 (2010 U.S. Census)

Cold Bay is located on the west end of the Alaska Peninsula. Archeological evidence indicates that people have lived here since soon after the last ice age, and that the resources of the area supported many people. Throughout the 1800s, after its discovery by non-Natives, Cold Bay was hunted and trapped for furbearing animals. In the 1940s, the U.S. established an airbase (Fort Randall), in support of the war effort. Cold Bay is within the Izembek National Wildlife Refuge, created in 1960. This location is along the migratory route of thousands of birds. Residents work in jobs related to government, air services, and fishing. The community's airport is a regional center for air transportation, with its long paved and lighted main runway and crosswind runway and FAA flight service station. The community has a seaplane base and a boat dock, and is on the state ferry route.





Student population: 6
Resident population: 35 (2010 U.S. Census)

False Pass is located on the eastern shore of Unimak Island. Isanotski Strait, which is alongside False Pass, separates Unimak Island, the first island in the Aleutian Islands, from the Alaska Peninsula and connects the Pacific Gulf of Alaska with the Bering Sea. Isanotski Strait is too shallow for the passage of large sea vessels, but it was traveled by the Unangan people, who lived here before non-Natives arrived. A homesteader moved to False Pass in the early 1900s. When a cannery was built in 1917, False Pass grew with residents who relocated from nearby villages. The economy of False Pass is based on commercial fishing and fish processing, and services that support both. Travel to False Pass is by sea and air. The state ferry runs here May through October.

Sand Point and Unalaska, Adak
and Aleutian Region School District

Student population: 108
Resident population: 938 (2010 U.S. Census)
King Cove, also known as Agdaagux, is located on the south side of the Alaska Peninsula, 29 kilometers southeast of Cold Bay. The community is situated on a sand spit that divides the bay of King Cove from King Cove Lagoon. A salmon cannery was established in 1911, which attracted Unangan people from nearby villages and fishermen from Scandinavia and Europe. The non-Natives introduced their customs, which influence the local culture still. All activities related to commercial fishing and fish processing support the economy of King Cove. Travel to the community is by sea and air. The state ferry travels to King Cove between May and October.

Student population: 409
Resident population: 4,376 (2010 U.S. Census)
Unalaska is a community at the head of Iliuliuk Bay on the north coast of Unalaska Island. A bridge connects Unalaska with Amaknak Island and the settlement of Dutch Harbor. The Unangan people lived on both islands at the time that Russian exploration occurred here in the mid-1700s. By 1768, Russian fur traders had made this location a trading port. A Russian Orthodox church was built in 1825, and a school, clinic, and orphanage were established by the Methodist Church by 1880. Residents were evacuated from Unalaska for the duration of World War II after the island was attacked by enemy forces. The local economy is based on commercial fishing, fish processing, and the services and facilities that support these activities. Air transportation is available year-round, and a state ferry runs between April and October.

Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Student population: 20
Resident population: 326 (2010 U.S. Census)
Adak is a village located at Kuluk Bay on Adak Island. The Unangas occupied Adak Island at the time of Russia's exploration for furs in the Aleutian Islands. Adak's strategic location during World War II led the U.S. to install a military station, which remained after the war to become a Naval Air Station. At times, military personnel and their families increased the local population by as many as 6,000. Following closure of the base in 1997, the military facilities became the property of the Aleut Corporation under a land transfer agreement. Much of Adak's business today supports commercial fishing, fishing fleets, and seafood processing. Adak has about 16 miles of paved roads in addition to gravel and dirt roads. A paved runway accommodates passenger and cargo jet service.

Location: 58.40° N, 134.55° W

Juneau

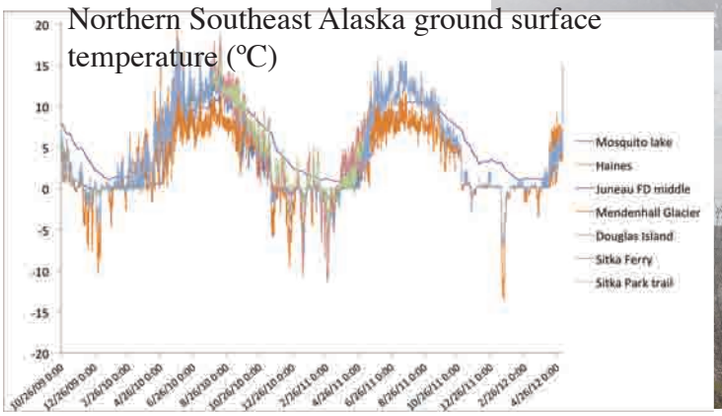
City & Borough of Juneau School District

Student population: 4,743

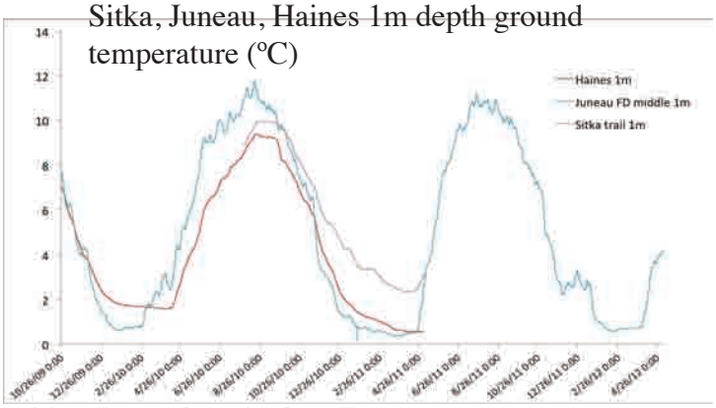
Juneau, the capital of Alaska, with 30,427 residents (2008 DCCED Certified Population), is located on the mainland of southeast Alaska, across the Gastineau Channel from Douglas Island. The community is 929 kilometers (577 miles) southeast of Anchorage by air. Tlingits of the Auke tribe, the indigenous people of this area, used this location as a fish camp. Juneau's development, which began in the 1880s, was based on gold mining. Prospectors were drawn to the area, and mining interests on both Douglas Island and mainland Juneau became world-scale mines, one of them operating until the 1940s. Presently, a mine near Juneau still produces gold, silver, lead, and zinc. In 1906, Juneau became Alaska's territorial capital, replacing Sitka. Juneau, today, is the third largest city in Alaska, with the many services and businesses commonly found in cities. State government operates in Juneau. During legislative sessions, the city's population increases with state legislators and their staff. The University of Alaska Southeast is located near Juneau. Though not on the state road system, Juneau has daily jet service to Anchorage and is on the Alaska Marine Highway route, as well. Marine facilities include a seaplane landing area, small-boat harbors, docks for barges and cruise ships, and a state ferry terminal.

Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

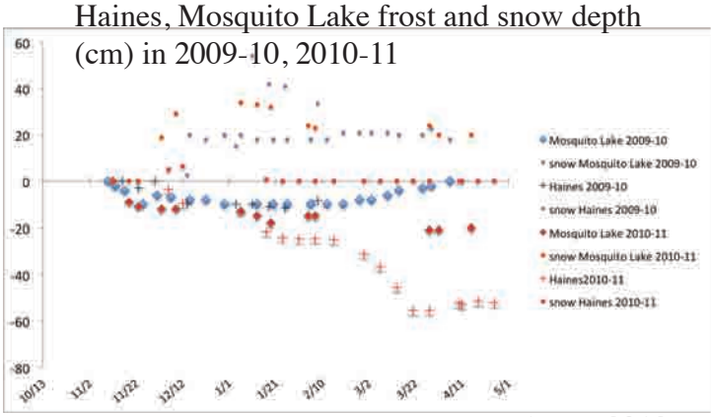
Northern Southeast Alaska ground surface temperature (ºC)



Sitka, Juneau, Haines 1m depth ground temperature (ºC)



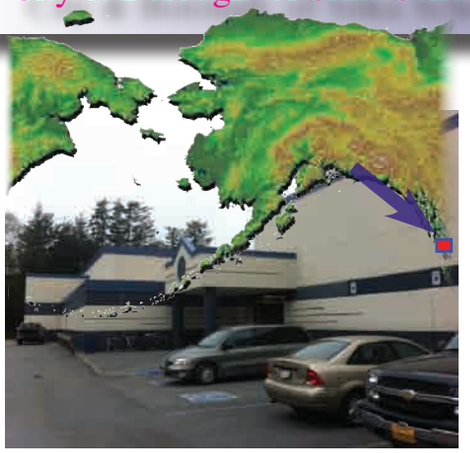
Haines, Mosquito Lake frost and snow depth (cm) in 2009-10, 2010-11



Location: 57.06° N, 135.35° W

Sitka

City & Borough of Sitka School District



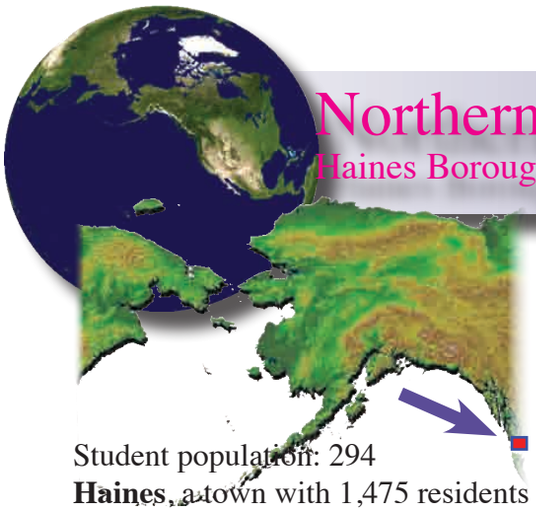
Student population: 1788

Sitka, a city with 8,881 residents (2010 U.S. Census), is located on the west coast of Baranof Island in southeast Alaska, 153 kilometers southwest of Juneau by air. Tlingits, the original inhabitants of Sitka, called their village "Shee Atika." Russian explorers arrived here in 1741, and within about 50 years, the Russian-American Company had established a trading post and fort, naming the site "New Archangel." This location was the capital of Russian Alaska from 1808 until Alaska was sold by Russia to the U.S. in 1867; it then was the capital of the new U.S. territory until 1906. Located within Sitka Sound, Sitka became a major shipping port on the north Pacific coast for salmon, lumber, and furs. Commercial fishing, fish processing, and gold mining have contributed to the community's economic growth since the late 1800s. During World War II, the U.S. Navy built an air base on nearby Japonski Island, which brought thousands of support personnel into the area. Today, the U.S. Coast Guard maintains a station there. Japonski and Baranof Islands are connected by bridge. Sitka is on the Alaska Marine Highway route and has an airport that supports daily jet service, a seaplane base, and boat harbors. The local economy is strengthened by business related to commercial fishing and fish processing, tourism, government, transportation, retail sales, and health care services.

Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

Northern Part of Southeast Alaska

Haines Borough School District, Hoonah City Schools and Chatham School District



Student population: 294

Haines, a town with 1,475 residents (2008 Estimated Population, not Certified), is located in southeastern Alaska, on the western shore of Lynn Canal between the Chilkoot and Chilkat Rivers. Tlingit, the original inhabitants of this area, referred to the location as Dei Shu, meaning "end of the trail." Dei Shu was along a trade route used by coastal and inland people. Non-Natives began to settle here in 1880. A Presbyterian mission and school, established in the early 1880s, was named Haines in honor of a key fundraiser for construction of the buildings. Gold prospectors heading for the Klondike River in Canada and for Porcupine Creek in Alaska helped Haines develop as a mining supply center, as the community was located along the route to both destinations. By the early 1900s, four canneries and a U.S. military post—Fort William H. Seward—had located in or near Haines. Over the years, commercial fishing and timber industries have figured importantly in the town's economy. Government, tourism, and transportation provide additional employment. Haines has an ice-free deep-water port. Freight ships and cruise ships use this port, as well as ferries, which connect the community to the rest of Southeast Alaska via the Alaska Marine Highway System. Haines is connected by road to Canada and Interior Alaska. The community has a paved runway, with daily flights to Juneau, a seaplane base, two boat harbors, a ferry terminal, and a cruise ship dock.

Key Facts (2009) Haines:
Annual mean ground temperature: 5.3°C
Freezing days: 124 days
Freezing degree-days: 20 °C days
Thawing degree-days: 1956 °C days

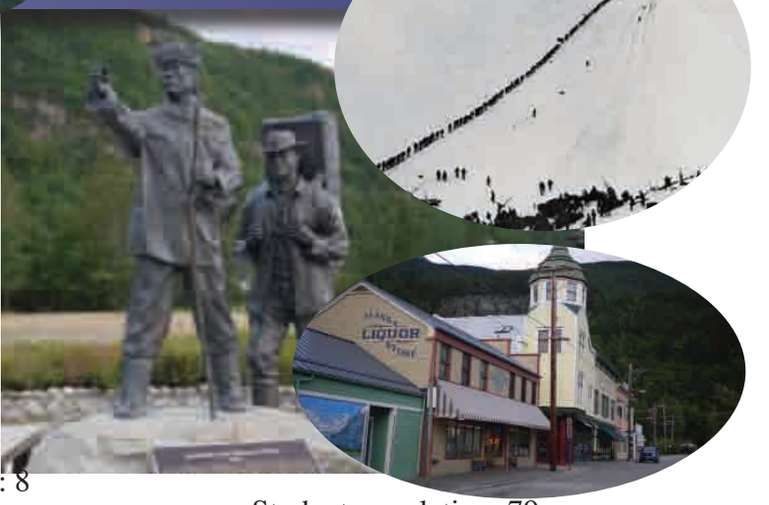
Student population: 18

Mosquito Lake, a village with 167 residents (2008 Estimated Population, not Certified), is located on the shore of a lake by the same name, west of the Chilkat River. The indigenous people of this area are the Chilkat Tlingits; they called this location Kuhnteah. In 1951, a road for recreation and logging was constructed to the lake from the Haines Highway. This settlement, which is near a state park and campground, has a school, fire station, and powerhouse.

Key Facts (2009) Mosquito Lake:
Annual mean ground temperature: 4.7°C
Freezing days: 16 days
Freezing degree-days: 3°C days
Thawing degree-days: 1721 °C days

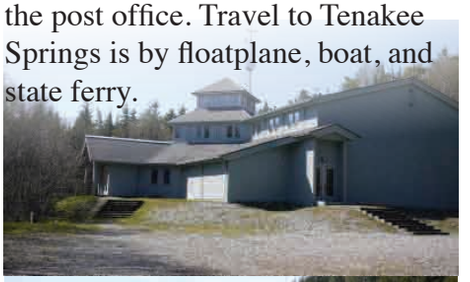
Student population: 124
Resident population: 760 (2010 U.S. Census)

Hoonah is located on the northeast shore of Chichagof Island, 64 kilometers west of Juneau by air. Hoonah, which means "village by the cliff," is the largest Tlingit village in Alaska. Huna is the tribal name of the people living here. During the 1880s, the Northwest Trading Company built a store in Hoonah, and the Presbyterian Church established a mission and school. Fish processing and cold storage businesses began in the early 1900s. Employment today is found in businesses related to commercial fishing and logging, and in local government and schools. Subsistence activities are an important part of peoples' lives. Travel to and from Hoonah is by plane, boat, and state ferry.



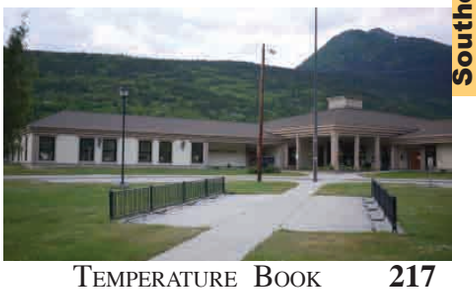
Student population: 8
Resident population: 131 (2010 U.S. Census)

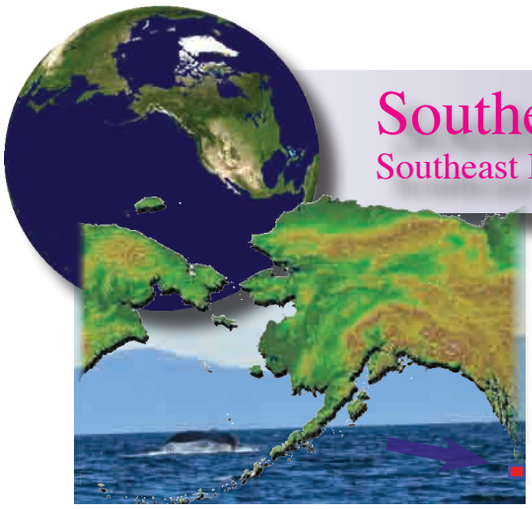
Tenakee Springs is located on the north shore of Tenakee Inlet, which cuts into the east side of Chichagof Island. The Tlingits named this location "tinaghu," which relates to a story about the loss of prized shields in a storm. The name means "coppery shield bay." The Tlingit are the indigenous people throughout this area. Natural hot springs are a geologic feature at Tenakee Springs, and they have been developed over time, as they draw the interest of visitors and newcomers. A store was established in Tenakee Springs as early as 1899. Residents work in commercial fishing, stores, local government, the school, and the post office. Travel to Tenakee Springs is by floatplane, boat, and state ferry.



Student population: 79
Resident population: 459 (2010 U.S. Census)

Angoon is located on the southwest coast of Admiralty Island, 88 kilometers southwest of Juneau. This location is the ancestral home of the Kootznoowoo Tlingit; they were here when explorers and fur traders from other countries entered the area in the 1700s. Fur trading was a major business through the 1800s and led to the establishment of a trading post by the Northwest Trading Company on Killisnoo Island, close to Angoon, in 1878. Other early business included whaling and fish processing. Today residents are employed in commercial fishing, logging, and education. Subsistence activities are an important part of residents' lives. Travel to Angoon is by floatplane, boat, and state ferry.





Southern part of Southeast Alaska

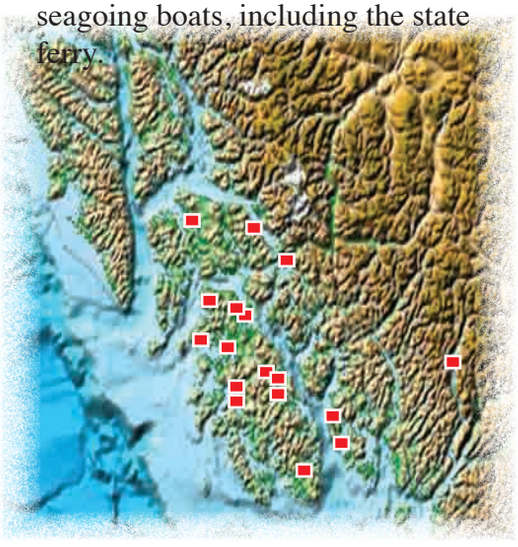
Southeast Island School District, Keka, Petersburg, Craig, Klawock, Ketchkan,Wrang

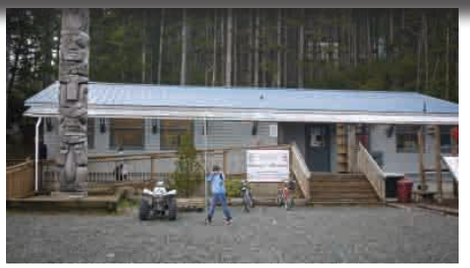
Student population: 12
Resident population: 176 (2010)
Coffman Cove is a community located on northeast Prince of Wales Island, 68 kilometers southeast of Wrangell. The site was named for Dewitt Coffman, a military officer on a U.S. Navy ship in the area in 1886. A logging business was started in the 1950s, and early settlement took the form of a logging camp. For a time, Coffman Cove was a major log transfer site on Prince of Wales Island. In 1958, the Alaska Statehood Act opened land for private ownership. Today, logging support services provide employment, as do tourism, commercial fishing, and oyster farming. The community has a public seaplane base, a boat launch, and dock, and is on the Prince of Wales Island road system.

Student population: 640
Resident population: 1,201 (2010)
Craig is located on Craig Island, which is connected to the west coast of Prince of Wales Island by a causeway. Historically, this is an area used by the Tlingit and Haida. Craig Miller established a fish packing company and cold storage plant here in 1911. By 1912, the community had a post office, school, sawmill, and salmon cannery. Over time, the fishing industry and a sawmill operation have helped to develop the local economy and provide jobs. Craig is connected by road to Klawock, where there is an airport, and to Hollis, which has ferry service. The community has a seaplane base, two small boat harbors, and a dock and boat launch.

Student population: 10
Resident population: 112 (2010)
Hollis is located on the east side of Prince of Wales Island, 56 kilometers west of Ketchikan. Between 1900 and 1915, Hollis was a focal point for gold and silver mining. Logging and logging-related activities have supported the local economy since the early 1950s. Hollis is along the Alaska marine highway route, and serves as the state ferry landing for residents of Prince of Wales Island. The community has a public seaplane base, harbor, dock, and boat ramp. Logging roads connect Hollis to other communities on the island.

Student population: 86
Resident population: 557 (2010)
Kake is located on the northwest coast of Kupreanof Island, about 153 kilometers southwest of Juneau. Kake is a Tlingit village, the ancestral home of the Kake Tlingits, for whom traditional customs remain important. In the 1800s, this area was traveled by European explorers and traders, and by the U.S. military after the purchase of Alaska from Russia. Kake had a government school and a store by 1891. A mission and post office were established in 1904. Timber harvesting and processing support the economy, providing jobs, which are also found with the city, school district, and Kake Tribal Corporation. Many residents commercial fish. Kake has a paved runway, a seaplane base, and facilities for seagoing boats, including the state ferry.

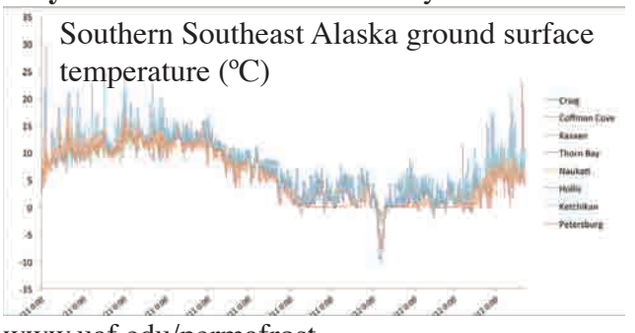




Student population: 14
Resident population: 49 (2010)
Kasaan is located on the east side of Prince of Wales Island, about 48 kilometers northwest of Ketchikan. Kasaan is a Tlingit name that means "pretty town." In the early 1700s, Haidas moved into the area from Queen Charlotte Islands. Copper mining developed as a business venture in the 1890s, and with it came construction of a mining camp, sawmill, post office, and general store. A fish cannery that closed in 1953, operated for nearly 50 years. Some residents are involved in commercial fishing, and most residents participate in subsistence activities for food. Kasaan has a public seaplane base, a dock, and a small boat harbor, and roads connect it to other communities on Prince of Wales Island.

Hayder:far south east community

Student population: 2,248
Resident population: 8,050 (2010)
Ketchikan is located on the southwestern coast of Revillagigedo Island, 378 kilometers south of Juneau, near Alaska's southern boundary. Ketchikan Creek was used by Tongass and Cape Fox Tlingits as a fish camp. Fish and timber resources attracted non-Natives to the area. Between 1886 and 1912, five canneries and a lumber mill were in operation. Over time, businesses related to fishing, timber, and tourism have helped develop the local economy. Ketchikan has grown to become a service center for surrounding communities. Jet air transportation is available, as is ferry service. The community has harbors and docking facilities for ferries, cruise ships, and seagoing boats



Key Facts:
Data is available in the Internet
Freezing days:
Freezing degree-days:
Thawing degree-days:

Student population: 72
Resident population: 471 (2010)
Thorne Bay is on the east coast of Prince of Wales Island. The community began as a logging camp and developed further from extensive logging activities. Sawmills, commercial fishing, tourism, and government service provide employment for residents, as do timber and fishery support businesses.

Student population: 490
Resident population: 2,948 (2010)
Petersburg is located on the northwest end of Mitkof Island, across the Wrangell Narrows from Kupreanof Island. This location on Mitkof Island was a summer fish camp of the Kake Tlingits. In the late 1890s, a Norwegian immigrant named Peter Buschmann, for whom this town is named, was instrumental in the building of a cannery, sawmill, and dock. By 1920, 600 people, many of Scandinavian descent, had settled in Petersburg, introducing their cultural influence. Fishing and fishing-related businesses are a major part of the economy in Petersburg.

Whitehorse

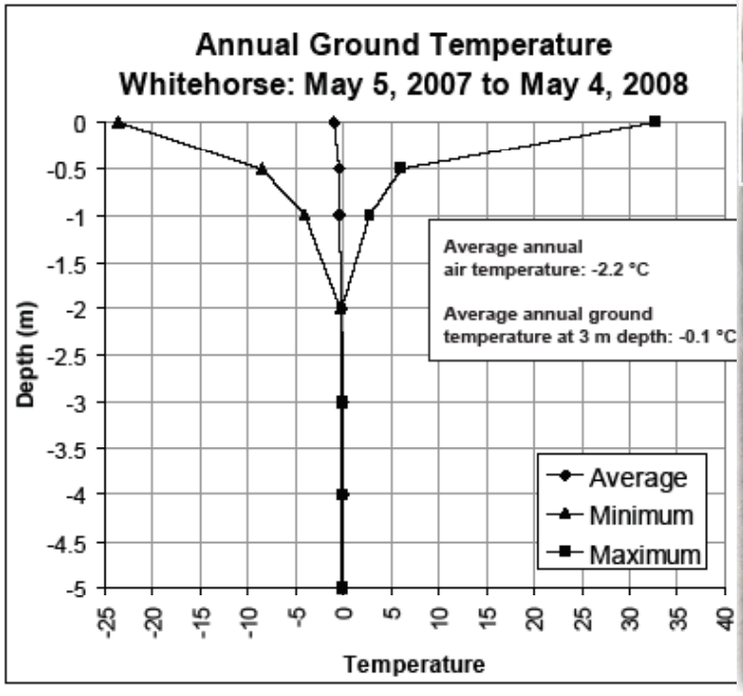
Golden Horn Elementary School

Whitehorse, a city with 22,213 residents, is located in southcentral Yukon in a wide valley of the Yukon River. Whitehorse is Yukon's territorial capital and largest community. The First Nations people traditionally used this area as a meeting place and a food-gathering place. Settlement of the community of Whitehorse began during the Klondike Gold Rush, around 1896. This location, at the head of navigable waters on the Yukon River, was important, as the river was the water route to the gold fields. In 1898, construction on the White Pass and Yukon Route Railway began; its completion linked Whitehorse with Skagway, a seaport in Alaska. Over the years, mining and highway construction have contributed to the development and growth of Whitehorse. The city, which has become the government and business center for Yukon, is also the headquarters for the Council of Yukon First Nations.

On May 4, 2007 a permafrost borehole was drilled in Cowley Creek subdivision, 2.2 km southwest of Golden Horn Elementary School (Figure 5). The borehole was drilled to 5 m depth approximately 40 m east of Cowley Creek and about 40 m southeast of Salmon Trail. This was the closest permafrost site to the school we could find because permafrost is very sporadic in Whitehorse.

- vegetation: white spruce forest, feathermoss forest
- soil: 10 cm surface organic layer overlying fine-grained silt that is very ice rich from 4-5 m depth.

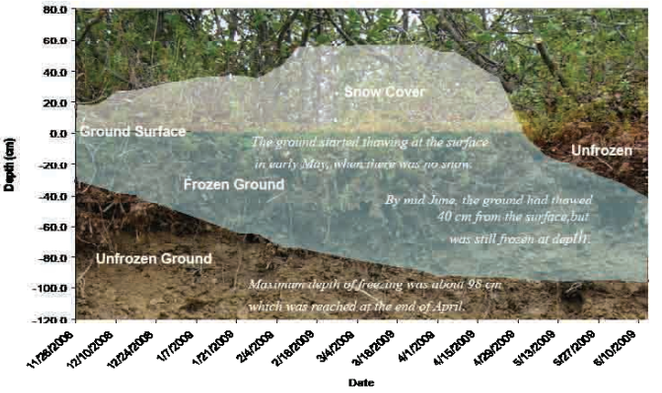
The graphs below show data collected from this site between 2007 and 2009.



HIGHLIGHTS

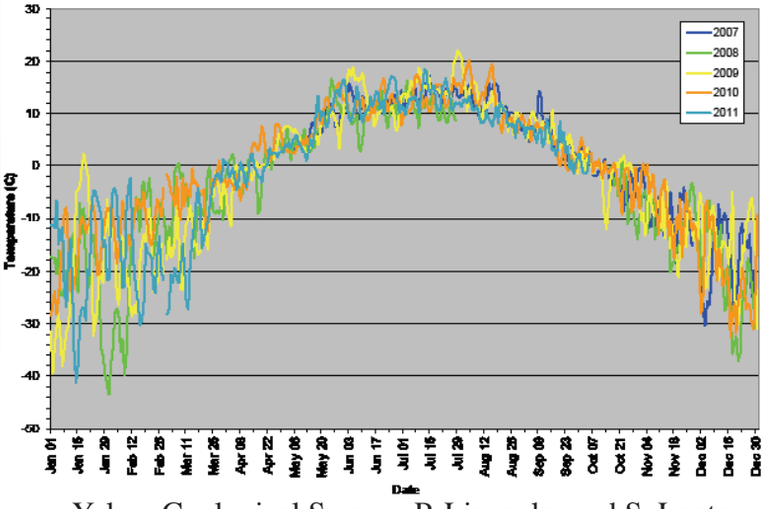
- Whitehorse is in the sporadic permafrost zone, and permafrost is only found in certain location where soil, moisture, and micro-climate conditions keep the ground cool enough.
- A frost tube was installed at Goldenhorn Elementary in November 2008.
- Measurements made by school students show that the ground froze down to 98 cm by the end of the winter.
- A permafrost monitoring station was installed at Cowley Creek in May 2007. Permafrost tempera tures are measured once every hour at various depths in a 5 m deep borehole.
- A large amount of ice was found 4 m below the ground surface near Cowley Creek.
- Ground ice melting from the permafrost has caused "thermokarst" and created a "drunken forest" at Cowley Creek.
- The active layer at Cowley Creek is 2 m thick.
- The temperature of permafrost measured at Cowley Creek is -0.2° C.
- The average annual air temperature at Cowley Creek was -2.2° C.
- The coldest air temperature measured last winter was -43° C on January 7, 2009, while the warmest temperature last summer was 33° C on July 29.

Frost tube was installed approximately 100 m north of Golden Horn Elementary School on November 19, 2008. The site is located beside a mature white spruce forest, amidst willow shrubs that fringe a grassy meadow and shallow pond. 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 Goldenhorn students.



Frost tube data measured by the Grade 5-7 Golden Horn Elementary students in Whitehorse during 2008/2009.

Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



Yukon Geological Survey: P. Lipovsky and S. Laxton

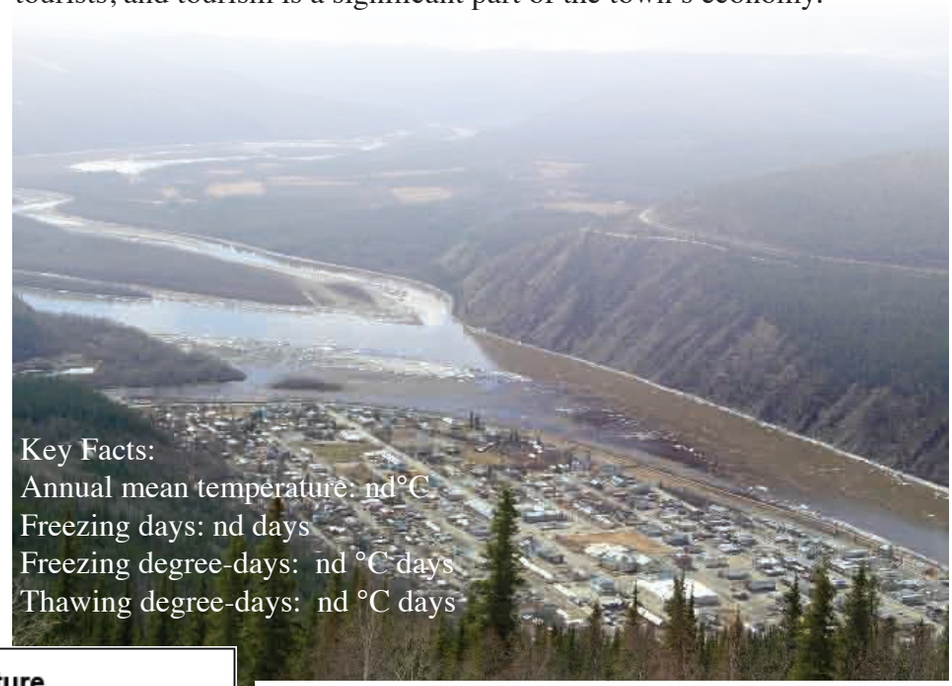
www.uaf.edu/permafrost

Location: 64.03° N, 139.29° W

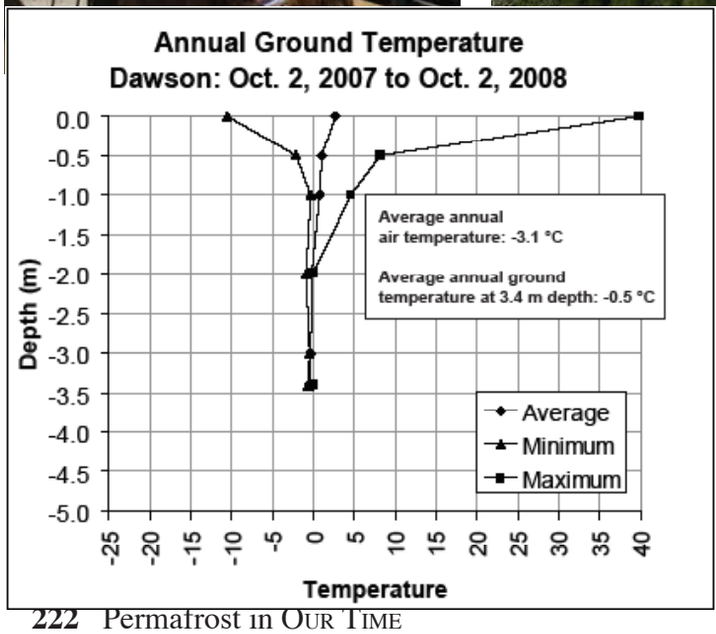
Dawson City

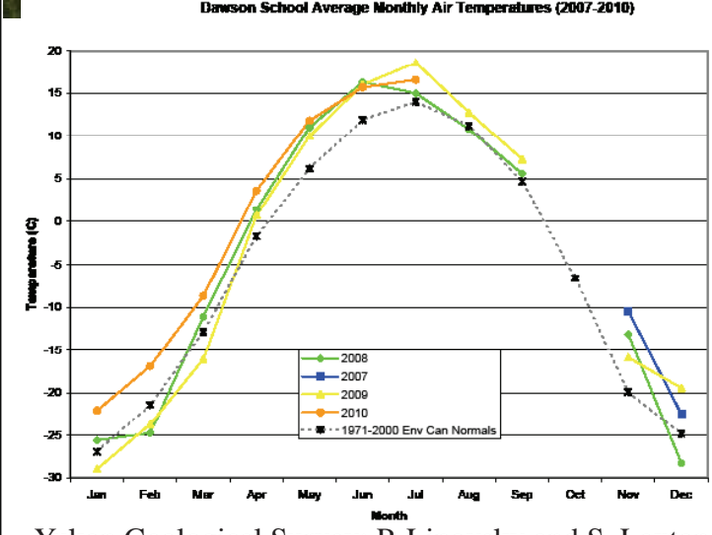
Yukon Territory, Canada

Dawson City, a town with 1,772 residents (Yukon Community Profiles, 2004), is located on the east bank of the Yukon River, at the mouth of the Klondike River. This town, which figures importantly in the historic Klondike Gold Rush, is 536 kilometers (333 miles) northwest of Whitehorse; it can be reached by road on the Klondike Highway. The First Nations people of the Dawson City area are Tr'ondëk Hwëch'in. The confluence of the two rivers was a traditional seasonal fishing camp. In 1896, gold was discovered in the Klondike Valley, and within two years, a town had developed, providing services to a population that swelled to 40,000. Four years later, the population dropped dramatically, with the gold rush over. As one of Canada's National Historic Sites, Dawson City has been able to preserve its buildings and historic areas. The town is popular with tourists, and tourism is a significant part of the town's economy.



Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



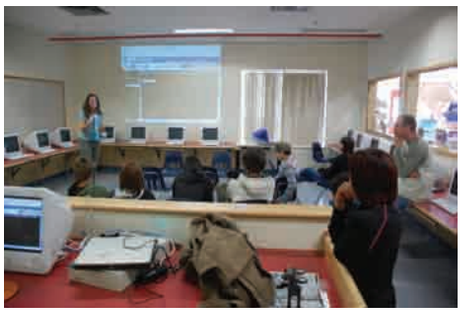


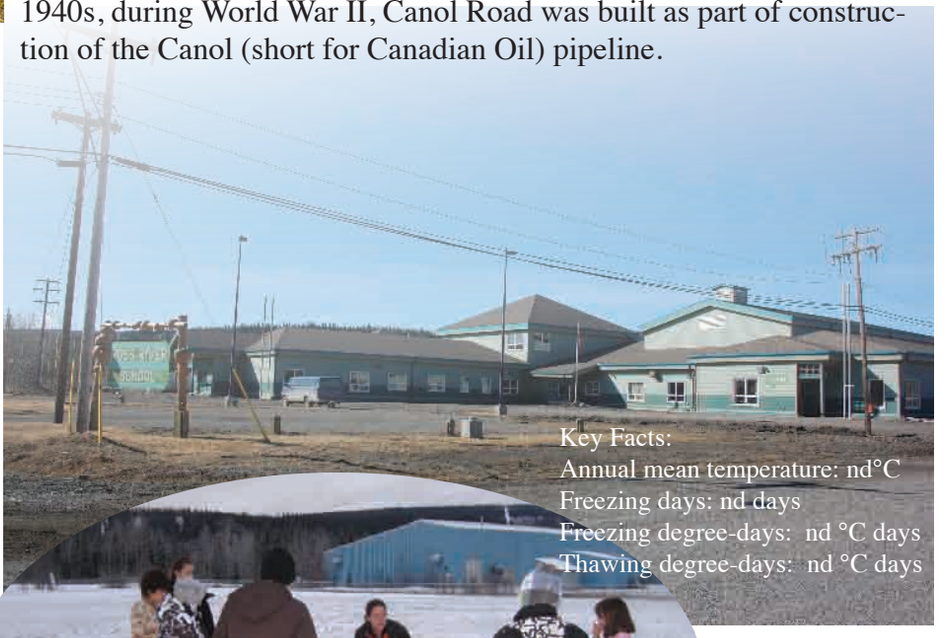
Yukon Geological Survey: P. Lipovsky and S. Laxton

Ross River

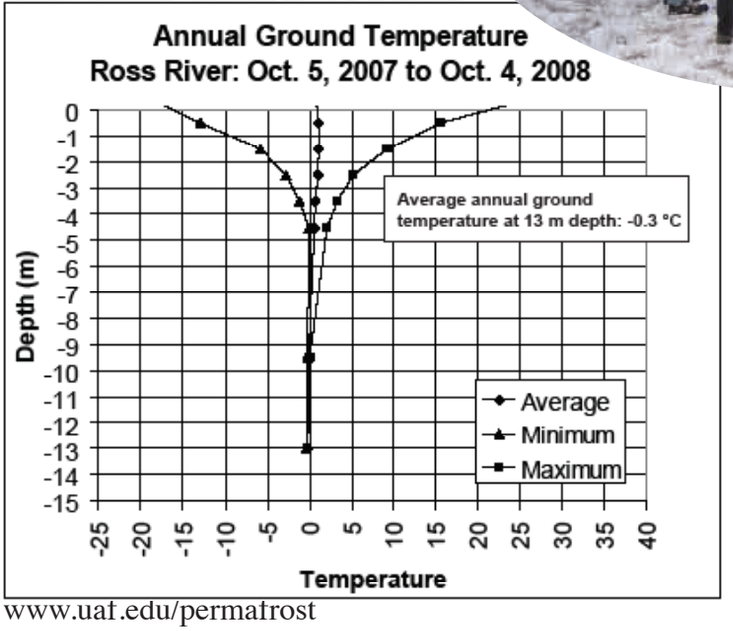
Yukon Territory, Canada

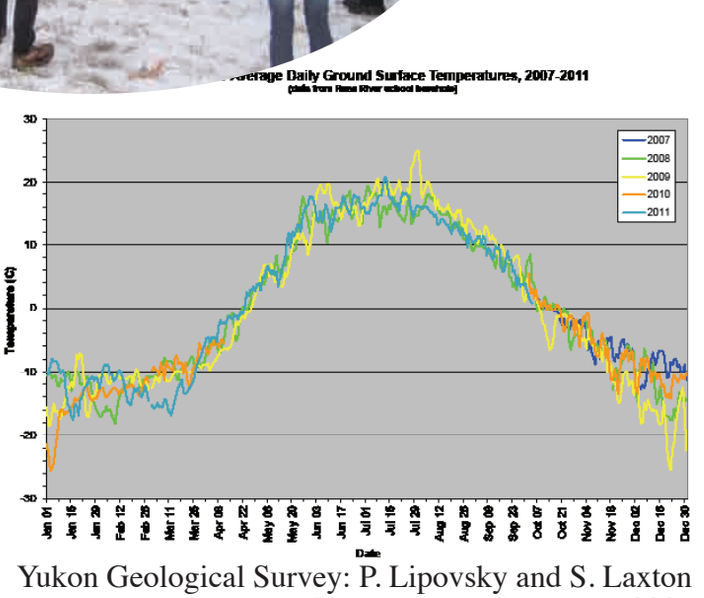
Ross River, a community with 335 residents, is located on the south bank of the Pelly River, 360 kilometers (224 miles) northeast of Whitehorse. The junction of the Campbell Highway and Canol Road are nearby, connecting Ross River with other highways in Yukon. First Nations people used this site on the Pelly River as a seasonal camp and gathering place. The Ross River Dena Council, located in Ross River, represents the Kaska Dena people, whose language is related to the Athabascan language group. Interest in prospecting and mining began here in the early 1900s. By 1903, a trading post had been established nearby. In the 1940s, during World War II, Canol Road was built as part of construction of the Canol (short for Canadian Oil) pipeline.





Key Facts:
Annual mean temperature: nd°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days





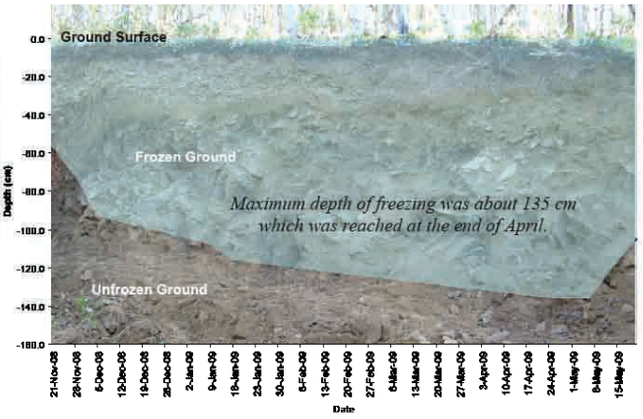
Yukon Geological Survey: P. Lipovsky and S. Laxton

Location: 62.22° N, 133.34° W

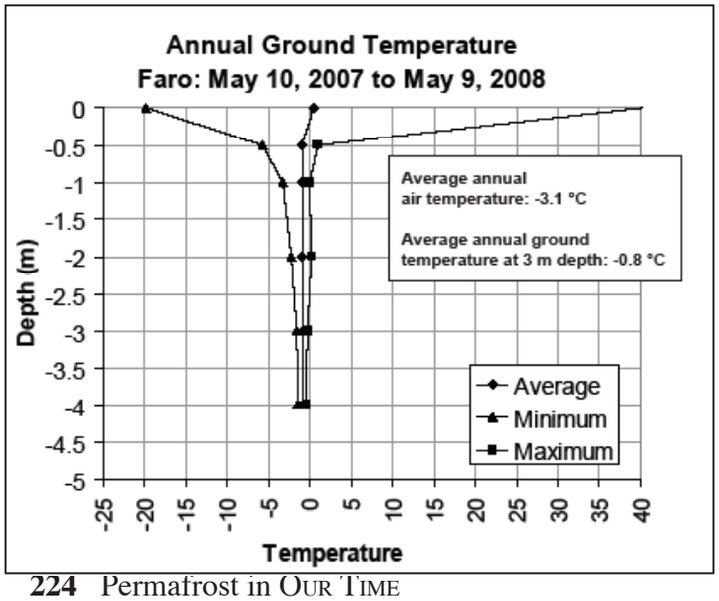
Faro

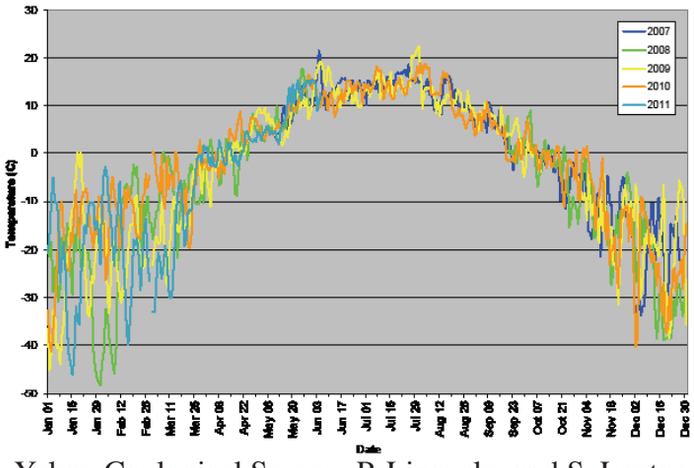
Yukon Territory, Canada

Faro, a community with 350 residents (Yukon Community Profiles, 2004), is located in the Pelly River Valley in the Anvil Mountains. Situated 356 kilometers (221 miles) northeast of Whitehorse, the town can be reached via the Robert Campbell Highway. The First Nations people of this area are the Kaska Dena of the Ross River. Faro developed in 1969 as a service town for a lead and zinc mine, located about 22 kilometers (14 miles) away. The community's population fluctuates, depending upon the status of the mine. In recent years, Faro's economy has included tourism and the arts.



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



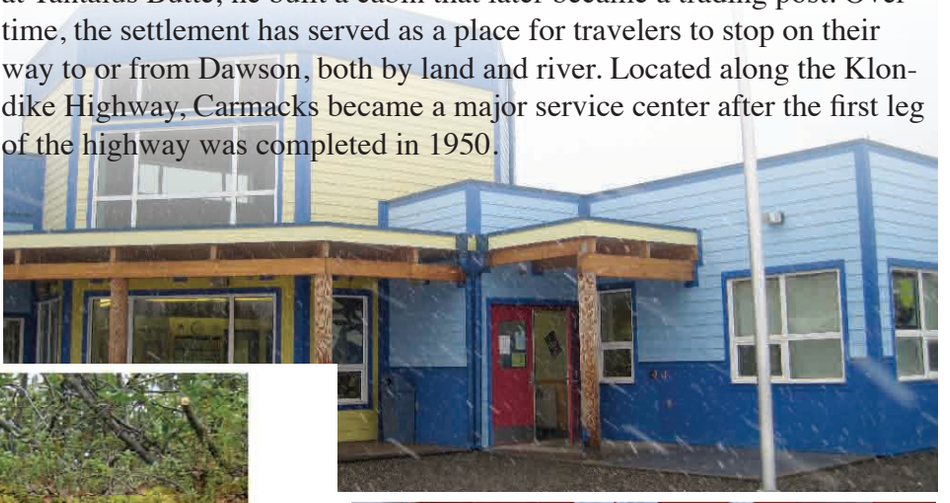


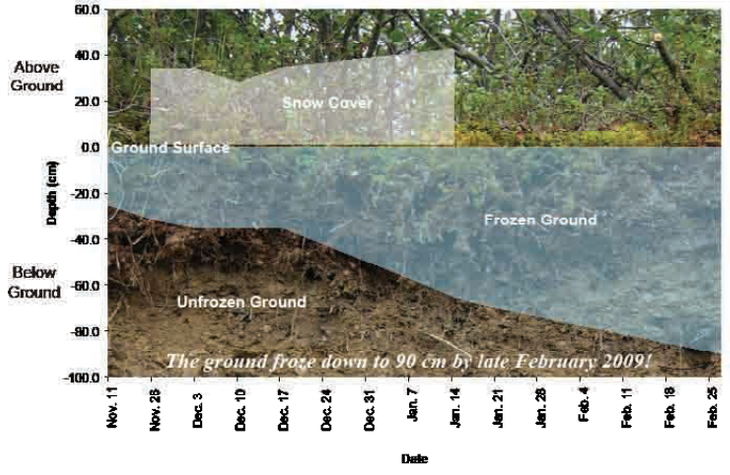
Yukon Geological Survey: P. Lipovsky and S. Laxton

Carmacks

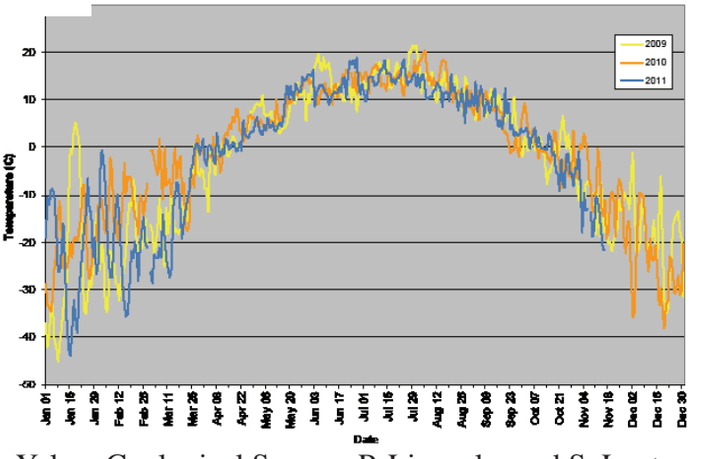
Yukon Territory, Canada

Carmacks, a community with 411 residents (Yukon Community Profile, 2004), is located at the confluence of the Yukon and Nordenskiold Rivers, 180 kilometers (112 miles) north of Whitehorse. The First Nations people of this area are Northern Tutchone. Interior and Northern Athabascans and the Coastal Tlingit used this meeting place of the two rivers as a trading stop on their river trade routes. The community of Carmacks takes its name from one of the people who discovered gold on the Klondike River near Dawson, George Carmack. Three years before the Klondike gold discovery in 1896, Carmack discovered a seam of coal near Carmacks at Tantalus Butte; he built a cabin that later became a trading post. Over time, the settlement has served as a place for travelers to stop on their way to or from Dawson, both by land and river. Located along the Klondike Highway, Carmacks became a major service center after the first leg of the highway was completed in 1950.





Frost tube data measured by Ms. Duncan's Grade 6/7 class in Carmacks show surface ground freezing patterns during the winter of 2008/2009.



Yukon Geological Survey: P. Lipovsky and S. Laxton

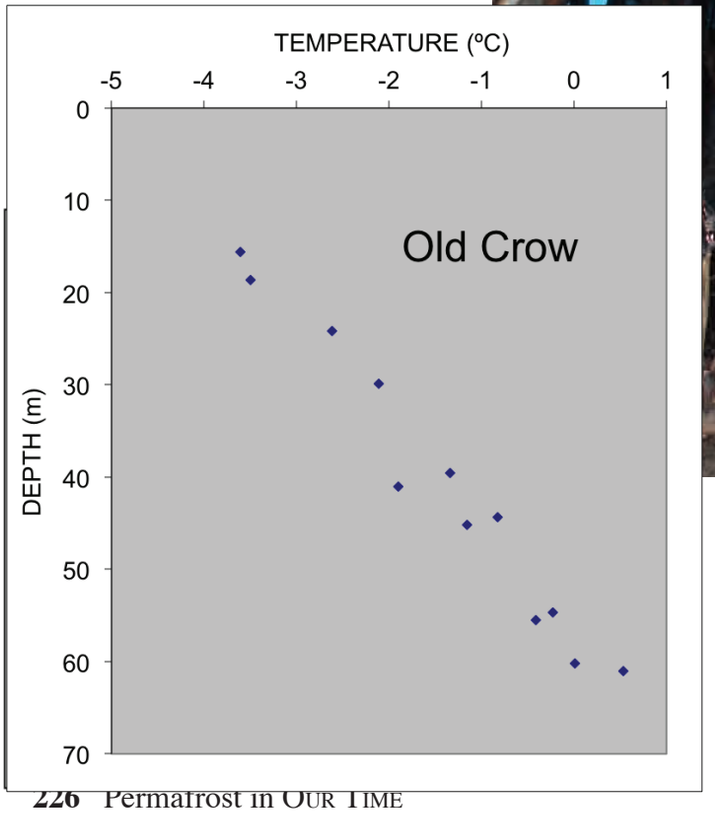
Location: 67.58° N, 139.82° W

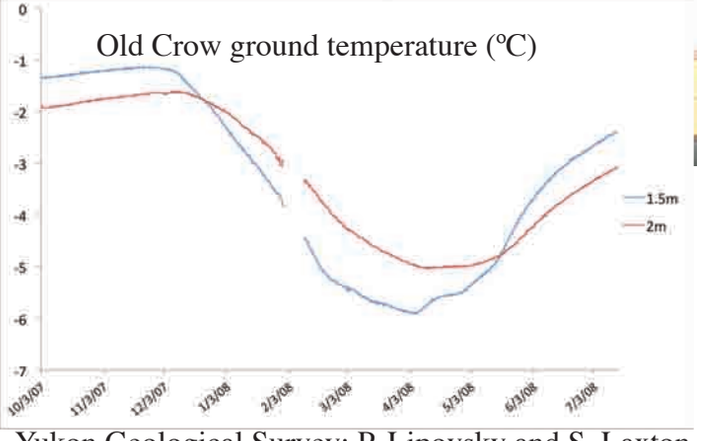
Old Crow

Yukon Territory, Canada

Old Crow, a community with 265 residents (Yukon Community Profiles, 2004), is located on the north bank of the Porcupine River, about 800 kilometers (497 miles) north of Whitehorse. Archaeological findings indicate human habitation in the area for over 15,000 years. The Vuntut Gwitchin are First Nations people here. The site of Old Crow, along the Porcupine River, was a traditional gathering, hunting, and trading location. In the 1950s, after a school and store were built, people began to settle at Old Crow, remaining year-round. In 1995, the Vuntut National Park, located nearby, was created. It and the Old Crow Flats, also located nearby, are jointly managed by the Canadian government and the Vuntut Gwitchin First Nation. The Porcupine Caribou herd figures importantly as a local food source.

Key Facts:
Annual mean ground temperature: °C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days





Yukon Geological Survey: P. Lipovsky and S. Laxton

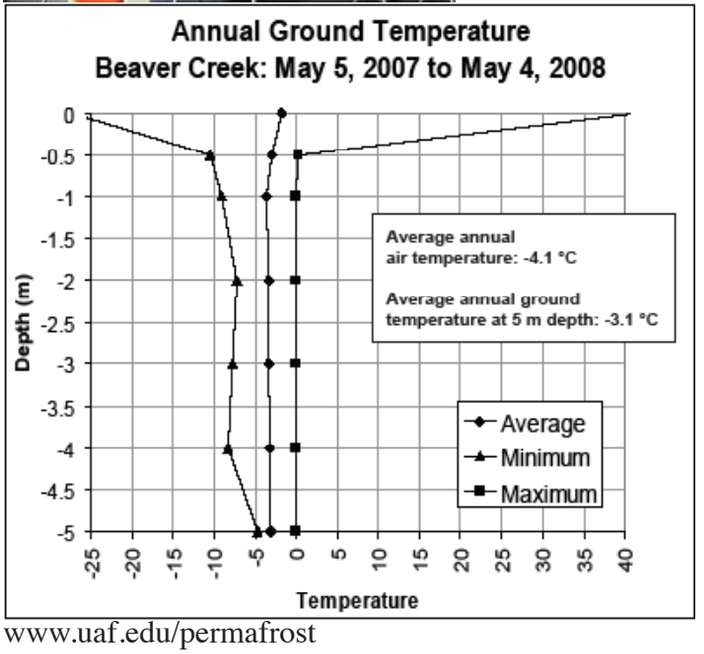
Location: 62.34° N, 140.84° W

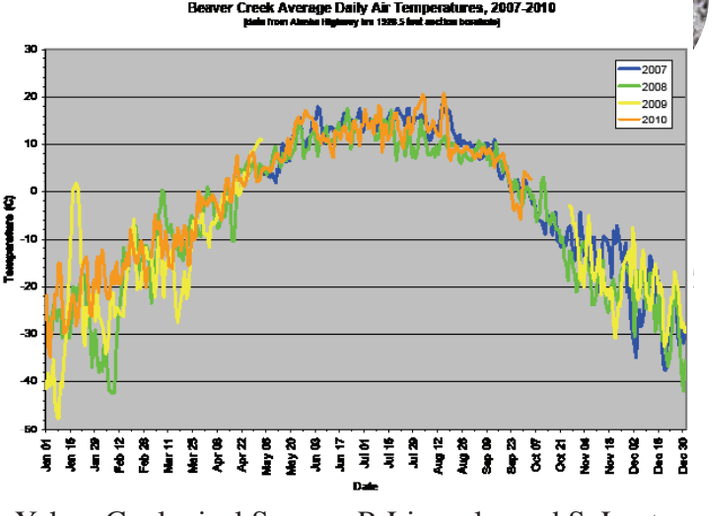
Beaver Creek, Destruction Bay

Yukon Territory, Canada

Beaver Creek, a community with 109 residents (Yukon Community Profiles, 2004), is located at Milepost 1202 on the Alaska Highway. The First Nations people of this area are Upper Tanana Athabascans. White River First Nation is based in Beaver Creek. When the border between Canada and Alaska was being surveyed in the early 1900s, Beaver Creek was established as a camp for workers. Miners took an interest in the area at about the same time. The town is on the route of the Alaska Highway, which was constructed in the 1940s. Beaver Creek is Canada's westernmost settlement. Its highway location, just 32 kilometers (20 miles) southeast of the Alaska-Canada border, serves as the site for a Canadian Customs post. The community is also a service center for highway travelers.

Destruction Bay, a community with 52 residents (Yukon Community Profiles, 2004), is located on the western shore of Kluane Lake, the largest lake in the Yukon Territory. The First Nations people of the Kluane Lake region are Southern Tutchone, a Kluane First Nations people who live mainly in southern Yukon Territory. Settlement at Destruction Bay began in the 1940s, while the Alaska Highway was being built; the site was used as a construction and maintenance center. The Alaska Highway passes by Destruction Bay at Milepost 1083.





Yukon Geological Survey: P. Lipovsky and S. Laxton

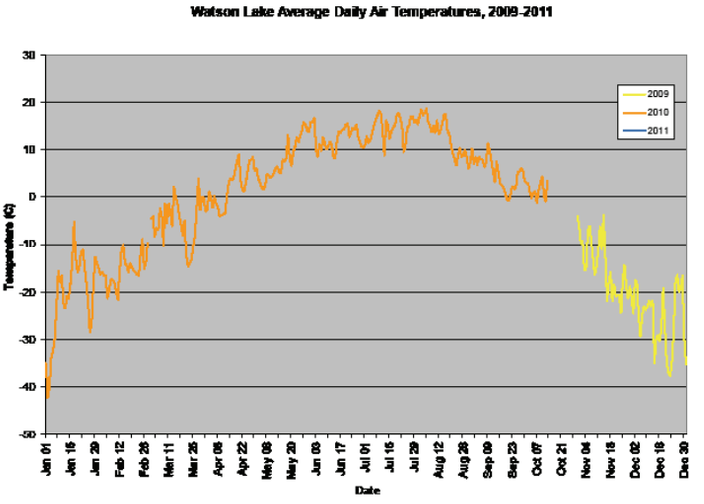
Location:60.15° N, 128.88° W

Watson Lake

Yukon Territory, Canada

Watson Lake, a town with 1,545 residents, is located in southeastern Yukon near the British Columbia border, about 455 kilometers (283 miles) northwest of Whitehorse. The Robert Campbell Highway, which begins at Watson Lake, and the Alaska Highway connect this town by road with the rest of the territory and beyond. The area around Watson Lake is the traditional lands of the Liard First Nation people. Watson Lake was established as a community in 1939, when the Canadian government built an airport there as one of a number of airports it was building across the north. The community served as a supply and service center for airport construction and, later, for highway construction when the Alaska Highway was built. Watson Lake is presently a service center for highway travelers and the region around it.

Key Facts:
Annual mean ground temperature: °C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days



Yukon Geological Survey: P. Lipovsky and S. Laxton

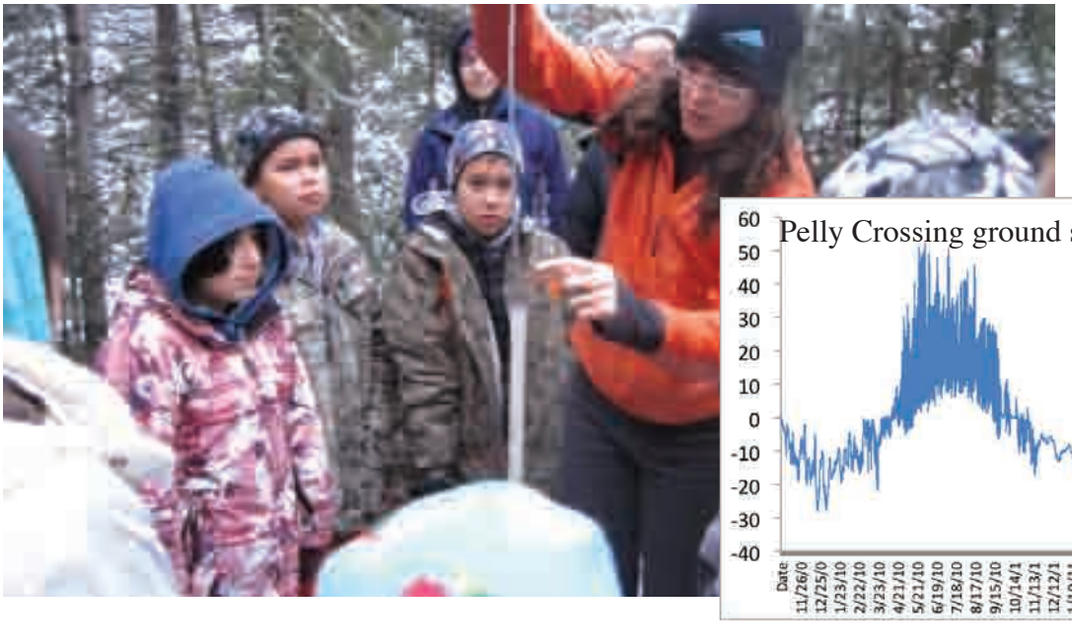
Location: 62.82° N, 136.57° W

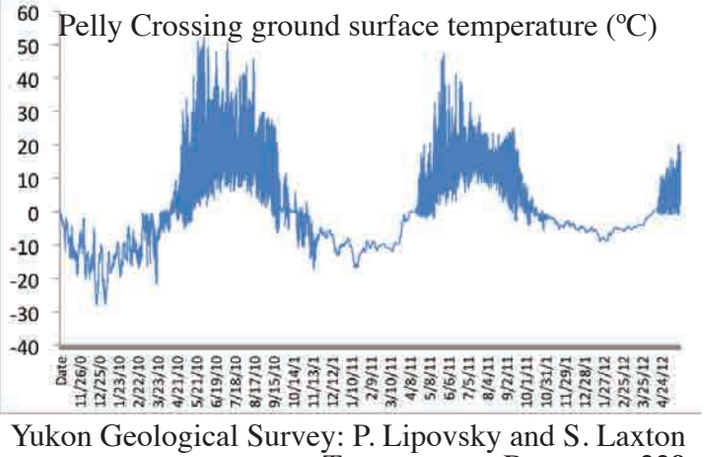
Pelly Crossing

Yukon Territory, Canada

Pelly Crossing, a community with 277 residents (Yukon Community Profiles, 2004), is located on the banks of the Pelly River, about 282 kilometers northwest of Whitehorse. The town is along the route of the Klondike Highway. This area is home to the Selkirk First Nation people. Their traditional use of this site on the Pelly River was as a campsite when traveling to Ta'Tla Mun (formerly Tatlain Lake). A homesteader and his family moved nearby in the early 1900s. Later, the construction of the Klondike Highway brought with it the establishment of a ferry crossing and a camp for workers.

Key Facts:
Annual mean ground temperature: °C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days





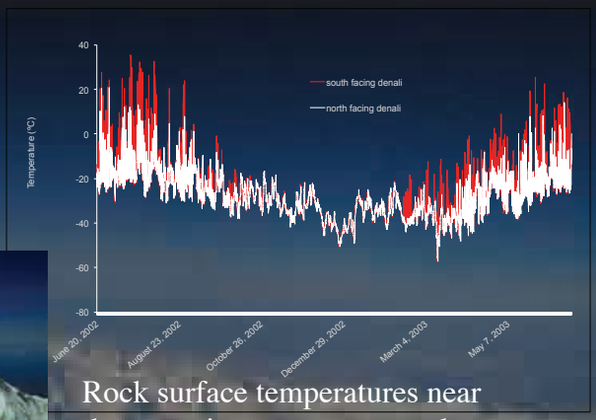
Yukon Geological Survey: P. Lipovsky and S. Laxton

Location: 63.08° N, 151.03° E

Denali

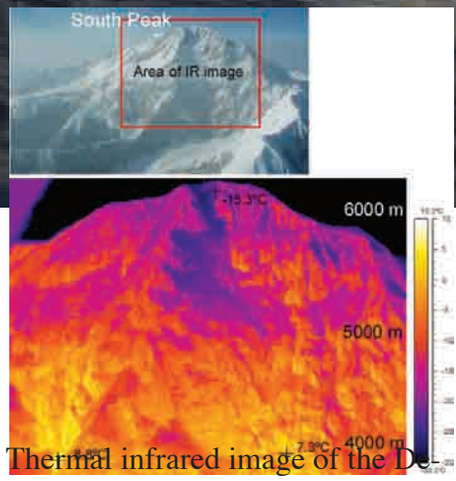
Coldest place (?) in the Arctic

Mount McKinley, or Denali (Koyukon Athabaskan for "The High One") is the highest mountain in North America, with a summit elevation of 6149m (20,320 feet) above sea level. In 1910, four locals (Tom Lloyd, Peter Anderson, Billy Taylor, and Charles McGonagall), known as the Sourdough Expedition, attempted McKinley despite a complete lack of climbing experience. They spent approximately three months on the mountain. However, their purported summit day was impressive: carrying a bag of doughnuts each, a thermos of hot chocolate, and a 14-foot (4.2 m) spruce pole, two of them reached the North Summit, the lower of the two, and erected the pole near the top. According to them, they took a total of 18 hours. No one believed their success (partly due to false claims that they had climbed both summits) until the true first ascent, in 1913. The first ascent of the main summit of McKinley came on June 7, 1913, by a party led by Hudson Stuck and Harry Karstens. The first man to reach the summit was Walter Harper, an Alaska Native. Robert Tatum also made the summit. Thier report confirmed the Sourdough ascent, and today it is widely believed that the Sourdoughs did succeed on the North Summit. However, the pole was never seen before or since, so there is still some doubt.



Rock surface temperatures near the summit area are extremely cold. The annual mean temperature reaches -26 ºC at the south facing wall and -27.6 ºC at the north facing wall. Compared with inland Antarctica, where the rock wall temperature is -21.6°C at the Ellesworth Mountains (81°S), this is the coldest place we have a datalogger!!

Since 1990, the Japan Alpine Club and Denali National Park and Preserve were maintained a weather station near Denali Pass. This is one of the highest meteolorogical stations in the world.



Thermal infrared image of the Denali's south buttress. Rock surface temperature indicated is -15 ºC near the summit on May 10, 2003.

Key Facts:
Annual mean ground temperature: -27.6°C
Freezing days: nd days
Freezing degree-days: nd °C days
Thawing degree-days: nd °C days

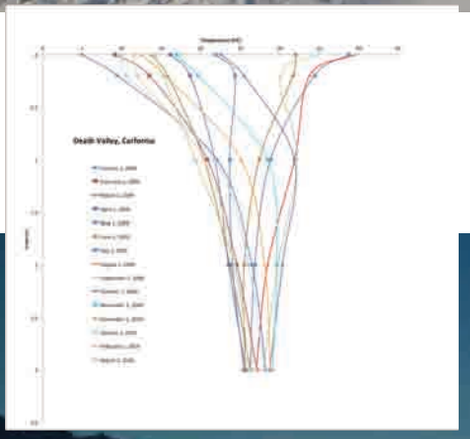
Vintage picture from our honored permafrost researcher Professor Leslie Viereck. This picture was his first successful ascent of the South Buttress of Denali in 1954. You can see a traditional triangle tent in front of the North Peak.

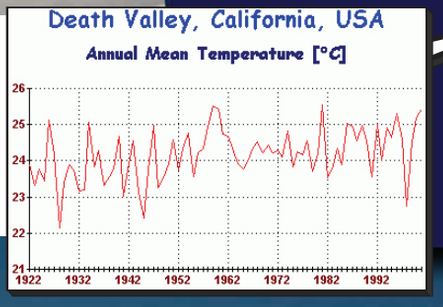
Searching for Permafrost

EXTREME TEMPERATURES ON EARTH

HOTTEST AIR TEMPERATURE EVER MEASURED IN WESTERN HEMISPHERE: DEATH VALLEY, CALIFORNIA.

COLDEST TOWN: OYMYAKON, RUSSIA, REACHED -71.2°C.

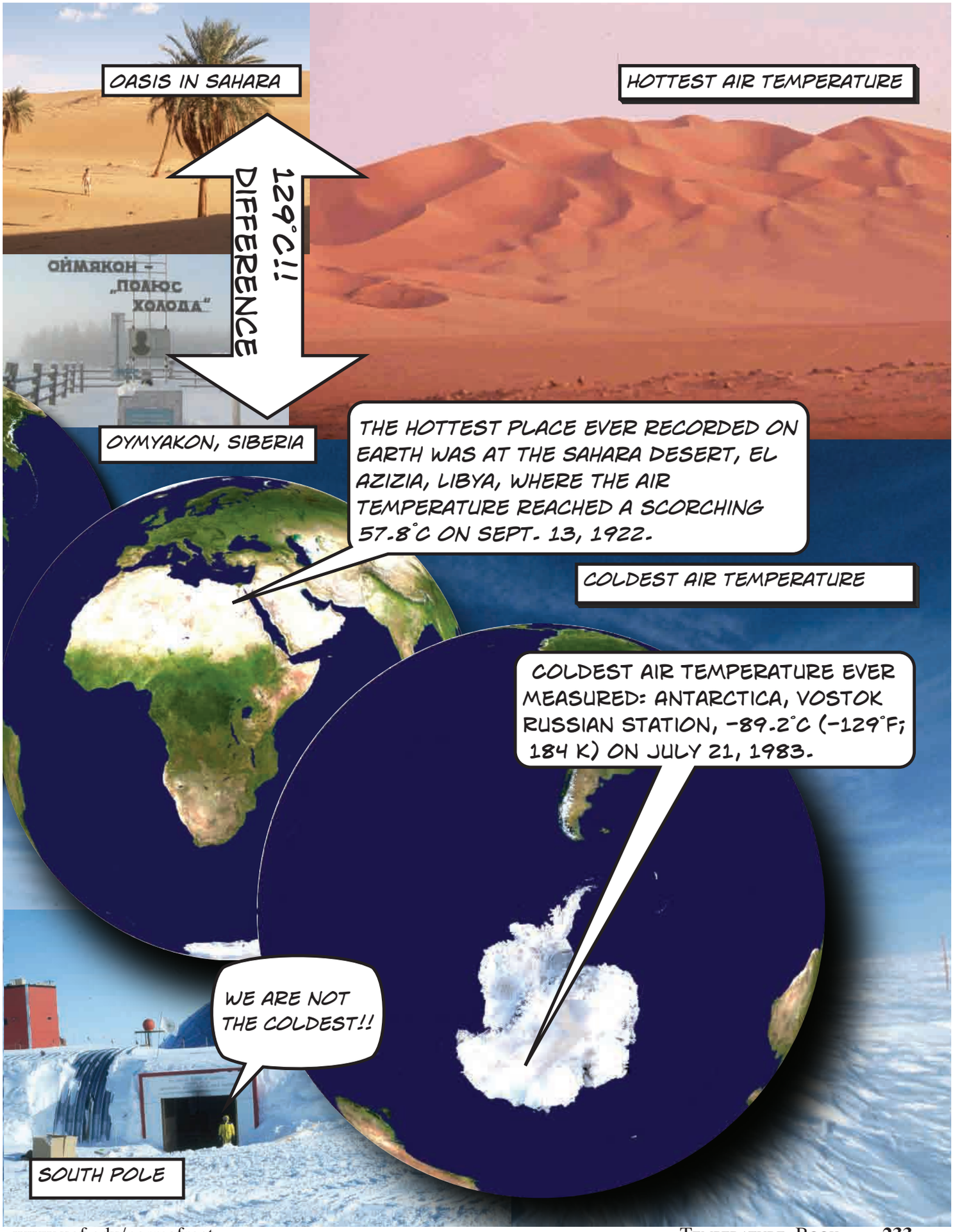


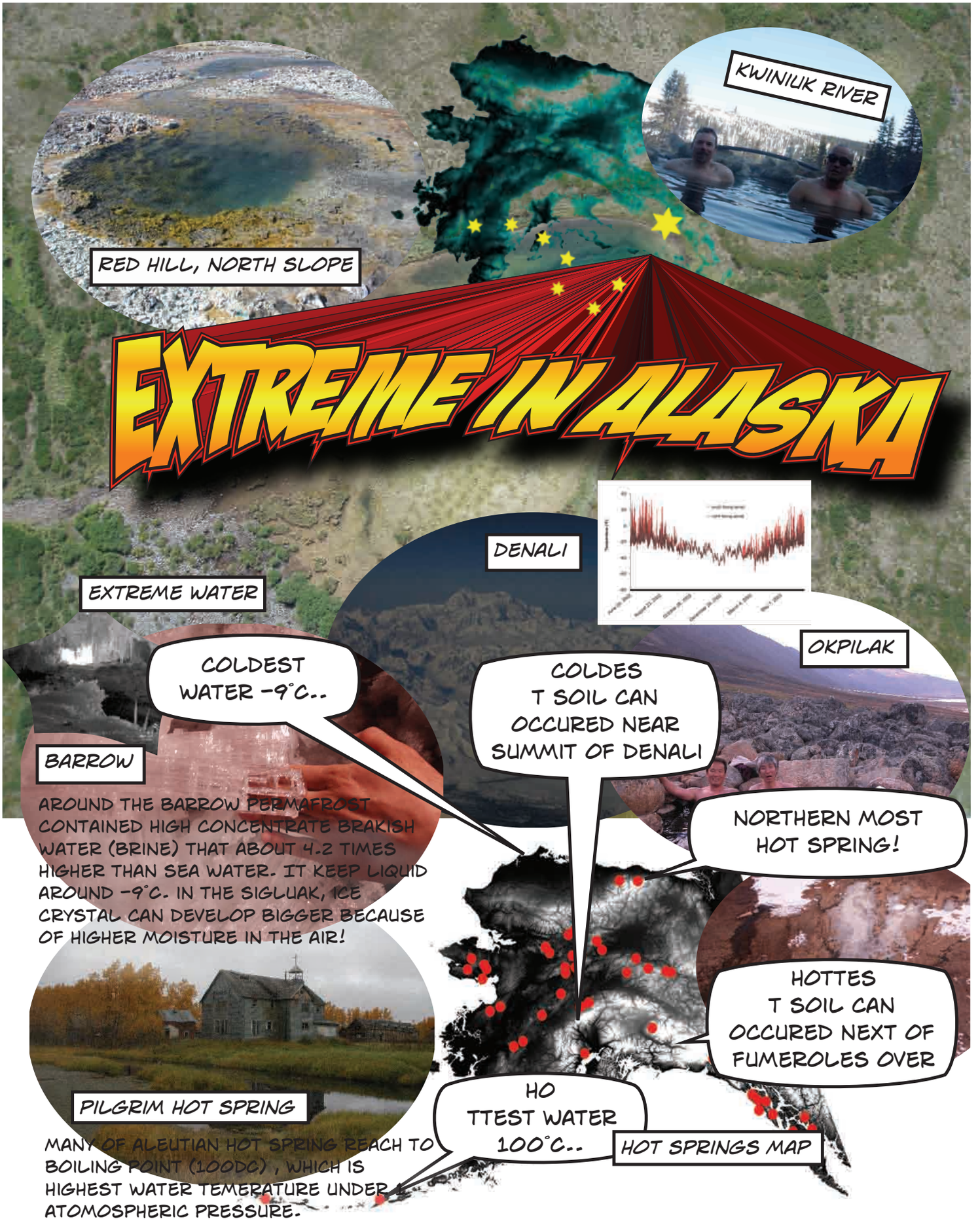


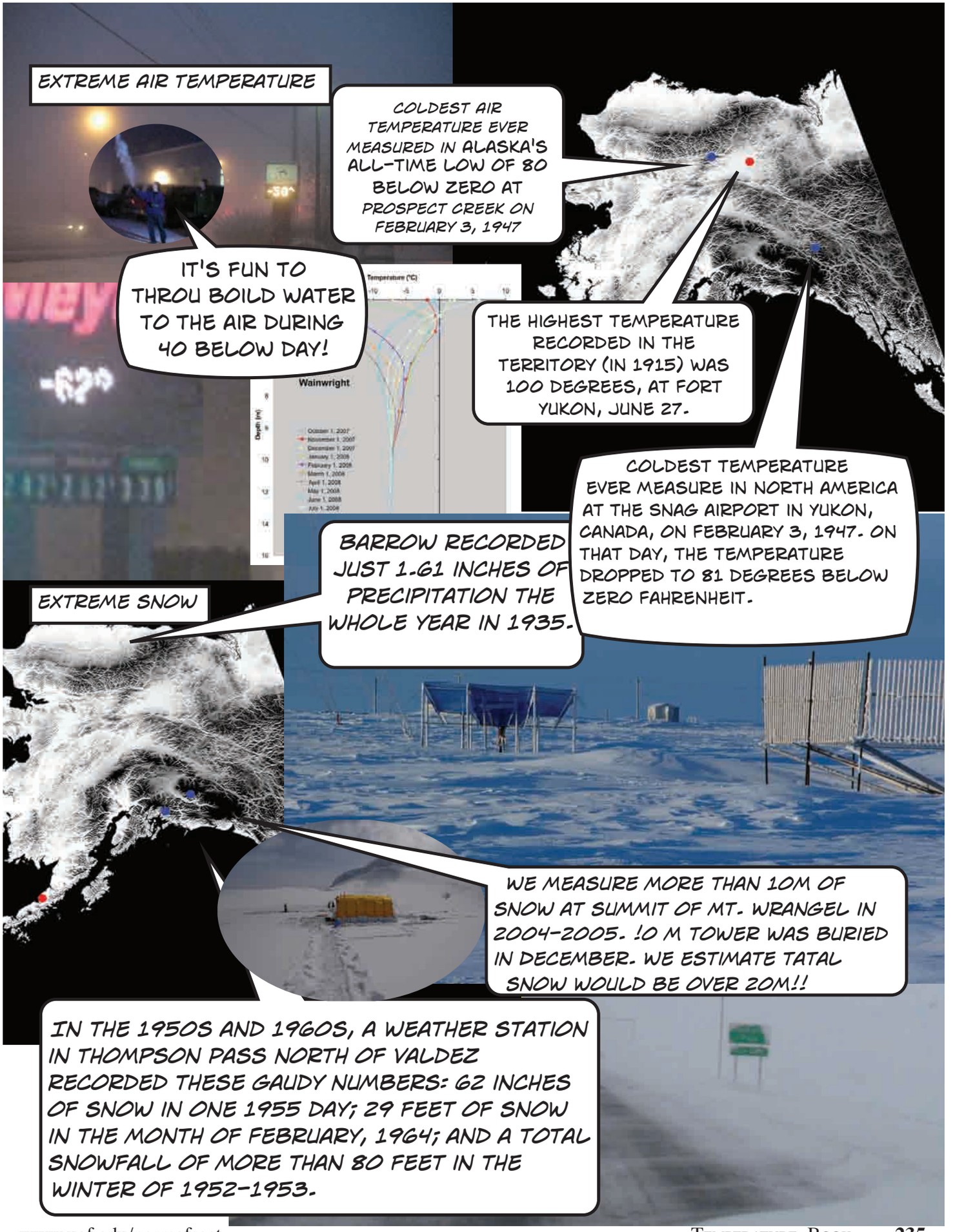
AT DEATH VALLEY, WE HAVE THREE GROUND SURFACE TEMPERATURE THERMOMETERS AND ONE 3 METER BOREHOLE.

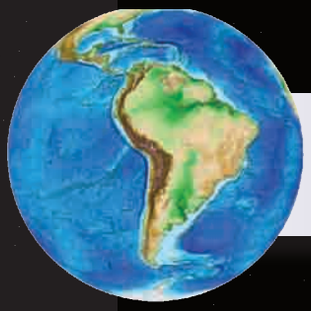
THE DRILL SITE IN DEATH VALLEY IS AT THE LOWEST ELEVATION IN THE WESTERN HEMISPHERE (85 METERS OR 290 FEET) BELOW SEA LEVEL). THE ANNUAL MEAN GROUND TEMPERATURE AT THE 2 METER DEPTH IS 26°C. THE SOIL IS SATURATED WITH BRACKISH GROUNDWATER, AND LOTS OF SALT IS EXTRACTED. INTERANNUAL GROUND TEMPERATURE VARIATIONS ARE BIG, DUE TO THE CONTINENTAL CLIMATE (5 TO 40 °C)

THE SECOND HOTTEST PLACE RECORDED ON EARTH WAS IN DEATH VALLEY, CALIFORNIA, USA, WHERE IT GOT UP TO 56.7 °C ON JULY 10, 1913.


OASIS IN SAHARA
HOTTEST AIR TEMPERATURE
129°C!!
DIFFERENCE
ОЙМЯКОН –
„ПОЛЮС
ХОЛОДА"
OYMYAKON, SIBERIA
THE HOTTEST PLACE EVER RECORDED ON EARTH WAS AT THE SAHARA DESERT, EL AZIZIA, LIBYA, WHERE THE AIR TEMPERATURE REACHED A SCORCHING 57.8°C ON SEPT. 13, 1922.
COLDEST AIR TEMPERATURE
COLDEST AIR TEMPERATURE EVER MEASURED: ANTARCTICA, VOSTOK RUSSIAN STATION, -89.2°C (-129°F; 184 K) ON JULY 21, 1983.
WE ARE NOT THE COLDEST!!
SOUTH POLE


KWINIUK RIVER
RED HILL, NORTH SLOPE
EXTREME IN ALASKA
DENALI
EXTREME WATER
COLDEST WATER -9˚C..
OKPILAK
COLDES T SOIL CAN OCCURED NEAR SUMMIT OF DENALI
BARROW
AROUND THE BARROW PERMAFROST CONTAINED HIGH CONCENTRATE BRAKISH WATER (BRINE) THAT ABOUT 4.2 TIMES HIGHER THAN SEA WATER. IT KEEP LIQUID AROUND -9˚C. IN THE SIGLUAK, ICE CRYSTAL CAN DEVELOP BIGGER BECAUSE OF HIGHER MOISTURE IN THE AIR!
NORTHERN MOST HOT SPRING!
HOTTES T SOIL CAN OCCURED NEXT OF FUMEROLES OVER
PILGRIM HOT SPRING
MANY OF ALEUTIAN HOT SPRING REACH TO BOILING POINT (100DC) , WHICH IS HIGHEST WATER TEMERATURE UNDER ATOMOSPHERIC PRESSURE.
HO TTEST WATER 100˚C..
HOT SPRINGS MAP


EXTREME AIR TEMPERATURE
COLDEST AIR TEMPERATURE EVER MEASURED IN ALASKA'S ALL-TIME LOW OF 80 BELOW ZERO AT PROSPECT CREEK ON FEBRUARY 3, 1947
IT'S FUN TO THROU BOILD WATER TO THE AIR DURING 40 BELOW DAY!
THE HIGHEST TEMPERATURE RECORDED IN THE TERRITORY (IN 1915) WAS 100 DEGREES, AT FORT YUKON, JUNE 27.
COLDEST TEMPERATURE EVER MEASURE IN NORTH AMERICA AT THE SNAG AIRPORT IN YUKON, CANADA, ON FEBRUARY 3, 1947. ON THAT DAY, THE TEMPERATURE DROPPED TO 81 DEGREES BELOW ZERO FAHRENHEIT.
Wainwright
BARROW RECORDED JUST 1.61 INCHES OF PRECIPITATION THE WHOLE YEAR IN 1935.
EXTREME SNOW
WE MEASURE MORE THAN 10M OF SNOW AT SUMMIT OF MT. WRANGEL IN 2004-2005. !0 M TOWER WAS BURIED IN DECEMBER. WE ESTIMATE TATAL SNOW WOULD BE OVER 20M!!
IN THE 1950S AND 1960S, A WEATHER STATION IN THOMPSON PASS NORTH OF VALDEZ RECORDED THESE GAUDY NUMBERS: 62 INCHES OF SNOW IN ONE 1955 DAY; 29 FEET OF SNOW IN THE MONTH OF FEBRUARY, 1964; AND A TOTAL SNOWFALL OF MORE THAN 80 FEET IN THE WINTER OF 1952-1953.

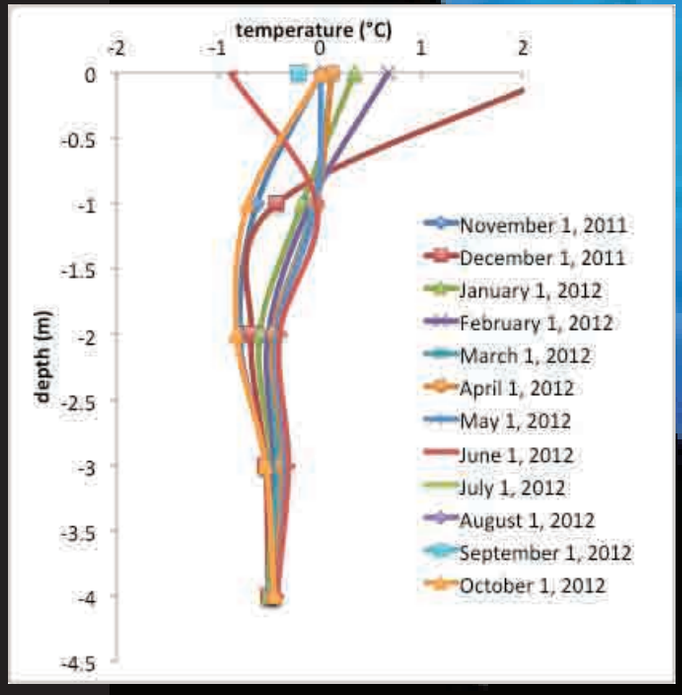


South America
the Andes

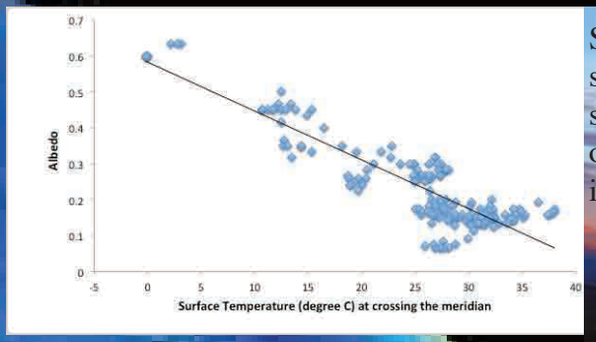
The Andes is the longest continental mountain range in the world. It is a continual range of highlands along the west coast of South America. This range is about 7,000 km long and the average height is about 4,000 m. The Andes extend from north to south through seven South American countries: Venezuela, Columbia, Ecuador, Peru, Bolivia, Chile and Argentina. The highest peak, Mount Aconcagua, rises to an elevation of about 6,962 m (22,841 ft) above sea level. The peak of Chimborazo in the Ecuadorean Andes is farther from Earth's center than any other location on Earth's surface, due to the equatorial bulge that results from the planet's rotation. The world's highest volcanoes are in the Andes, including Ojos del Salado on the Chile-Argentina border which rises to 6,893 m (22,615 ft). Over 50 other Andean volcanoes also rise above 6,000 m (19,685 ft). Permafrost is commonly seen above 5,500 meters in tropical regions (Peru, Bolivia), and at lower elevations in Argentina and Chile, including many rock glaciers. Volcanic activities (that is, whether a volcano is active or not) is one of the most important parameters for the presence or absence of permafrost, because most of the high mountains in the Andes are in many cases also volcanoes. In these peaks, higher heat flow causes the ground to stay warmer (sometimes more than 10°C) in spite of the cold annual mean air temperature.

Mexico is not Andes countries, but has higher mountain over 5000m presence of permafrost

permafrost station at 5300m Nevado Coropuna



Nevado Chachani (6,057 m) is the highest of the mountains near the city of Arequipa in southern Peru. Volcanic activity has not been observed recently, and permafrost is present at elevations above 5,350m on south-facing slopes and rock glaciers. The permafrost temperature at our monitoring site is -0.4°C. Soil materials at the borehole site are white and tufted in appearance with many pore spaces; these pore spaces are often filled in with ice. Daily freeze thaw cyccle reached less than 20cm during summer months.

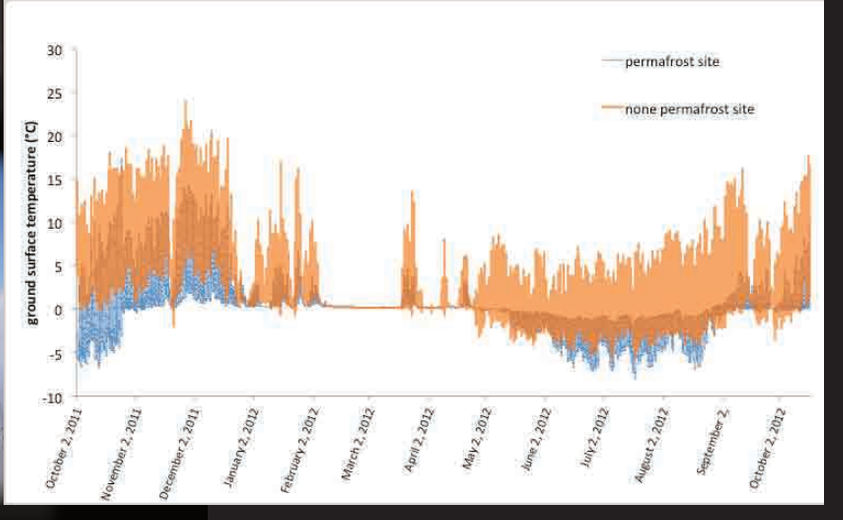


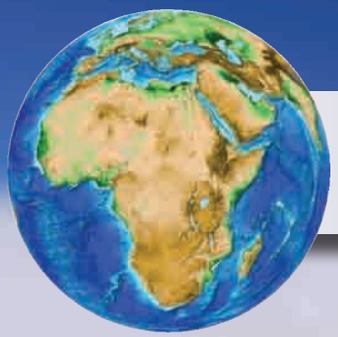
Surface albedo is also important in tropical mountains. When solar rays strike the ground in tropical regions, they have a much stronger effect than in Polar Regions. Darker surfaces absorb lots of heat, and white surfaces are usually a good hint that permafrost is present.

Glaciares de escombros, Valle del Strelkov (Trombotto, 1996)

Dry and wet seasons are important to stabilized permafrost. Depending on whether permafrost was absent or present, our monitoring sites showed big ground surface temperature differences due to snow cover periods. A permafrost site will be snow-covered almost all winter, and the ground stays at negative temperatures (see graph below).

Freeze-thaw cycles making patterned ground, very commonly seen stripes in tropical high mountains

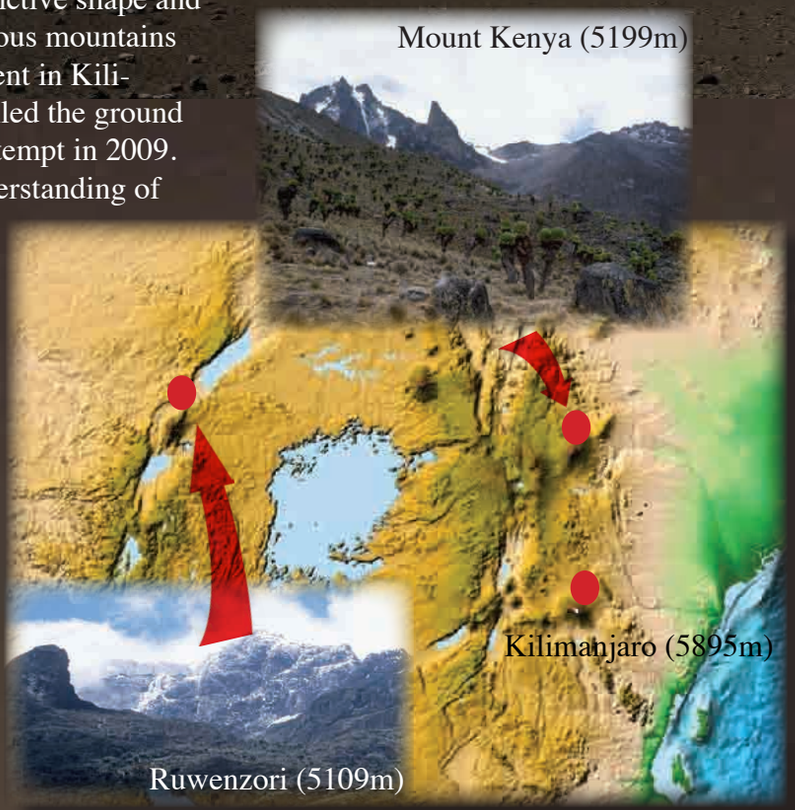


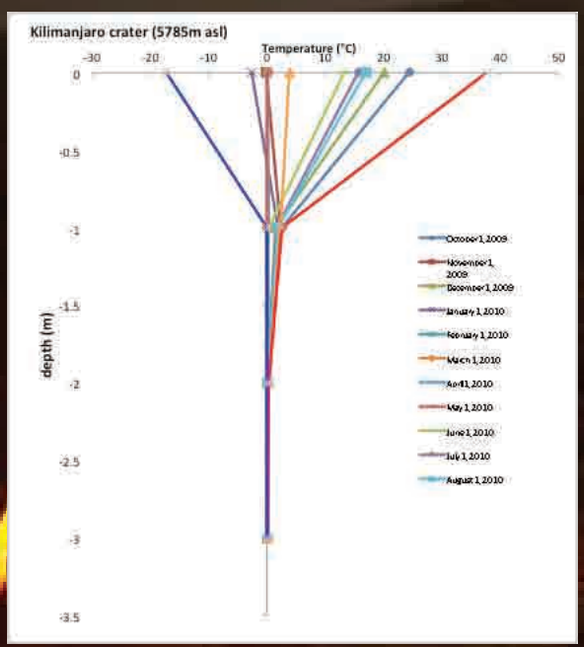


Africa
Kilimanjaro

Snows and glaciers of Kilimanjaro: Maybe everybody has heard of them at least once. Mount Kilimanjaro, with its big, distinctive shape and unique location along the equator, is one of the most famous mountains in the world. However, whether or not permafrost is present in Kilimanjaro is almost unknown, because no one had ever drilled the ground around the summit area – before us! We made our first attempt in 2009. We did definitely find permafrost, we gained a better understanding of the thermal state of the ground of this mountain.

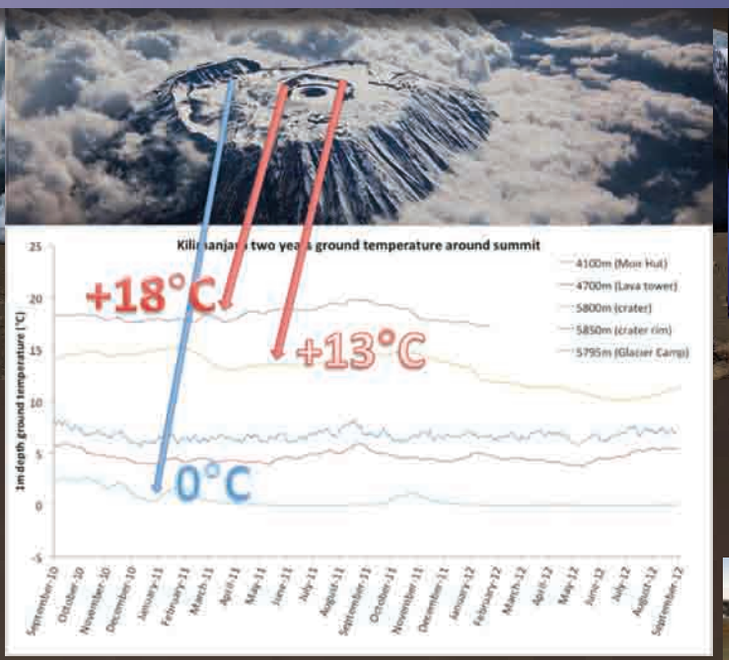
There are three mountains in Africa that have glaciers: Mount Kilimanjaro (5,895m), Mount Kenya (5,199m), and Ruwenzori (5,109m). All three are close to each other, located around Lake Victoria near the equator. It seems only Kilimanjaro could support stable permafrost, which usually appears only at elevations higher than 5,500m, in equatorial regions. The presence of the glaciers is most likely due to higher precipitation than to temperature factors.



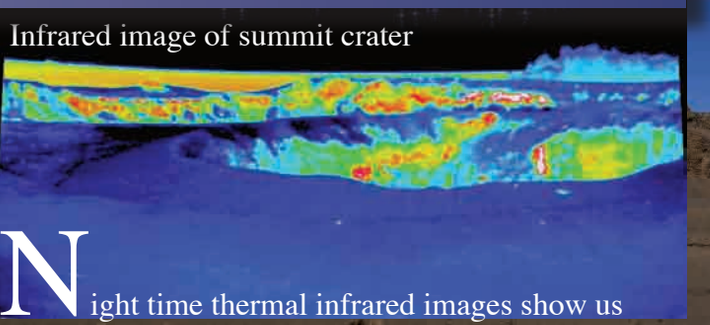


Permafrost Permafrost is very critical here around the summit area. One of our temperature monitoring sites shows that 3 meters below the ground surface the temperature is -0.03°C all year around. This means simply that the thawing/freezing temperature is controlled by latent heat. The trumpet curve of the temperature profiles is very different than that of the Arctic region. Kilimanjaro really doesn't have big seasonal changes, so there almost no seasonal temperature fluctuations like the ones we see in the Arctic, where there can be more than a 50-60°C difference between summer and winter. On the other hand, Kilimanjaro does have big daily fluctuations of 40 to 50°C difference between day and night. Sunshine controls a lot here.

Location: 3.8° S, 37.35° E



Kilimanjaro is a large stratovolcano. Two of its three peaks, Mawenzi and Shira, are extinct while Kibo (the highest peak) is dormant and could erupt again. The last major eruption has been dated to between 150,000 and 200,000 years ago.
Although it is dormant, Kibo has fumaroles that emit gas in the crater. Several collapses and landslides have occurred on Kibo in the past, one creating the area known as the Western Breach.

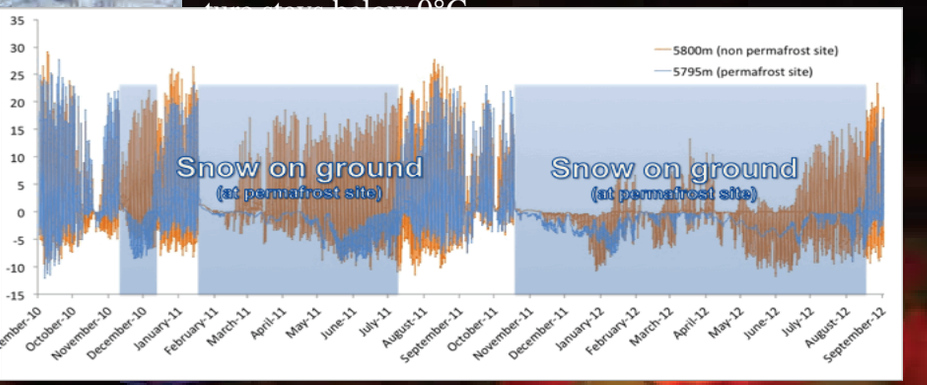


Infrared image of summit crater

Night time thermal infrared images show us several hot spots (above). The summit crater rim and inside is more than 30°C (red-orange color). Even the crater floor (blue color: colder than 0°C) is very warm (10-20°C) at 1m below ground (left graph). Permafrost is unlikely to be present near the crater.

Visible image of summit crater

Snow is very important to the thermal state in Kilimanjaro as well as other tropical mountains. Solar radiation is very strong; usually ground surface temperatures exceed 40°C when the sun hits the ground. When snow covers the ground, even the air tempera-

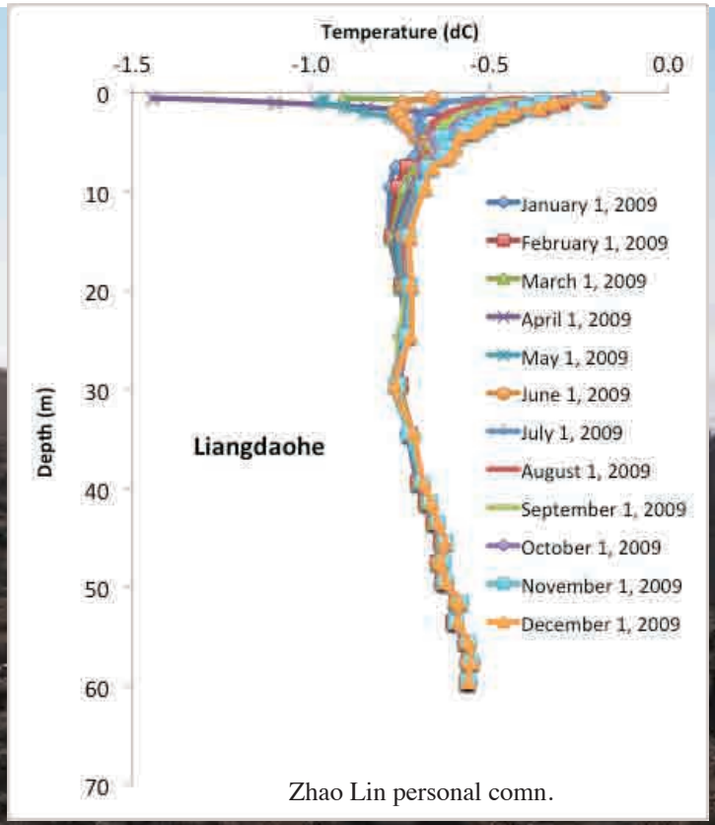


Tibet - Central Asia

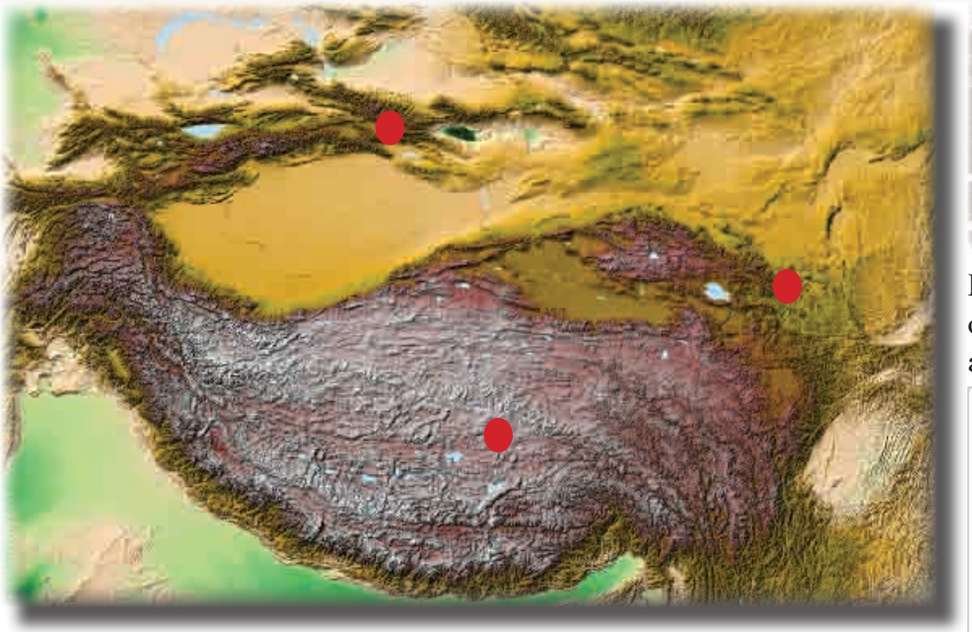
China

Tibetan Plateau is surrounded by massive mountain ranges. The plateau is bordered to the south by the Himalayan range, to the north by the Kunlun Mountains which separate it from the Tarim Basin, and to the northeast by the Qilian Mountains which separates the plateau from the Hexi Corridor and Gobi Desert. To the east and southeast the plateau gives way to the forested gorge and ridge geography of the mountainous headwaters of the Salween, Mekong, and Yangtze rivers in western Sichuan (the Hengduan Mountains) and southwest Qinghai. In the west the curve of the rugged Karakoram range of northern Kashmir embraces it. The Tibetan Plateau is bounded on the north by a broad escarpment where the altitude drops from around 5,000 metres (16,000 ft) to 1,500 metres (4,900 ft) in less than 150 kilometres (93 mi). Along the escarpment is a range of mountains. In the west the Kunlun Mountains separate the plateau from the Tarim Basin. The line of mountains continues east of the plateau as the Qin Mountains which separate the Ordos Region from Sichuan. Permafrost is present generally at altitudes of 4100-4500m above sea level. Permafrost at lower altitudes is a little higher on south facing slopes.

The plateau is a high-altitude arid steppe interspersed with mountain ranges and large brackish lakes. Annual precipitation ranges from 100 to 300 millimetres (3.9 to 12 in) and falls mainly as hailstorms. The southern and eastern edges of the steppe have grasslands which can sustainably support populations of nomadic herdsmen, although frost occurs for six months of the year. Permafrost occurs over extensive parts of the plateau. Proceeding to the north and northwest, the plateau becomes progressively higher, colder and drier, until reaching the remote Changthang region in the northwestern part of the plateau.



Zhao Lin personal comn.

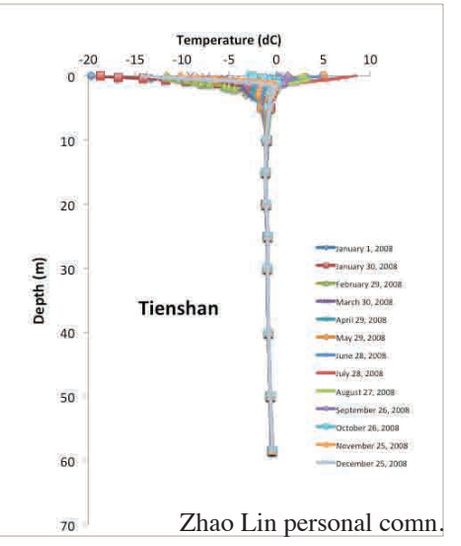


On the Tibetan Plateau, permafrost at lower latitudes is present and widely distributed. Over most of the plateau, the permafrost is about 100 meters thick and the temperature is warmer than -1°C. The permafrost area spreads across not only China, but also India, Nepal, Afghanistan and Kyrgyzstan, and Kazakhstan (in the Tienshan Mountains).

www.uaf.edu/permafrost

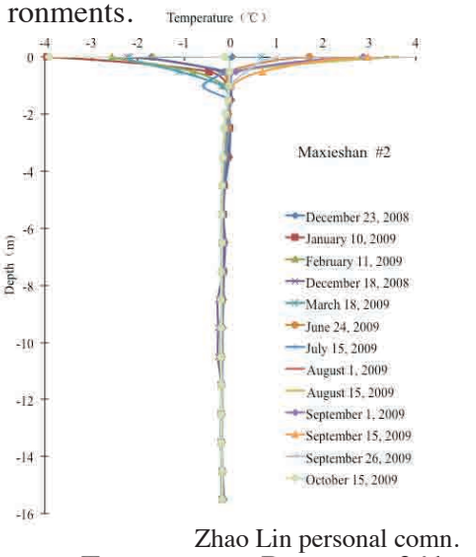
Around the Himalayas, several lisalthas, icing (aufeis), and rock glaciers are observed at glacier retreated U-shape valley bottom. At the mountain such as Mt Everest (8848m), frozen bedrock had severely weathered by freeze-thaw cyclies. Limestone band (Yellow band) is patecullaly intence weathering.

Mashan is located at the east end of this region and has permafrost at altitudes higher than 3500 m above



Zhao Lin personal comn.

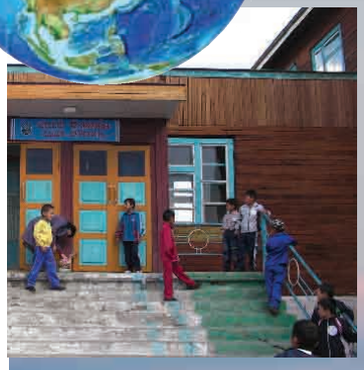
Permafrost in the Tienshan Mountains is well-studied. The lower limit of the permafrost is 4000m on south facing slopes, and 3500m on north facing slopes. Strong solar radiation causes asymmetric environments.



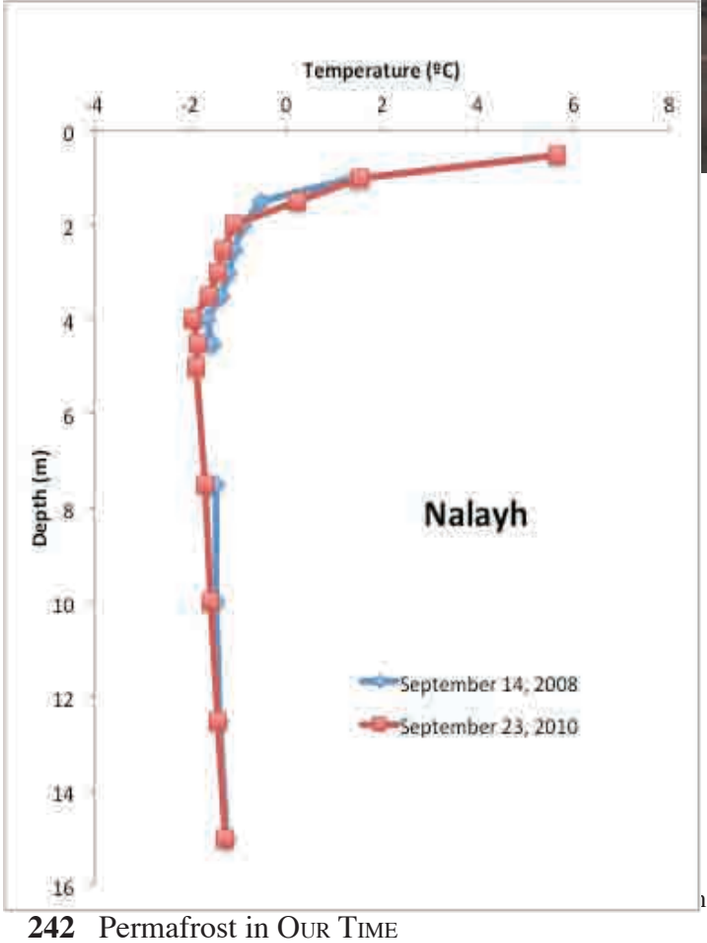
Zhao Lin personal comn.

Southern Siberia-Central Asia

Altai - Hangay Mountains, Mongolia



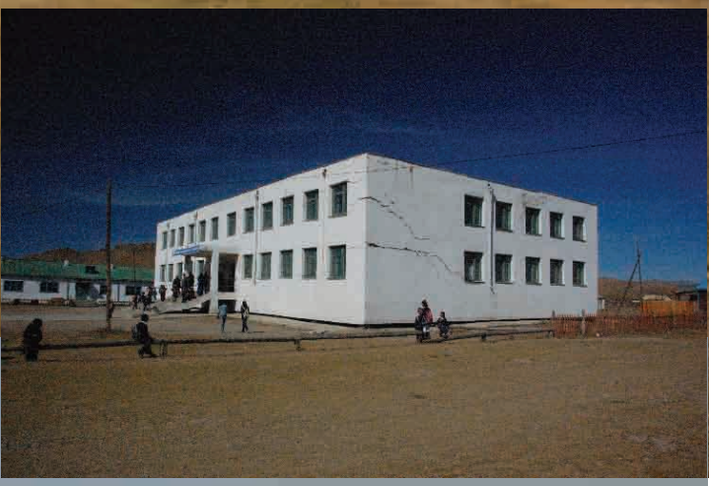
Permafrost distribution in Mongolia occupies almost two thirds of Mongolia, predominantly in the Khentei, Hovsgol, Khangai and Altai mountains and surrounding areas. The territory is characterized by mountain and arid-land permafrost, sporadic to continuous in its extent, and occupies the southern fringe of the Siberian permafrost zones. Most of the permafrost is at temperatures close to 0°C, and thus, is thermally unstable.



Initial results of thermal monitoring in six of the 13 boreholes indicate that the mean annual permafrost temperatures per decade, was increased by 0.05–0.15°C in the Khentei and Khangai mountains and by 0.15–0.25°C in the Hovsgol mountain regions. The rate of temperature change is higher on south-facing slopes than on north-facing ones, and temperature increases in ice-poor permafrost are more pronounced than in ice-rich permafrost. The average geothermal gradient is about 2°C per 100 m, decreasing towards the surface due to recent warming. The lower limit of continuous permafrost on south-facing slopes ranges from 1400 to 2000 m in the Hovsgol and Khentei mountains, and from 2200 to 3200 m in the Altai and Khangai mountains. The lowest limit of sporadic permafrost is found between 600 and 700 m a.s.l.

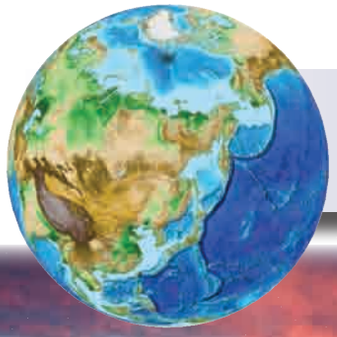
In the continuous and discontinuous permafrost areas, taliks are found on steep south-facing slopes, under large river channels and deep lake bottoms, and along tectonic fractures with hydrothermal activity. In sporadic and isolated permafrost areas, frozen ground is found only on north-facing slopes and in fine-grained and moist deposits.

Perennial frost mounds are widespread in both large and small intermountain lake basins in Mongolia. They are found in areas where permafrost is geographically discontinuous, as well as those underlain by continuous permafrost.

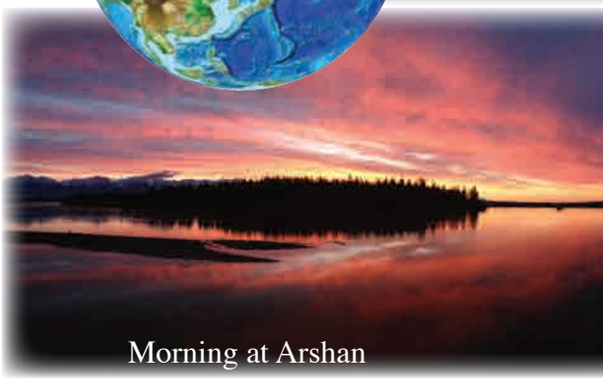


Cryogenic processes such as frost heaves, cracks, icing, thermokarst, solifluction and stone polygons have developed everywhere in the permafrost zone of Mongolia.

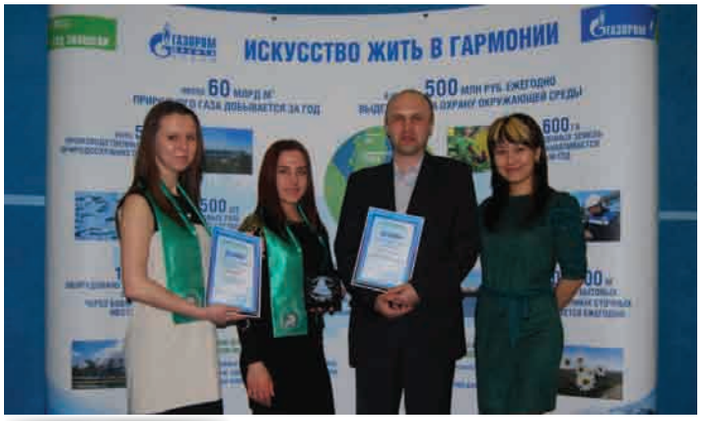
Permafrost monitoring shows that permafrost in Mongolia is degrading at various, but considerable rates depending on the local natural conditions. Permafrost, especially sporadic and isolated, is very sensitive to climate change and human activities. Besides climate warming, factors of permafrost degradation are deforestation on the taiga and desertification in the steppe zones of Mongolia. Permafrost monitoring in this areas is, therefore, of both scientific and practical importance.



Siberia
Russia


Morning at Arshan

Siberian permafrost contributes the biggest portion of the world's total permafrost. Characteristics for this permafrost vary from warm to cold and from very thin (less than a few m) to the very thickest (over 1000m). Currently (in 2013) 33 schools located in both eastern and western Siberia participate in our network. Permafrost is thin or absent in the glaciated area created during the Last Glacier Maximum, which makes up most of western Siberia. Subsea permafrost is also widely present in the north, offshore of the Arctic Coast.

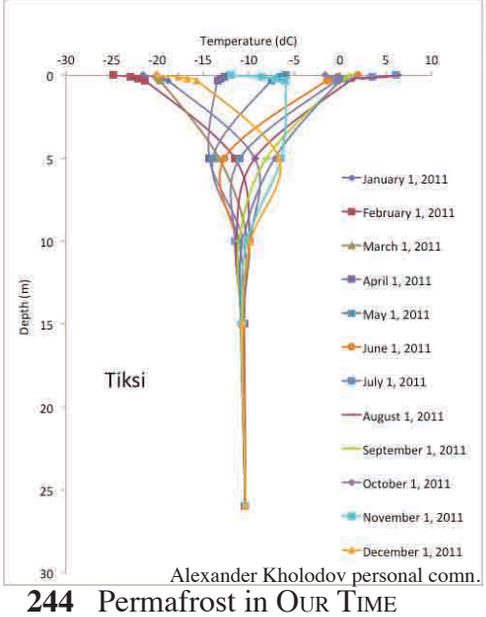


At Sludyanka

Frost tube in Russian schools - a reward schoolgirls and their head of Novy Urengoy the Second Yamal Environmental Forum in April 2013.

Old Chara school

retired geography teacher join us at Butakovo school

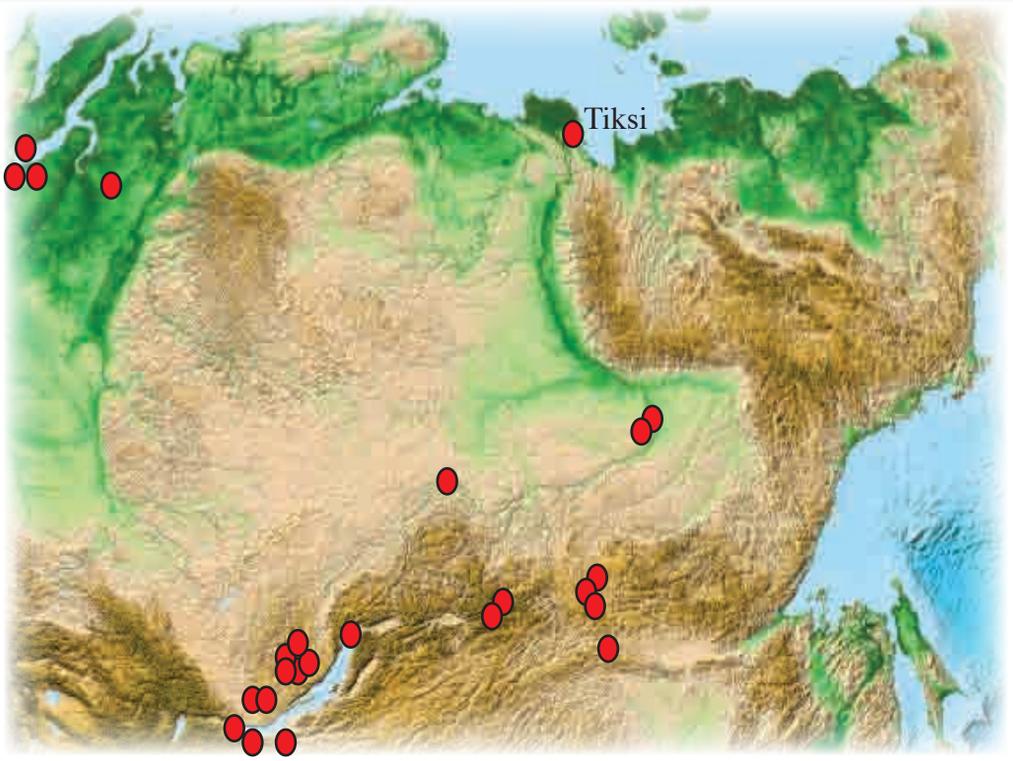


Alexander Kholodov personal comn.

The northern coastal islands (Novosibirisk Islands) are one of the coldest permafrost areas in Siberia. The Tiksi trumpet curve (on the left) indicates temperatures of -11°C at zero annual amplitude. Tiksi is located at the mouth of the Lena River. Interestingly, Oymyakon (one of the coldest places in the Northern Hemisphere: -72°C minimum) does not have the coldest permafrost temperature, thanks to the area's very hot summer temperatures.

Labitnangi school

Verkholensk school



Permafrost/Active Layer monitoring program in Siberia was establish in 2012. We plan to expand to more areas in the future.

#1 Yakutsk school

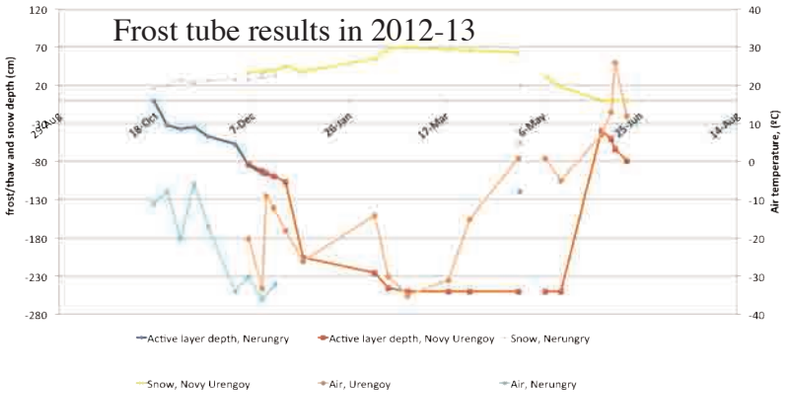
#14 Yakutsk school

Khatimi school

Lensk school

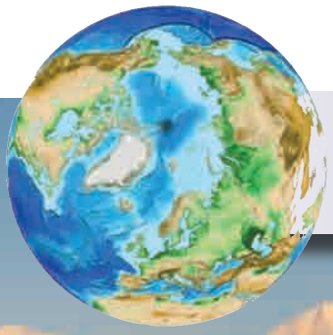
Children's Environmental Station in Novy Urengoy

Iengra: one of the indigenous people's communities



First frost tube results from Novy Urengoy (western Siberia) and Nerungry (eastern Siberia)

Julia Stanilovskaya personal comn.

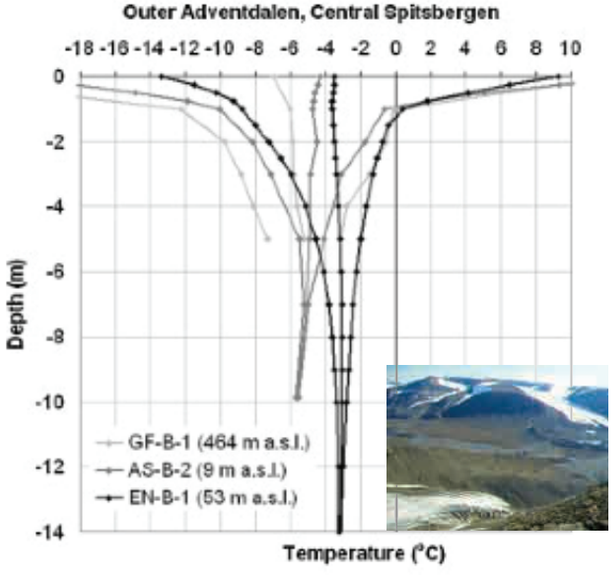


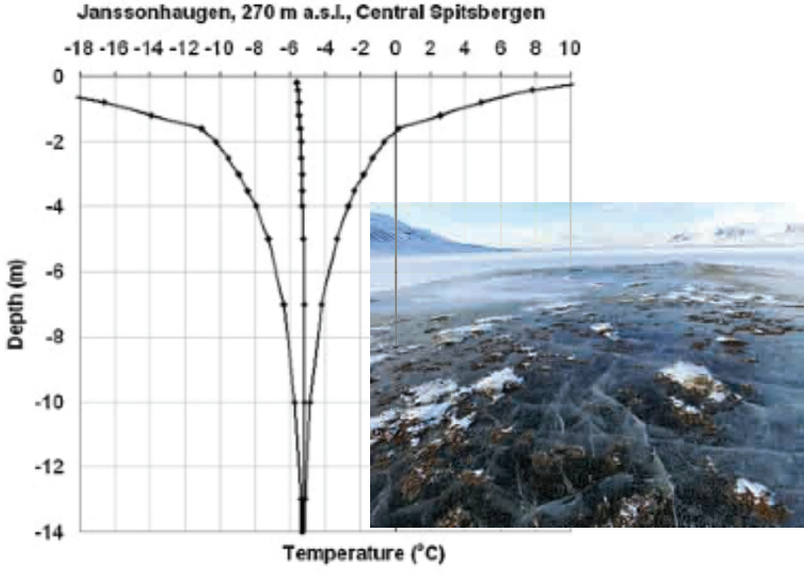
Scandinavia -Svalbard

Norway, Sweden, Finland

Svalbard, Norway; Longyearbyen School
On February 28 2008 a borehole was drilled close to Longyearbyen School (elementary to high-school) as part of the IPY TSP Norway project with the purpose of monitoring temperature in the permafrost. The hole was drilled about 100m south of the school to a depth of nearly 10m. A hammer drill rig was used. A weasel tracked vehicle was used to pull the rig and a compressor at the drill site.

Site description
-The drill site is in the dry part of the river plain of the Longyearelva river, with coarse densely packed glaciofluvial sediments.
-The site has a thin snowcover in wintertime
-There is no vegetation and no organic horizon at the site.
-Ice lenses from 2-3 cm and up to 5-7 cm thick were encountered during drilling.
-The borehole was encased with a PVC plastic tube that was closed at the bottom end. A thermistor string with sensors at depths of 0, 0.25, 0.5, 1, 2, 3, 4, 5, 7 and 9m below the surface was placed in the casing and connected to a Geoprecision datalogger. There was a problem with the datalogger, so data is missing from late Oct 2008 to late January 2009 and from late March to early May 2009.
The graphs show data collected from 2008 to 2009.
-No frost tube has been installed at the site.





Highlights

-Permafrost is continuous in Svalbard, and its temperature at the top ranges from -2 to -6°C depending on local climate, snow cover and vegetation conditions at the ground surface, and soil moisture and thermal properties of the subsurface.

-Measurements from the borehole show that:

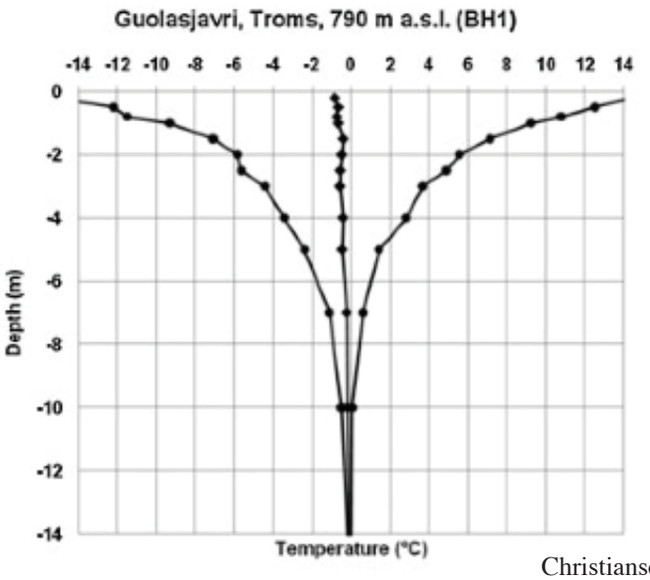
-The temperature at the surface ranges from 20°C in summer to -25°C in winter.

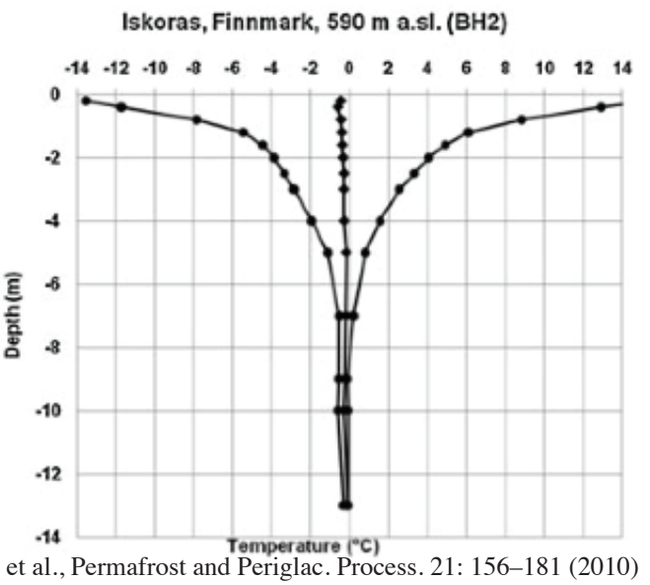
-The permafrost temperature is -3 to -4°C at 9m depth.

-The active layer is about 2.5m thick.

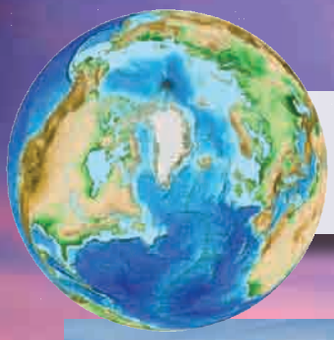
-The average annual air temperature measured at Svalbard Airport (located 4.6 km to the northwest) is -4.5°C. The maximum air temperature is 12 °C and the minimum is -28°C.

Besides Svalbard, permafrost is present in northern Scandinavia and in alpine areas. Palsa peatland is common in northern Finland; it can develop ice lenses accumurating to plateau or mound shape landforme. Thawing of these ice lenses affects much infrastructure.



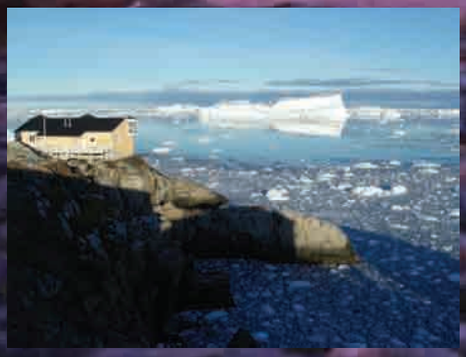


Christiansen et al., Permafrost and Periglac. Process. 21: 156–181 (2010)

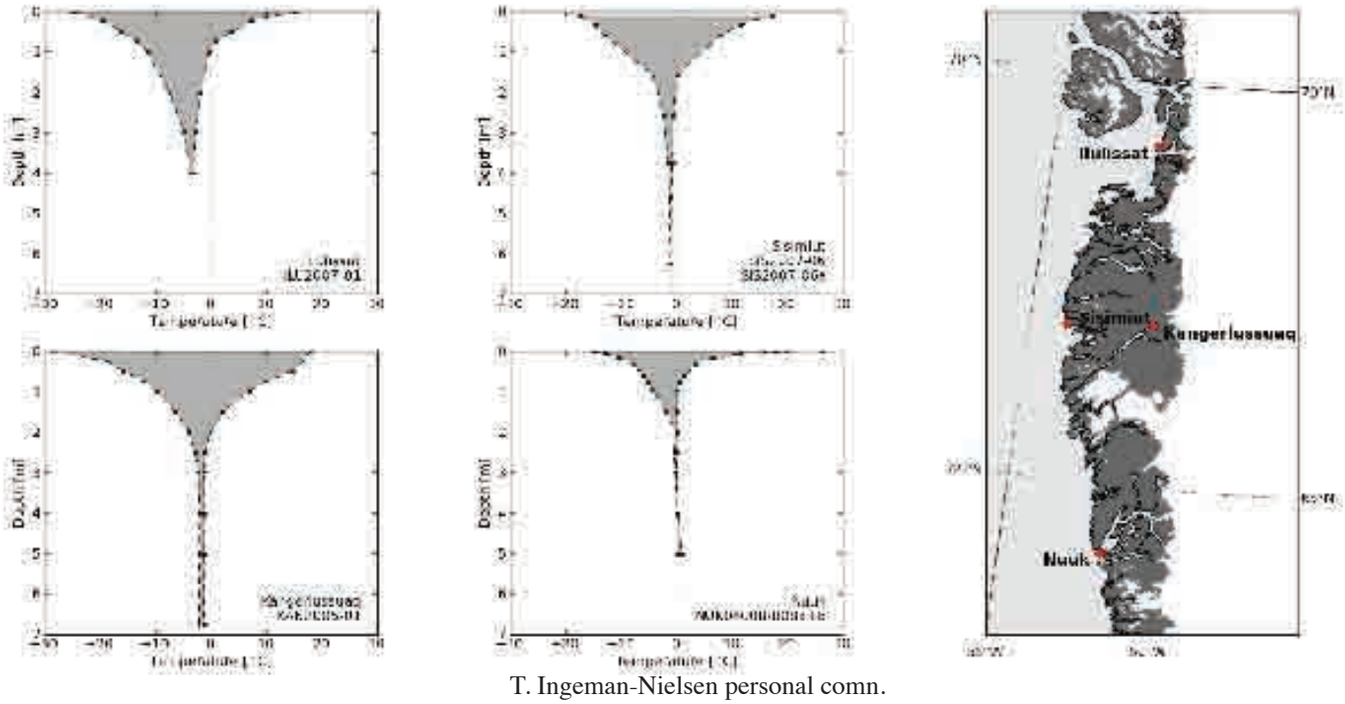


Greenland

Kallahit Nunaatt

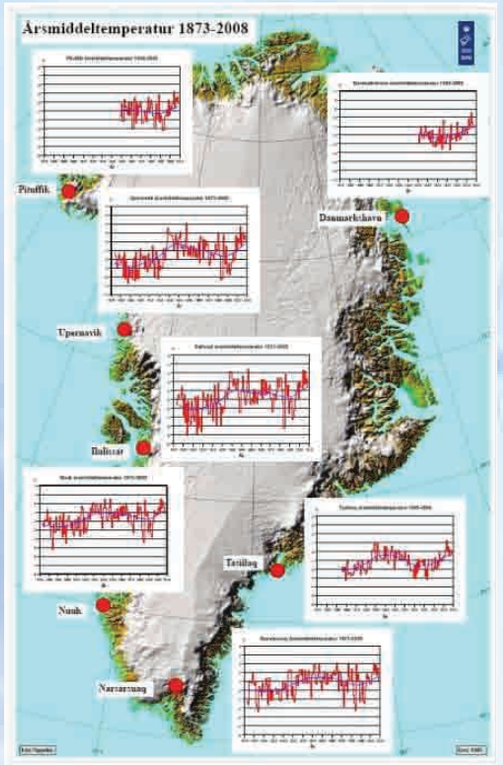


Greenland (Kallahit Nunaatt) occupies the biggest ice cap in the Northern Hemisphere. Open terrain permafrost is located on the edge of the ice cap and the fjords. Permafrost is absent in the southern part of Greenland, but permafrost is present north of Nuuk (the Capital) and Tasiilaq (on the east coast). Most of the inhabited areas are in the middle and the south part of western Greenland. Most of the permafrost is on Precambrian bedrock, and some is in glaciomarine sediments that have undergone isostatic rebounding. At the same time, these sediments contain large amounts of salt and brackish water (Cryopeg). These soils are a big challenge for infrastructure.



T. Ingeman-Nielsen personal comn.

The permafrost temperature in Western Greenland is warm, most times above -3 ºC or warmer. The temperature from Illulissat shows a -3.2ºC at zero annual amplitude permafrost temperature. Also many open system pingos are reported around the Disko Bay area (Disko Island, Nugsuaq Peninsula).



Since its time as a US air foorce base in 1951-1992, Kangerlussuaq has been one of the longest operations permafrost monitoring sites in Greenland. Several monitoring boreholes are monitored and connected with a computer system.

Annual mean temperature 1873 – 2011 from weather staions in Denmark, the Faroe Islands and West Greenland. Since 1873 the temperature in Copenhagen and Torshavn has risen. In West Greenland the temperature likewise rose until approximately 1940. After that point there has been a falling trend until recent years, when a new upward trend began (http://www.dmi.dk/dmi/en/index/klima/klimaet_indtil_nu/temperaturen_i_groenland.htm).

Catastrophic lake drainages or permafrost-related hydrological actions are common in Greenland. This huge pro-glacier lake (left) was suddenly drained and caused flooding in 2009 (right).

Pingo in Sarqaq Dalen, west Greenland

Patterned Ground in Sarqaq Dalen west Greenland

Edge of the Ice Cap and newly exposed bedrock

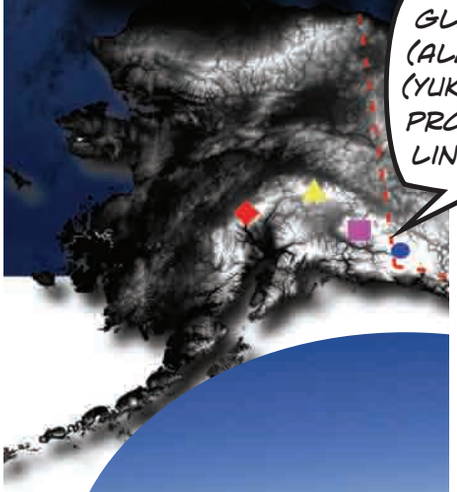
Cold War era radar station (DYE-2) at the Ice Cap

LET'S CHECK GLACIER TEMPERATURES

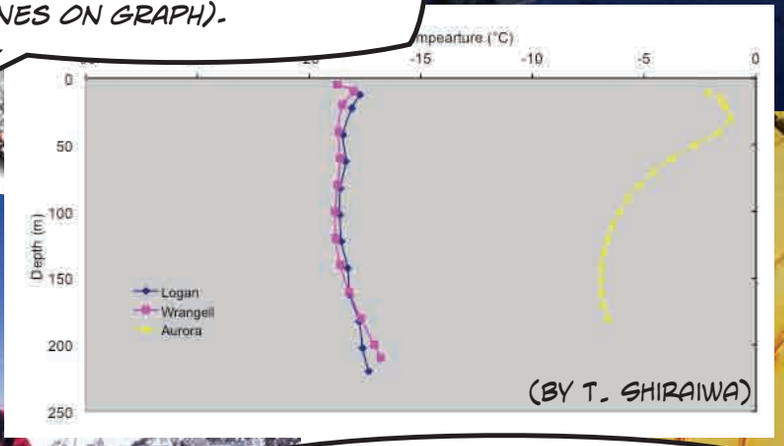
PERMAFROST AND GLACIERS HAVE SOMETHING IN COMMON. BOTH STAY BELOW 0°C. THEIR SUBSURFACE TEMPERATURE PROFILES ARE SIMILAR, BUT GLACIERS HAVE A SIMPLER STRUCTURE. THE MATERIAL OF PERMAFROST IS SOIL, SEDIMENT, UNFROZEN WATER AND ROCK, WHILE THE MATERIAL OF GLACIERS IS MAINLY ICE OR SNOW!

GLACIER SCIENTISTS SET UP A TENT OVER THE DRILL AND STAY ON THE GLACIER SEVERAL WEEKS TO A YEAR!

ALASKA & YUKON

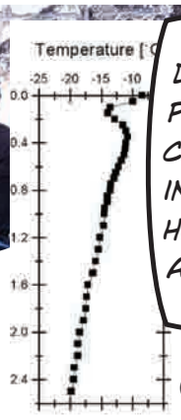


GLACIERS ON MT. WRANGELL (ALASKA) AND MT. LOGAN (YUKON, CANADA) HAVE SIMILAR PROFILES (SEE COLORED LINES ON GRAPH).



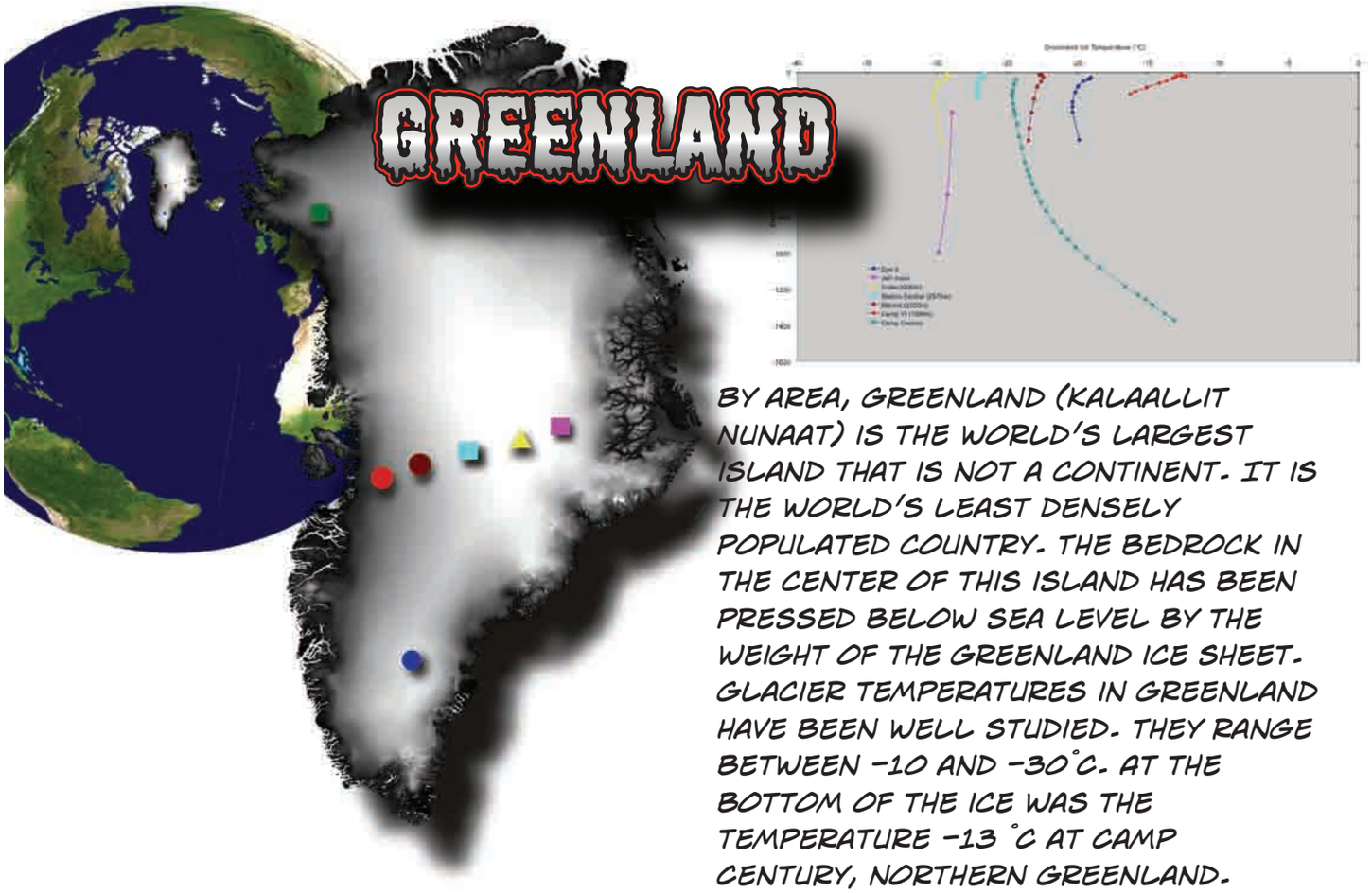
(BY T. SHIRAIWA)

ON DENALI, SNOW SURFACE TEMPERATURE IS AROUND -27°C.

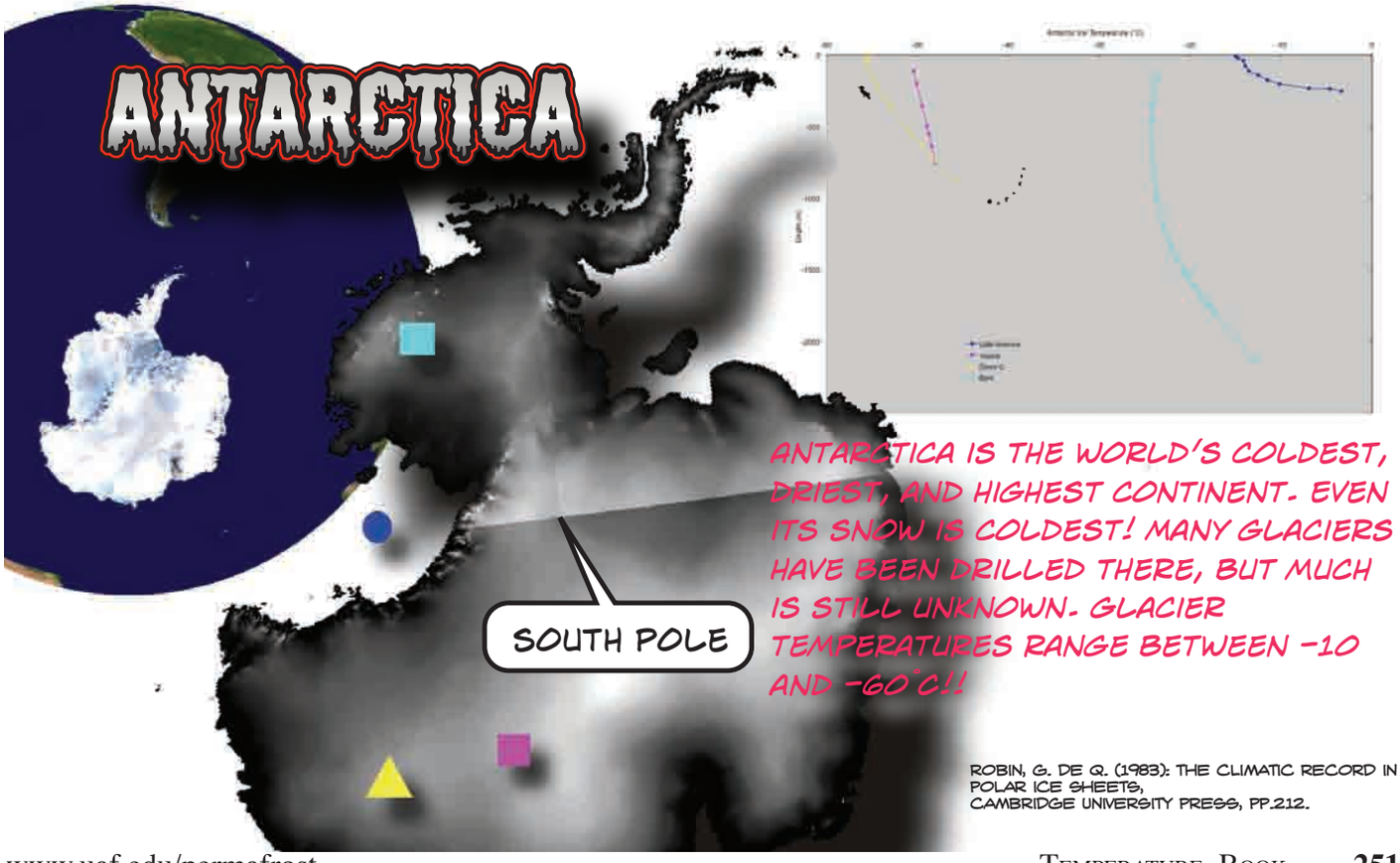


WE CAN DRILL DEEPER IN GLACIERS THAN IN PERMAFROST. ICE CORES CONTAIN IMPORTANT INFORMATION ABOUT EARTH'S HISTORY, LIKE ITS PAST CLIMATE AND PLANT LIFE.

(BY S. KANAMORI)



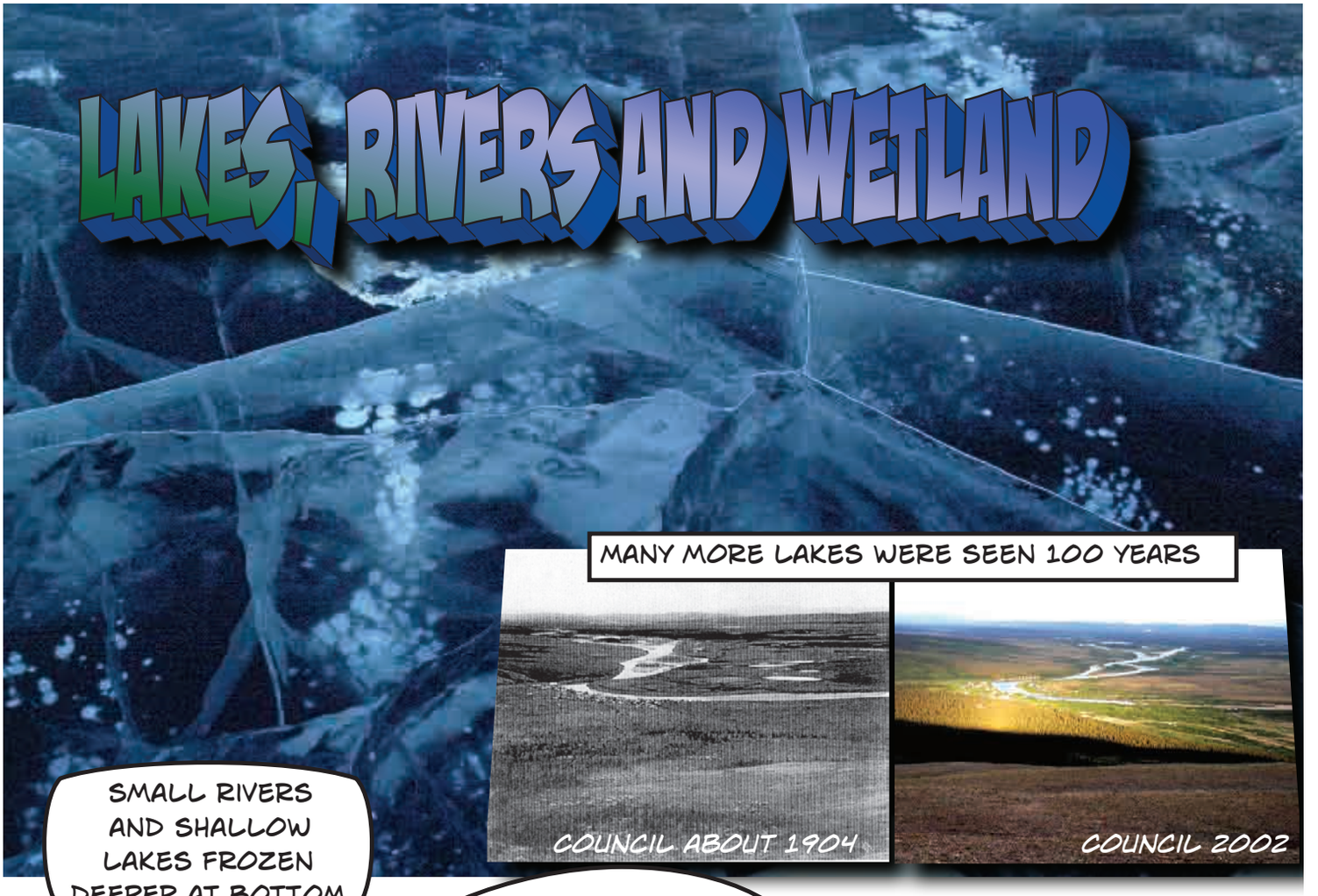
BY AREA, GREENLAND (KALAALLIT NUNAAT) IS THE WORLD'S LARGEST ISLAND THAT IS NOT A CONTINENT. IT IS THE WORLD'S LEAST DENSELY POPULATED COUNTRY. THE BEDROCK IN THE CENTER OF THIS ISLAND HAS BEEN PRESSED BELOW SEA LEVEL BY THE WEIGHT OF THE GREENLAND ICE SHEET. GLACIER TEMPERATURES IN GREENLAND HAVE BEEN WELL STUDIED. THEY RANGE BETWEEN -10 AND -30˚C. AT THE BOTTOM OF THE ICE WAS THE TEMPERATURE -13 ˚C AT CAMP CENTURY, NORTHERN GREENLAND.

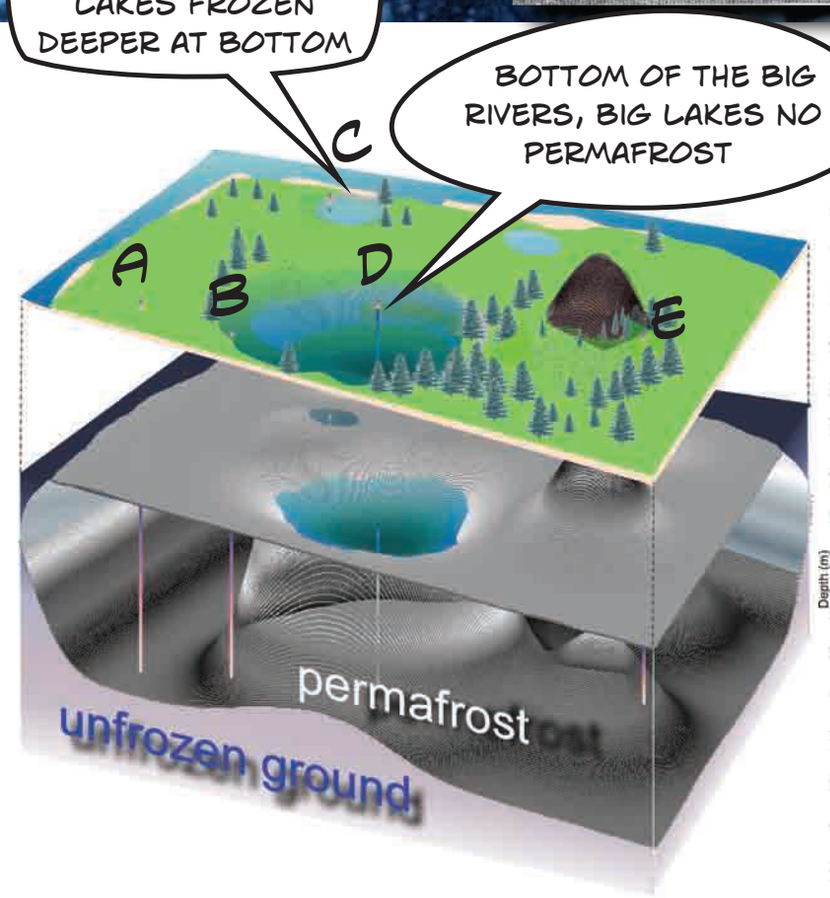


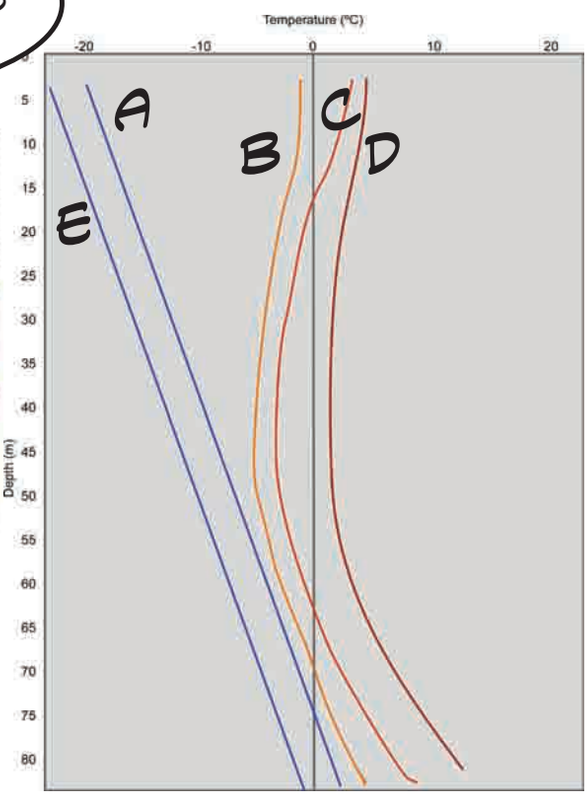
ANTARCTICA IS THE WORLD'S COLDEST, DRIEST, AND HIGHEST CONTINENT. EVEN ITS SNOW IS COLDEST! MANY GLACIERS HAVE BEEN DRILLED THERE, BUT MUCH IS STILL UNKNOWN. GLACIER TEMPERATURES RANGE BETWEEN -10 AND -60˚C!!

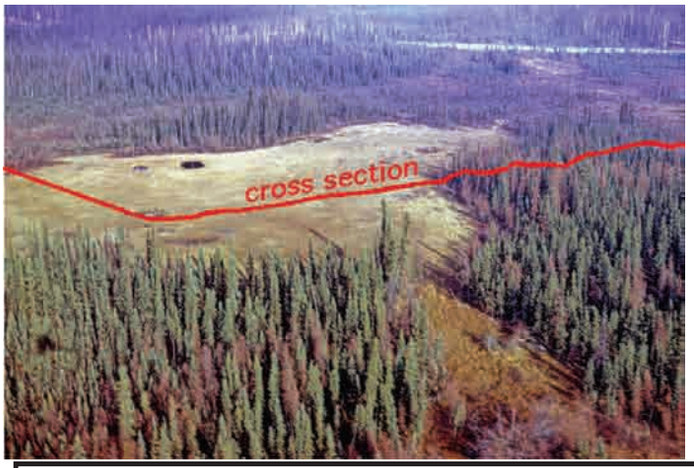
ROBIN, G. DE Q. (1983): THE CLIMATIC RECORD IN POLAR ICE SHEETS, CAMBRIDGE UNIVERSITY PRESS, PP.212.

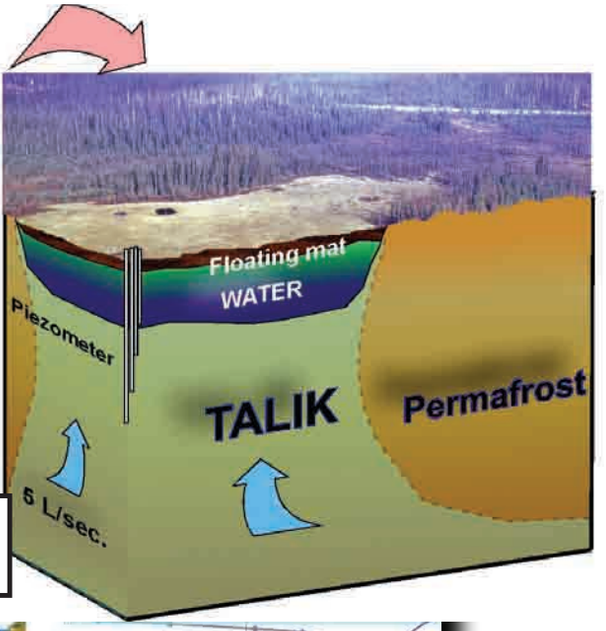
LAKES, RIVERS AND WETLAND



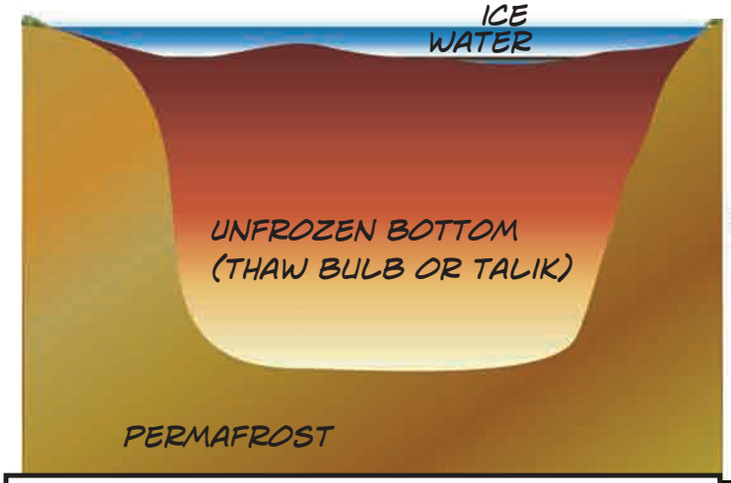


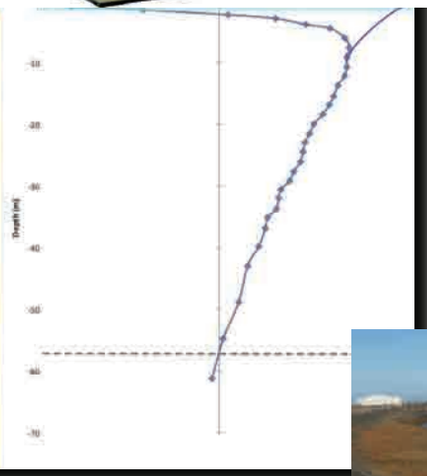






THE CASE OF A FAIRBANKS PEAT LAKE (WARM PERMAFROST)





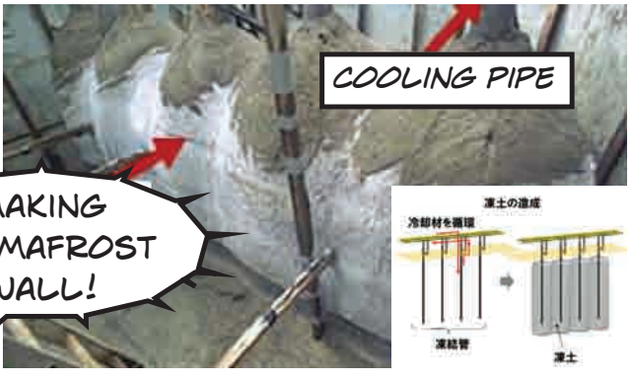
IN THE CASE OF BARROW, BIG LAKE HAS GOMETERS OF TALIK

Brewer, M.C., 1958, Some results of geothermal investigations of permafrost: American Geophysical Union Trans., vol. 39, 19-26.

PERMAFROST IS IMPERMEABLE....

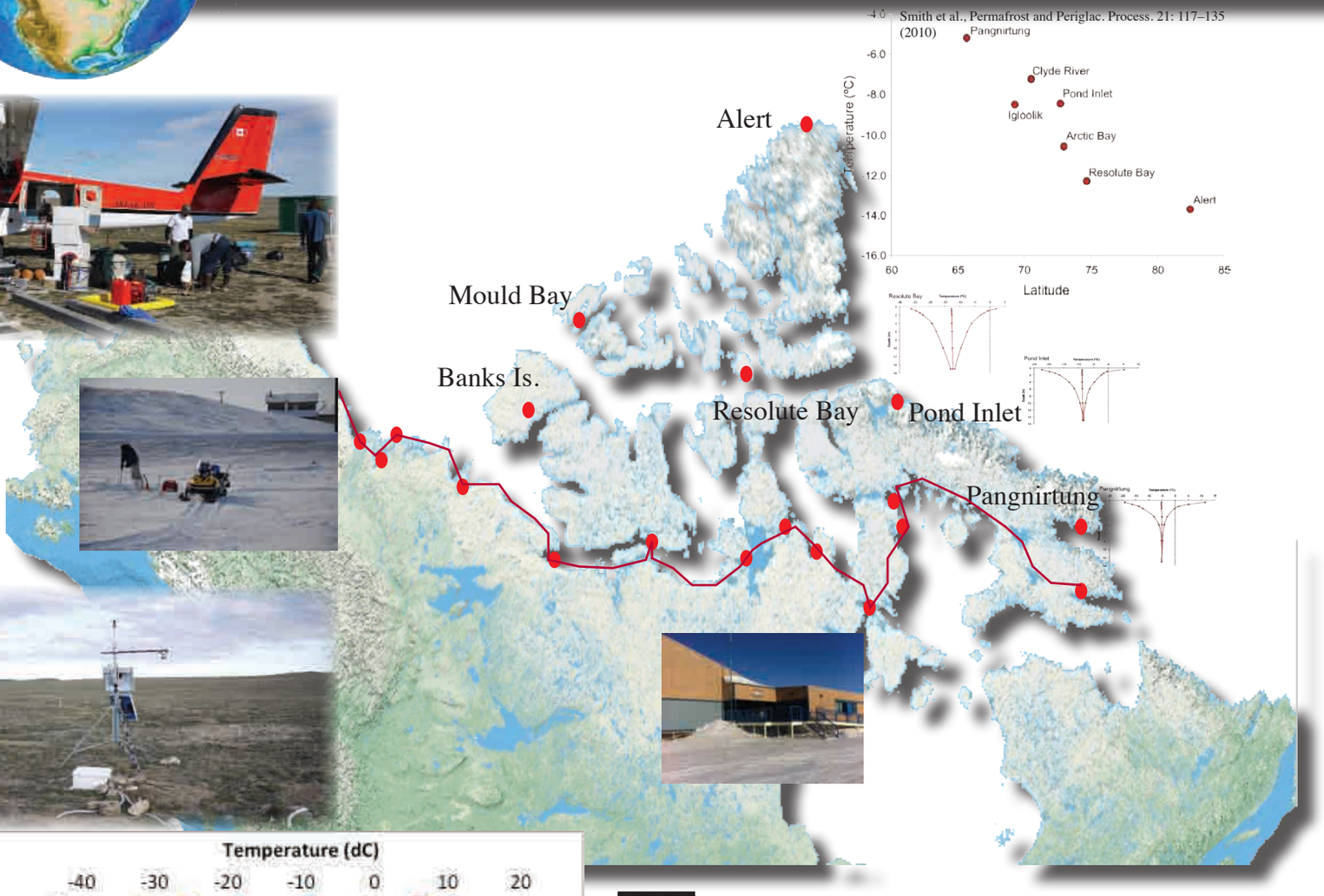
WE ARE USING FROZEN GROUND FOR CITY CONSTRUCTION UNDER THE SEA, RIVER TUNNELS, ETC. WE MAKE ARTIFICIAL FROZEN SOIL TO PREVENT THE GROUNDWATER FROM SEEPING OUT, THEN BUILD THE TUNNEL.... THIS TECHNOLOGY IS ALSO USING FOR BLOCK THE NUCLEAR CONTAMINATED GROUNDWATER IN FUKUSHIMA, JAPAN

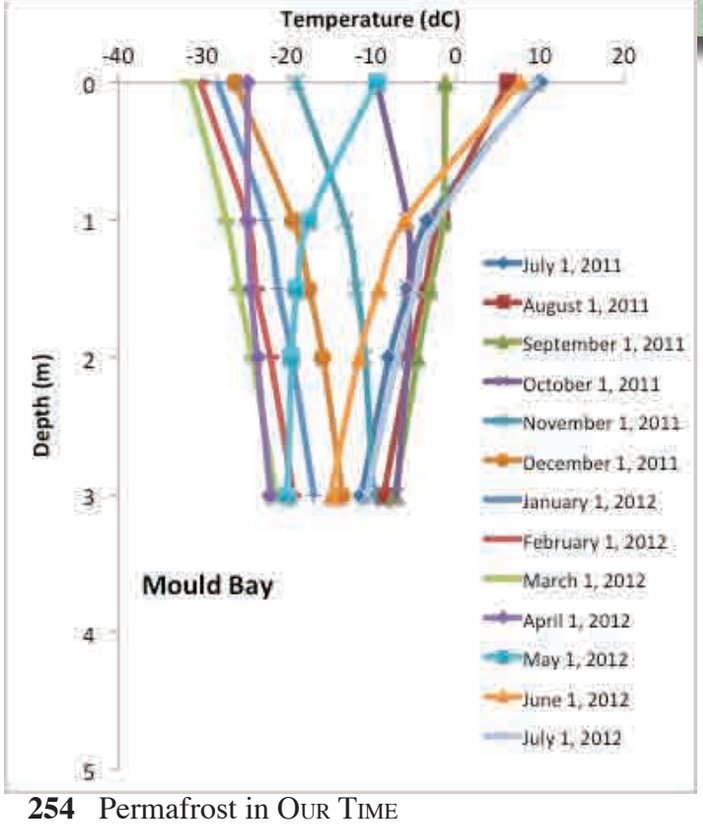
THE TUNNEL CROSSING TOKYO BAY USED THIS FROZEN TECHNOLOGY.



Canadian Arctic

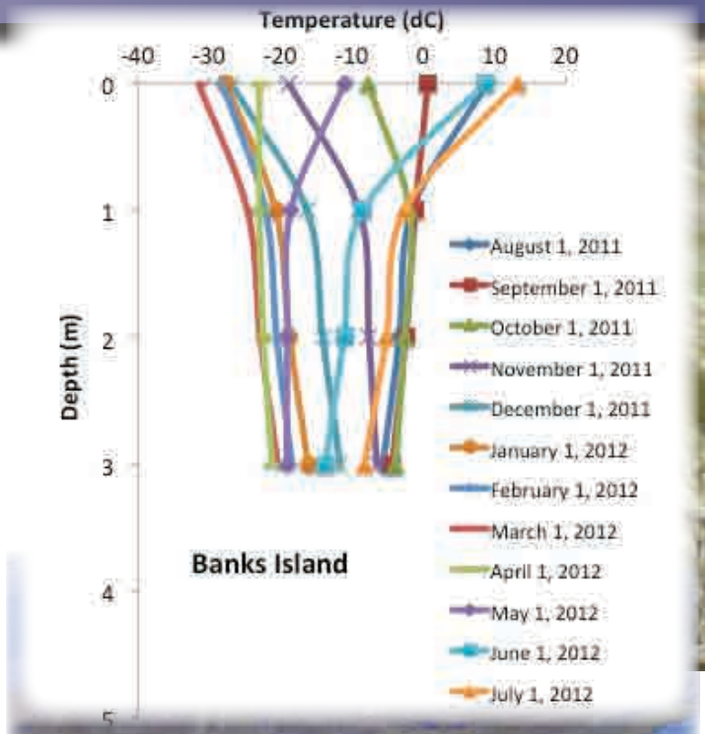
Canada





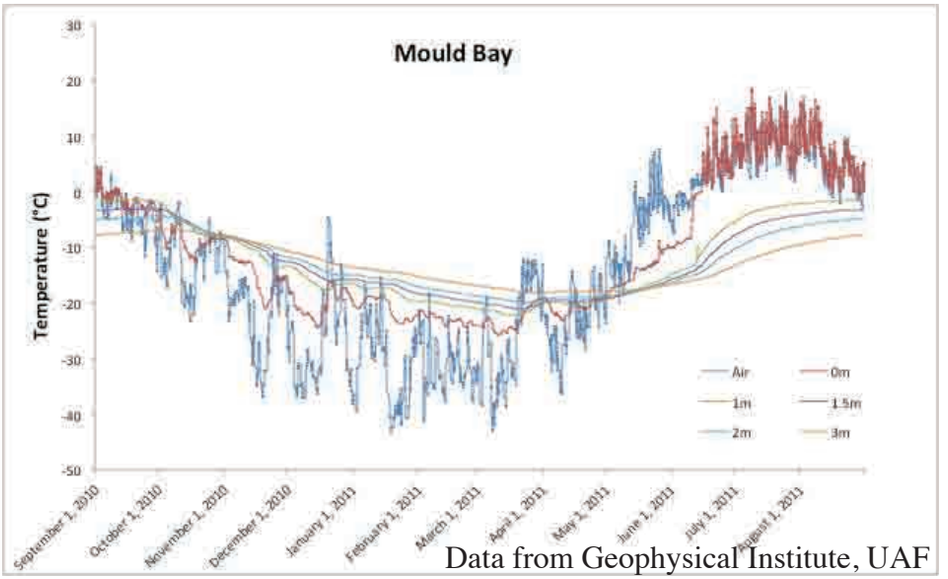
The Canadian Arctic Archipelago is located in the northern extremity of North America and covers about 1,424,500 sq. km (550,000 sq mi). This group of 36,563 islands comprises much of the territory of Northern Canada – most of Nunavut and part of the Northwest Territories. It is one of the coldest permafrost temperature regions in the Northern Hemisphere. Resolute Bay (74.7ºN, 94.9ºW), the most northern settlement in this area, had a permafrost temperature of -12.3 ºC. In Mould Bay (Prince Patrick Island the westernmost of the Queen Elizabeth Islands in the Northwest Territories) the permafrost temperature was -13ºC and Alert was -14ºC.

Data from Geophysical Institute, UAF



Retrogressive thaw slumps are commonly seen in the Western part of the Canadian Arctic (Banks Island, Herschel Island). These huge thaw slumps trigger buried massive ice in the permafrost and lots of suspended solids are discharged to the ocean.
Over 1450 pingos have formed on the Mackenzie Delta TukTuktoyaktuk Peninsula.

Annual temperature graph shows less than 3 months of positive temperature at the ground surface. Mean Annual Air Temperature was -13. 7 ºC and Mean Annual ground surface Temperature was -10.9ºC. The main cause of this thermal offset is snow accumuration during 9 months of winter.

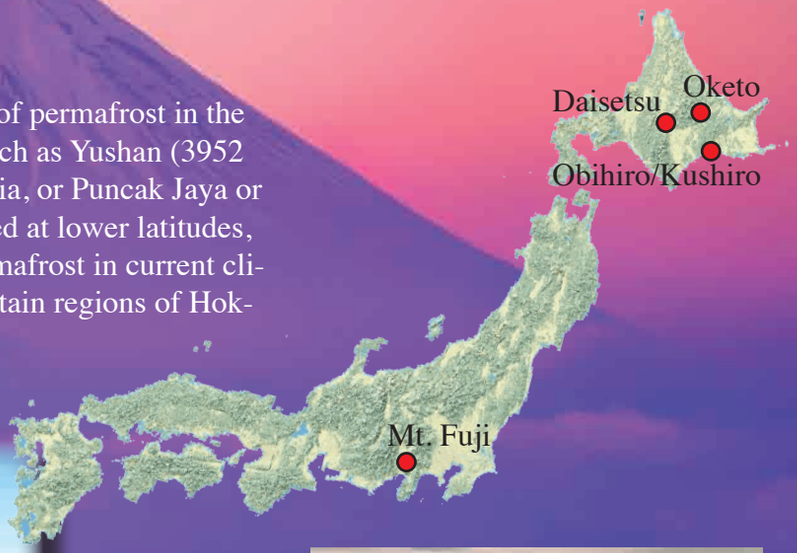


Data from Geophysical Institute, UAF

Western Pacific

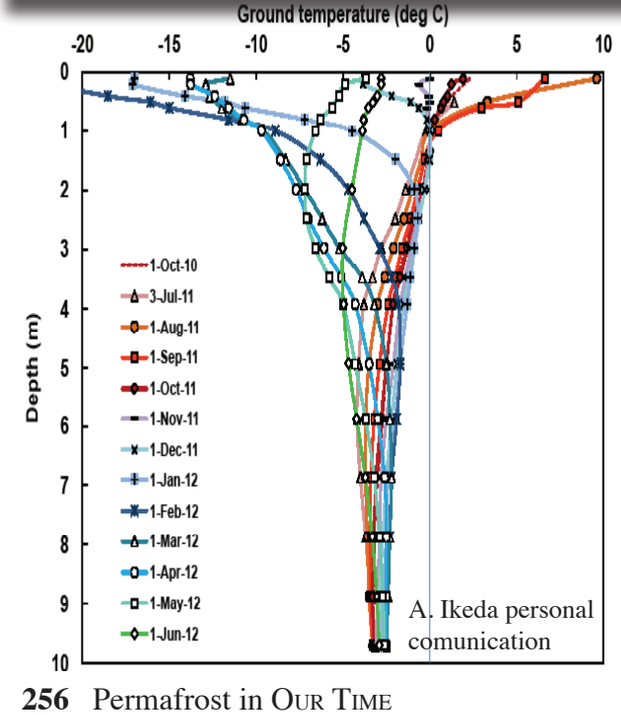
Japan

Mount Fuji (3776 m) is the southern limit of permafrost in the Western Pacific. Several high tropical mountains such as Yushan (3952 m) in Taiwan, Mount Kinabaru (4095 m) in Malaysia, or Puncak Jaya or Carstensz Pyramid (4884 m) in Indonesia are located at lower latitudes, but likely these are not high enough to develop permafrost in current climatic conditions. Permafrost is present in the mountain regions of Hokkaido and Honshu islands.

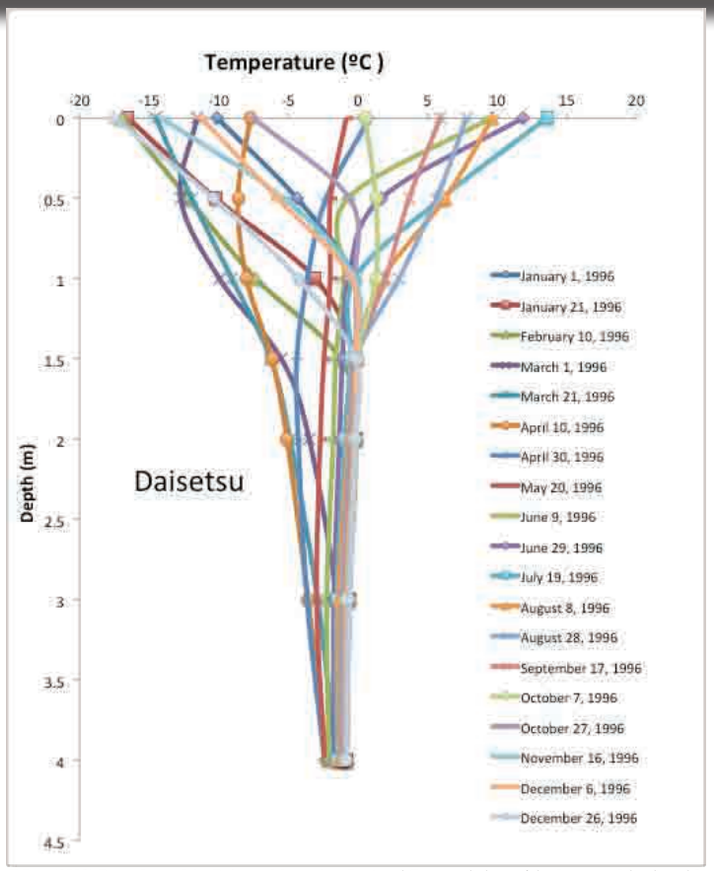


Drilling operation photo cradit A. Ikeda

Tokyo downtown and Mount Fuji



Mount Fuji, located on Honshu Island, is the highest mountain in Japan at 3776 m (12,389 ft). An active stratovolcano that last erupted in 1707–08, Mount Fuji lies about 100 k (62 mi) southwest of Tokyo, and can be seen from there on a clear day. Mount Fuji's exceptionally symmetrical cone, which is snow-capped several months a year, a well-known symbol of Japan, is frequently depicted in art and photographs, and is visited by sightseers and climbers. Permafrost is present at most of the summit area, as low as 3000 m north-facing slopes. The borehole temperature is -3°C at 10 m depth near the summit. As an active volcano, Mount Fuji's geothermal heat flow is higher, and the permafrost is considered recent, since the last eruption (1708). This newly developed, young permafrost is a unique phenomenon. Surficial geology is also important for the presence of permafrost. The ice-rich ash layer or tuff would provide strong thermal resistance; it is an ideal material for stable permafrost on the mountain.

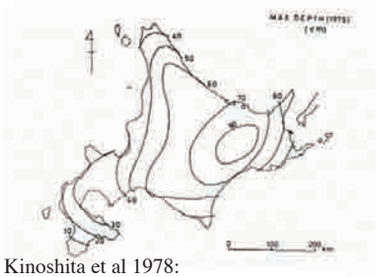


T.Sone(2003) Permafrost of the Daisetsu Mountains, *Regional Geomorphology of the Japanese Islands, vol.2, Geomorphology of Hokkaido, T.Koaze, M.Nogami, Y.Ono and K.Hirakawa editors* University of Tokyo Press, ISBN4-13-064712-1(in Japanese). pp136-139.

Daisetsu (also spelled Taisetsu) Volcano is a group of 8 stratovolcanoes, lava domes, and a small 2 km wide caldera in central Hokkaido. The lower limit of permafrost is above 1650 m a.s.l. depending on winter snow conditions and the surficial geology (sand and gravel). The Hokkaidaira borehole (left) shows that the active layer is between 1 m and 1.5 m, and the permafrost temperature is around -1°C at 4 m depth. In addition to the mountain area, some of the lower areas (MAAT 5°C, 480m a.s.l.) of Hokkaido Island have permafrost.

Hokkaidaira borehole site

Oketo scree site



Kinoshita et al 1978:
木下誠一，福田正己，矢作裕（1978）北海道における土の凍結深の分布，自然災害資料解析，5，10－15

Wide areas of eastern Hokkaido Island freeze severely during winter months. Seasonal frost depth sometimes reaches 1 m, which is deeper than the southern part of Alaska.

www.uaf.edu/permafrost

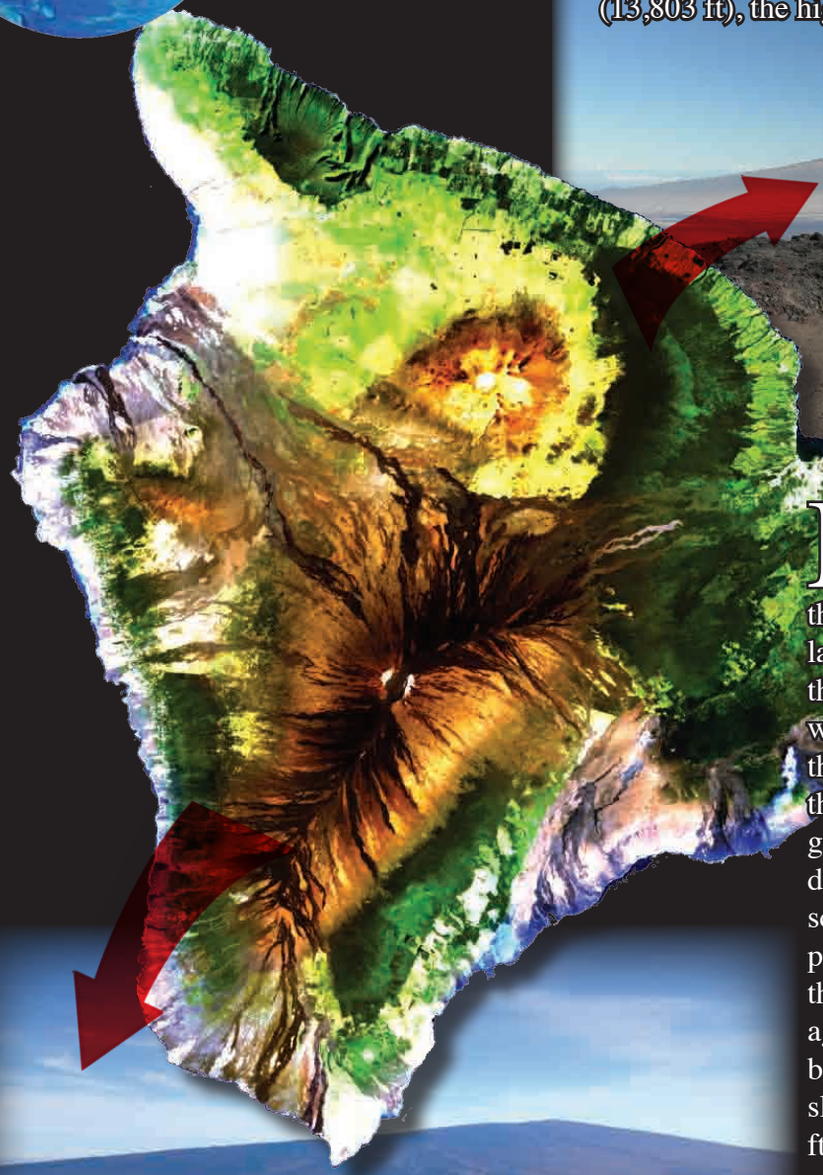
Presently, dozens of schools in Japan have frost tubes and ground temperature dataloggers. Japanese students measure frost depth in their school yards usually from November to March.

Palsas are seen at the Daisetsu permafrost site.

Dr. Harada(Japanese rep.) check frost depth

Hawai'i

Mauna Kea & Mauna Loa



Mauna Kea means "white mountain," elevation 4207 m (13,803 ft), the highest mountain on Hawai'i.

Many people find it hard to believe that there is permafrost in the tropical Hawaiian Islands, but due to altitude, there is on Hawai'i, the big island. If we go to higher latitudes (toward the poles), temperatures get colder. It's the same with altitude; the higher we climb, the colder the temperatures, both air and ground. Mauna Kea is at the critical height for developing permafrost. In late 1969, marine scientist, Dr. Alfred Woodcock, was the first person to discover and study the permafrost there. He found that, at the summit, the average air temperature was well above freezing, but at the permafrost site, on the north-facing slope of the summit crater at 4140 m (13,583 ft), it was much lower.

Highlights

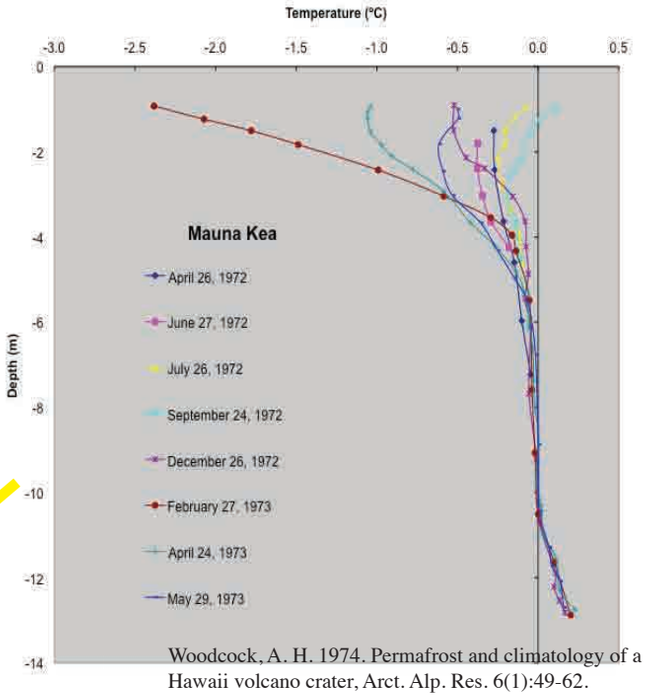
- Permafrost on Mauna Kea is at least 10 m thick.
- Permafrost's survival is associated with trapped radiationally cooled air, low incidence and angle of sunlight, and very dry atmosphere.
- Permafrost may be present on Mauna Loa, but this is not confirmed yet.

Mauna Loa means "long mountain," elevation 4169 m (13,678 ft), only 38 m (125 ft) lower than Mauna Kea. The NOAA Mauna Loa Observatory (MLO) is located at 3400 m (11,155 ft) on the northern slope of the mountain. The MLO monitors global atmosphere, including greenhouse gases and carbon dioxide, both contributors to the famous "global warming plot"!

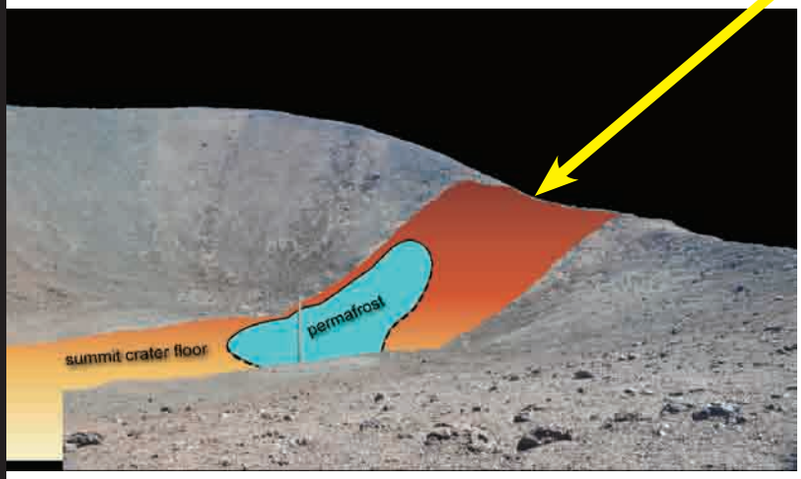
Panorama view from the summit of Mauna Kea 4207m (13,803 feet)

Location: 19.46° N, 155.27° W

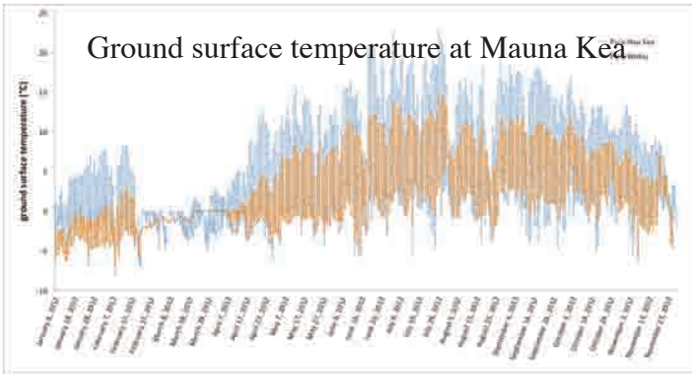
Mauna Kea was glaciated during the Ice Age. Morraines and erratics (isolated boulders) can be seen there today. These relict features reveal the existence of a past glacier (between 3000–3500 m altitude). The rate of temperature decrease with elevation, called the lapse rate, is constant at about 6.5°C/1000 m (43.7°F/3281 ft) below about 1250 m (4101 ft), and 4°C/1000 m (39.2°F/3281 ft) at higher elevations. In this case, permafrost should be absent below an altitude of about 5000 m (16,404 ft), but the permafrost at Mauna Kea is affected by local microclimate systems. This is a good example of tropical mountain permafrost distribution, and useful for Martian permafrost study.



Woodcock, A. H. 1974. Permafrost and climatology of a Hawaii volcano crater, Arct. Alp. Res. 6(1):49-62.

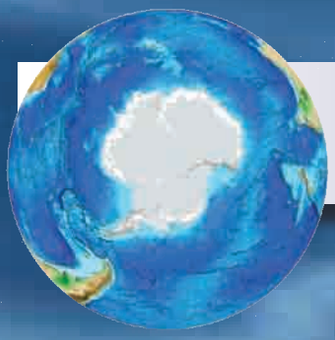


Stone stripes created by freeze-thaw cycles on Mauna Kea summit crater.



Ground surface temperature at Mauna Kea

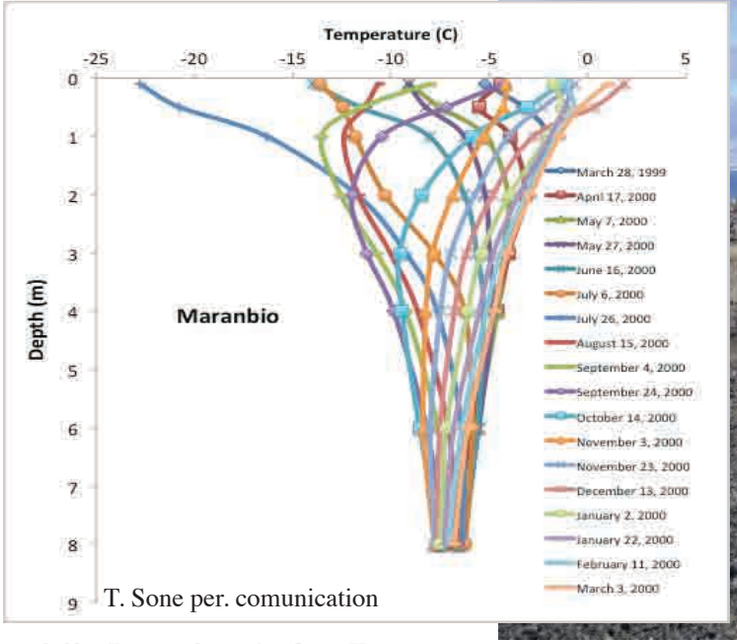
Permafrost at Mauna Kea is located on the lower north-facing slope of the summit crater. There is no permafrost at the crater floor. The location of this permafrost indicates the importance of reduced sunlight for permafrost survival. The interannual variation of temperature in a tropical alpine climate is typically small (about 4°C (39.2°F). Zero annual amplitude depth is about 5 m (16 ft) below ground and about -0.1°C (32°F). The base of the permafrost is 10.5 m (35 ft).



Antarctica
coldest continent

Antarctica is the coldest of Earth's continents. The coldest natural temperature ever recorded on Earth was –89.2 °C (–128.6 °F) at the Russian Vostok Station in Antarctica on 21 July 1983. Antarctica is a frozen desert with little precipitation; the South Pole itself receives less than 10(mm (4 in) per year, on average. Permafrost is present in only 0.36% (49 800 km2) of the Antarctic region, beneath virtually all ice-free terrain, except at the lowest elevations of the maritime Antarctic and sub-Antarctic islands. Antarctica is colder than the Arctic for three reasons. First, much of the continent is more than 3 kilometres (2 mi) above sea level, and temperature decreases with elevation. Second, the Arctic Ocean covers the north polar region. Third, earth is at aphelion in July (i.e., the earth is furthest from the sun in Antarctic winter), and the earth is at perihelion in January (i.e. the earth is closest to the sun in Antarctic summer. The orbital distance contributes to a colder Antarctic winter (and a warmer Antarctic summer) but the first two effects have more impact.

Marambio Station



T. Sone per. comunication

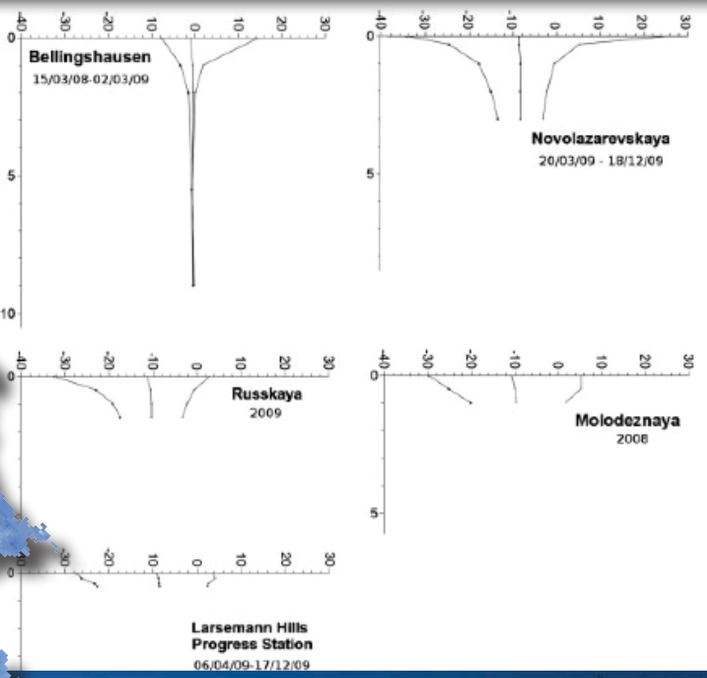
Russkaya Station

Permafrost temperatures at Marambio Station are much milder (-6.9°C) than those of inland Antarctica. However, these temperatures are much colder than the northern part of the Antarctica Peninsula, where most of the research stations are located. Permafrost temperatures are warmer than -1°C on the northern peninsula.

Molodeznaya Station

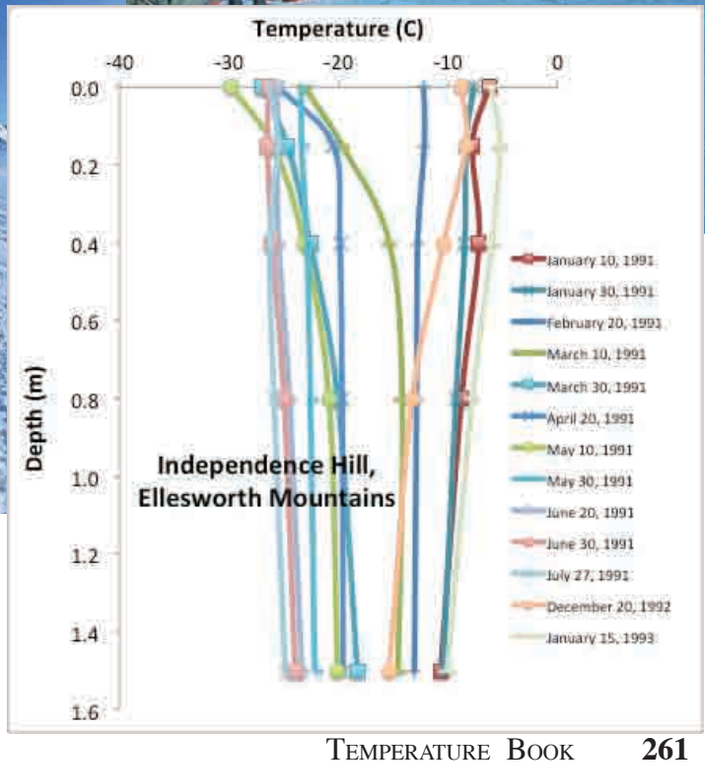
Larsemann Hills -progress Station

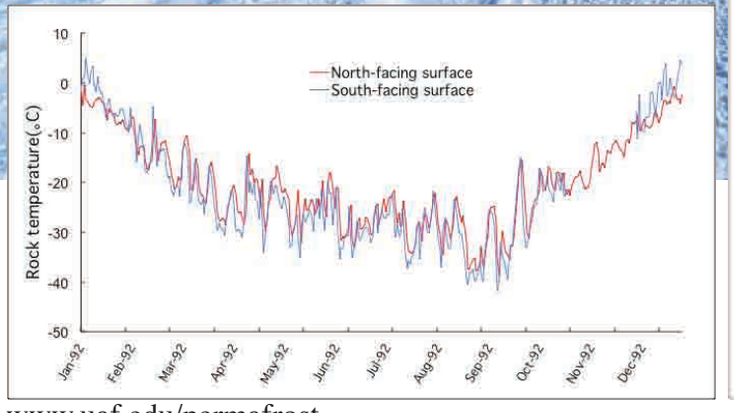
Amundsen-Scott South Pole Station



Freeze-thaw cycles are less frequent in Antarctica, although physical weather of rock surfaces is commonly seen. At Independence Hill, in the Ellesworth Mountains, Inland Antarctica, the rock surface temperature has exceeded 0°C only about 47 times, but the mean annual rock surface temperature was -21°C during the 1992-93 expedition. The inland permafrost temperature is also the coldest (colder than -20°C) compared with other Antarctic coastal stations.

The permafrost temperature at Novolazarevskaya Station was -8°C. Temperatures at the coastal stations were: Molodezhnaya Station, -9.8°C; Larsemann Hills-Progress Station in the Vestfold Hills region, 8.5°C; and Russkaya in Marie Byrd Land, 10.48°C (see V. Gonçalo et al.,2010, Permafrost & Periglacial Processes, 21:182-197).





Hadley-Apennine, Taurus-Littrow

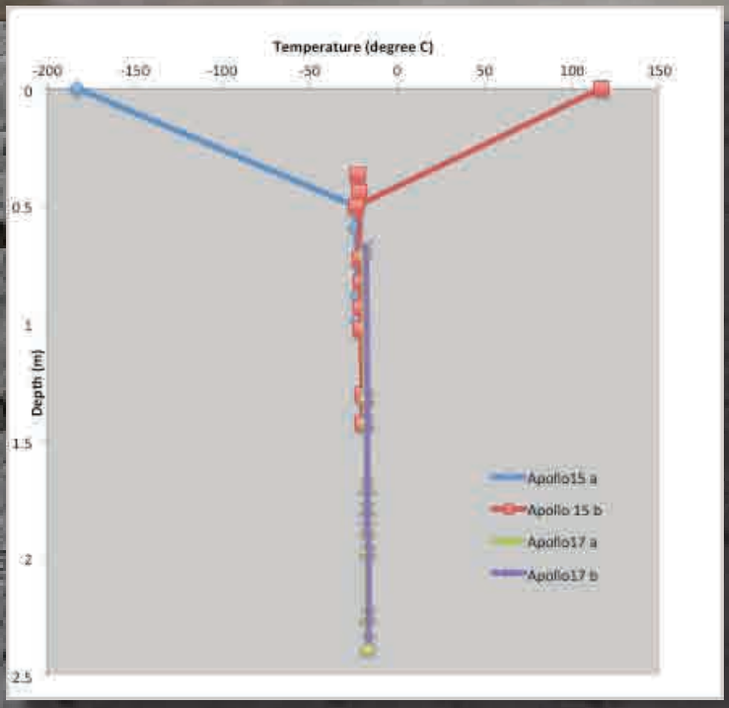
The Moon

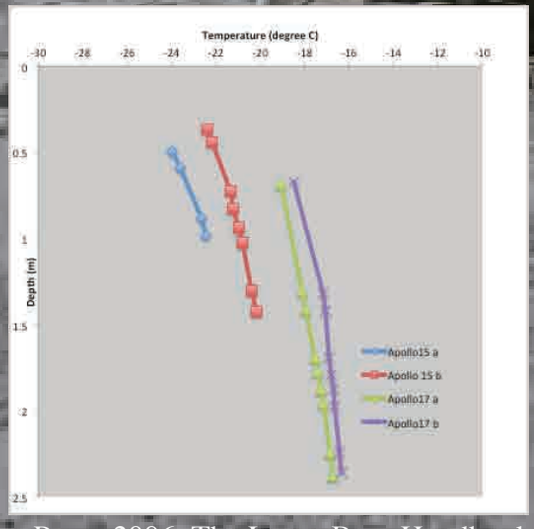
On July 26, 1971, during the Apollo 15 lunar landing mission, two thermal-property boreholes were drilled at 26°4'54" north latitude, 3°39'30" east longitude, at the base of the Apennine Mountains. The Apennines rise more than 4572 m (15,000 ft) along the southeastern edge of Mare Imbrium (Sea of Rains).

The final Apollo mission (Apollo 17 – December 7, 1972) landed at Taurus-Littrow, a lunar valley named after nearby Littrow crater and the Taurus Mountains, on the southeastern rim of the Serenitatis basin.

The target landing site was at 20°9'50.5" north latitude, 30°44'58.3" east longitude, about 750 km east of the Apollo 15 landing site at Hadley Rille.

The borehole was drilled to 2.9 m (right picture). The astronaut is leaning to the right to pick up the drill. The Solar Wind Spectrometer is in the foreground.

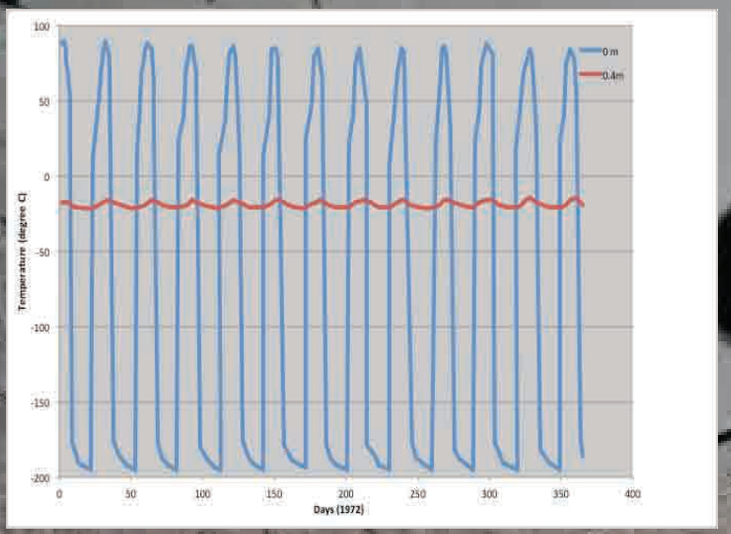


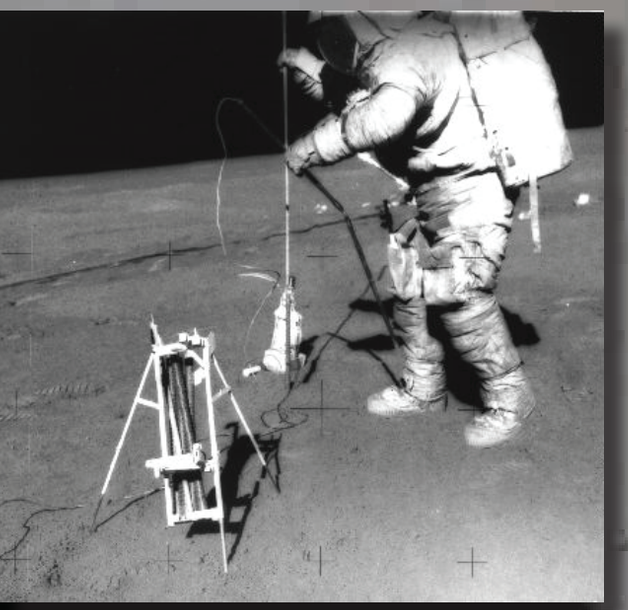


Eckart, Peter, 2006, The Lunar Base Handbook, 2nd Ed., McGraw-Hill, ISBN 978-0-07-329444-5.

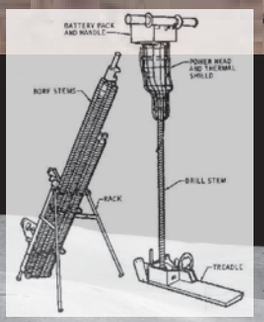
Location: 20.19° N, 30.77° E

Temperature sensors (platinum resister) were installed at approximately 2-3 m. During the Apollo 15 and 17 missions, temperature sensors (platinum resisters) were installed in 2–3 m boreholes at 20–26° north latitude. Unlike Earth, the moon experiences extreme daily temperature fluctuations, with a surface temperature of nearly 100°C during daytime and -200°C at night. The moon's soil temperature does not fluctuate below 0.4 m deep, indicating that lunar soil is good insulation (lower thermal conductivity). Lunar day and night correspond to the new moon and full moon cycle on Earth, about 13 times per year.





The Heat Flow Experiment (HFE) during the Apollo 15 mission. The drill rack is in the foreground and the ALSD is on the lunar surface behind the bore stem, which is emplaced in the ground. The dark, two-segment rod in the astronaut's left hand is the heat probe. The white probe emplacement tool is in the astronaut's right hand (AS-15-92-12407).

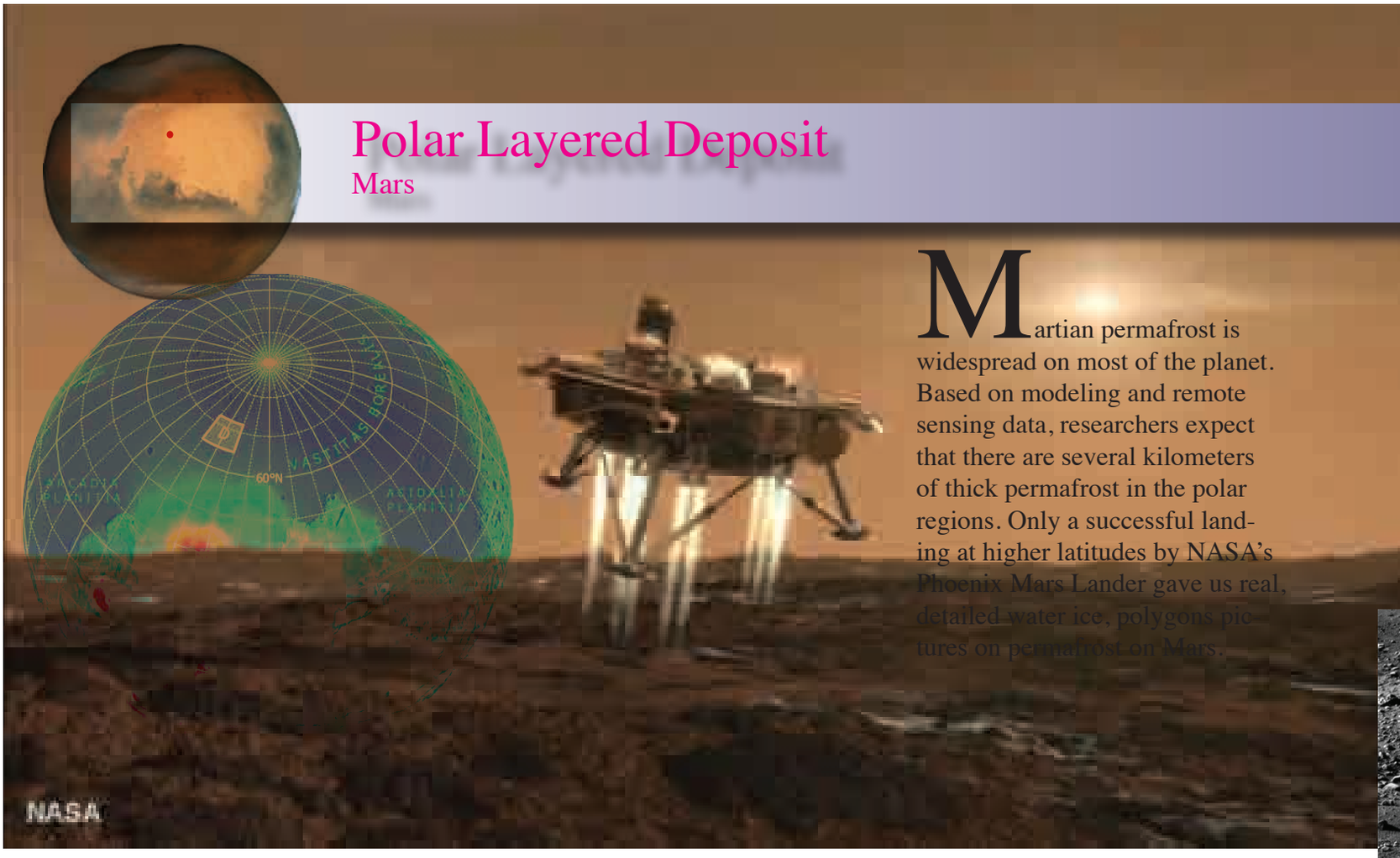


The Apollo Lunar Surface Drill was designed to extract soil column samples and create holes for emplacement of two heat flow probes and temperature sensors in the lunar surface. Each core stem segment was a rigid, hollow tube measuring about 40 cm in length. Joined together and driven into the surface, they enabled astronauts to drill as deep as 3 m into the lunar soil.

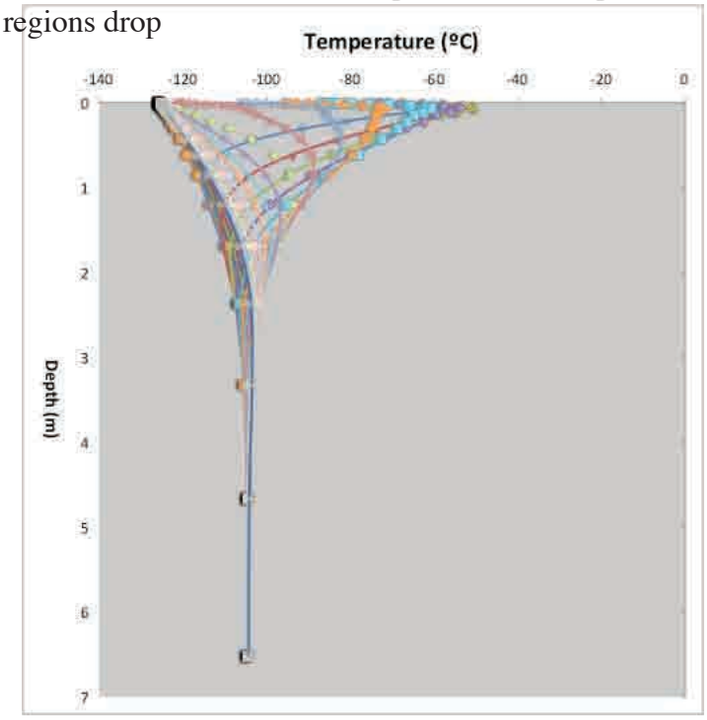
Polar Layered Deposit

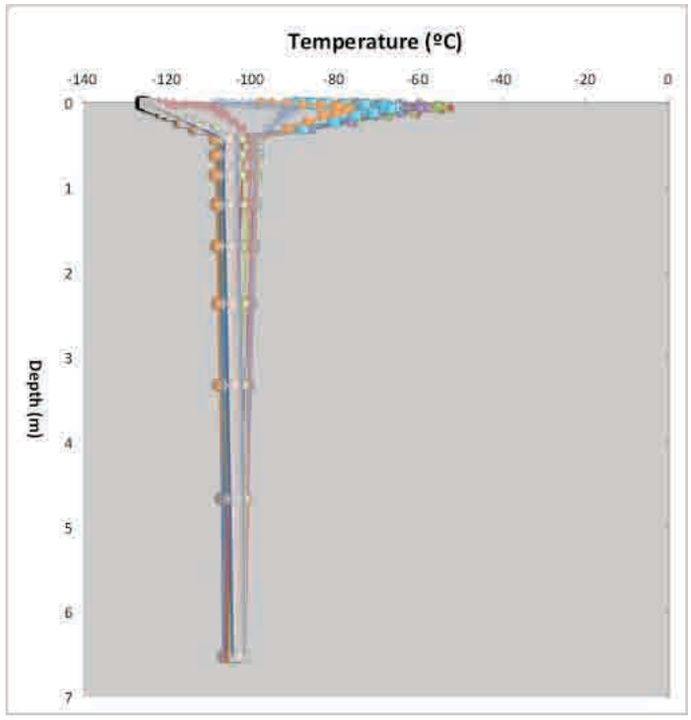
Mars

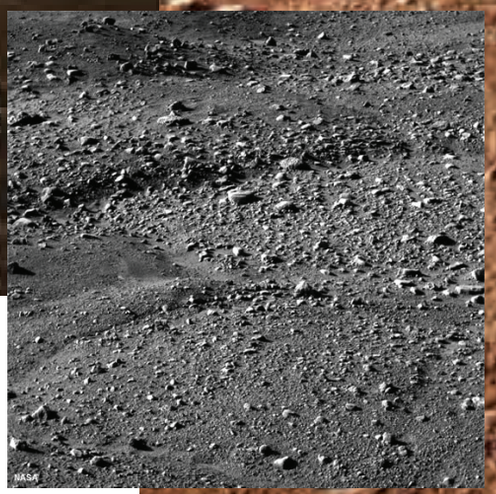
Martian permafrost is widespread on most of the planet. Based on modeling and remote sensing data, researchers expect that there are several kilometers of thick permafrost in the polar regions. Only a successful landing at higher latitudes by NASA's Phoenix Mars Lander gave us real, detailed water ice, polygons pictures on permafrost on Mars.



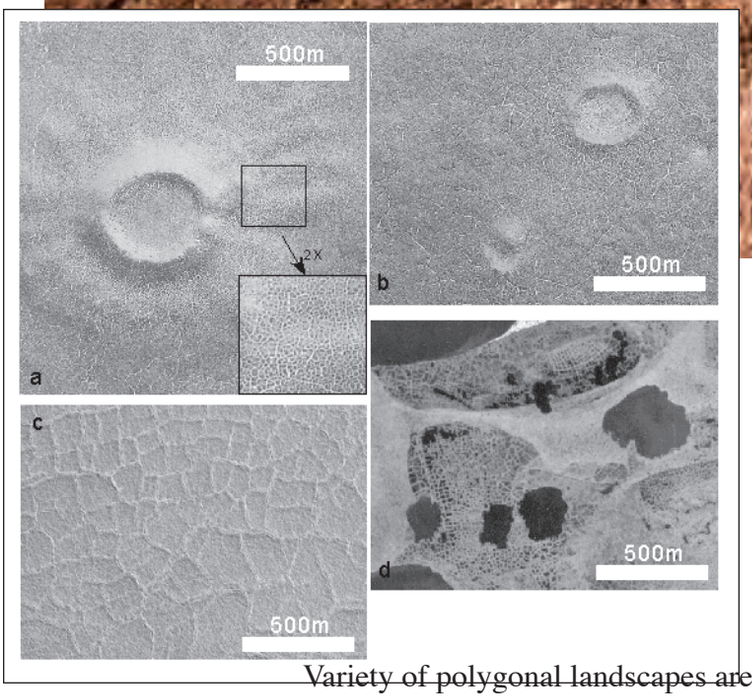
We are not yet drilled deeper boreholes on Mars. The following trumpet curves were developed through model simulation of up to 6.5m depth at 70º North. Ground surface temperatures of the polar regions drop to -126 ºC during winter months and -50 ºC in summer months. These two graphs shows the difference between dry conditions (left) and icy conditions (right). Model works are operated by M. Mellon (Icarus 169, 2004, 324–340)

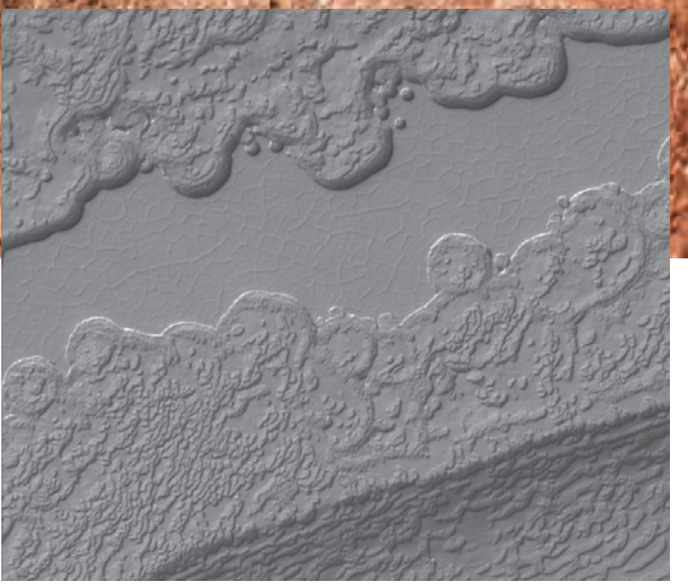




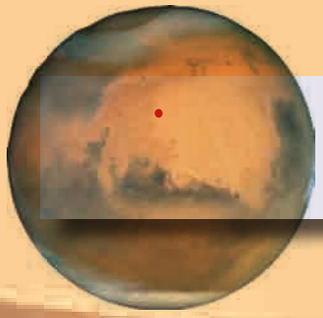


This image shows a polygonal pattern in the ground near NASA's Phoenix Mars Lander, similar in appearance to icy ground in the Arctic regions of Earth. Phoenix touched down on the Red Planet at 4:53 p.m. Pacific Time (7:53 p.m. Eastern Time), May 25, 2008, in an arctic region called Vastitas Borealis, at 68º north latitude, 234º east longitude. This is an approximate-color image taken shortly after landing by the spacecraft's Surface Stereo Imager, inferred from two color filters, a violet, 450-nanometer filter and an infrared, 750-nanometer filter. The Phoenix Mission is led by the University of Arizona, Tucson, on behalf of NASA. Project management of the mission is by NASA's Jet Propulsion Laboratory, Pasadena, Calif. Spacecraft development is by Lockheed Martin Space Systems, Denver. Image credit: NASA/JPL-Caltech/University of Arizona



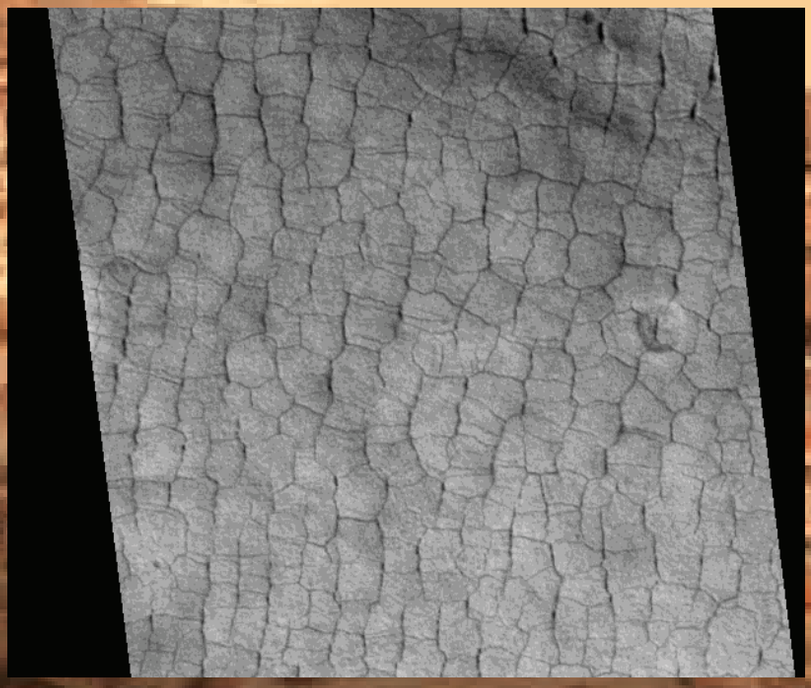


Variety of polygonal landscapes are found on Mars, especially polar regions (a, b, c). Some of the polygons must be frost contraction polygons- these are similar to ice wedge polygons in the Arctic regions on Earth (d).



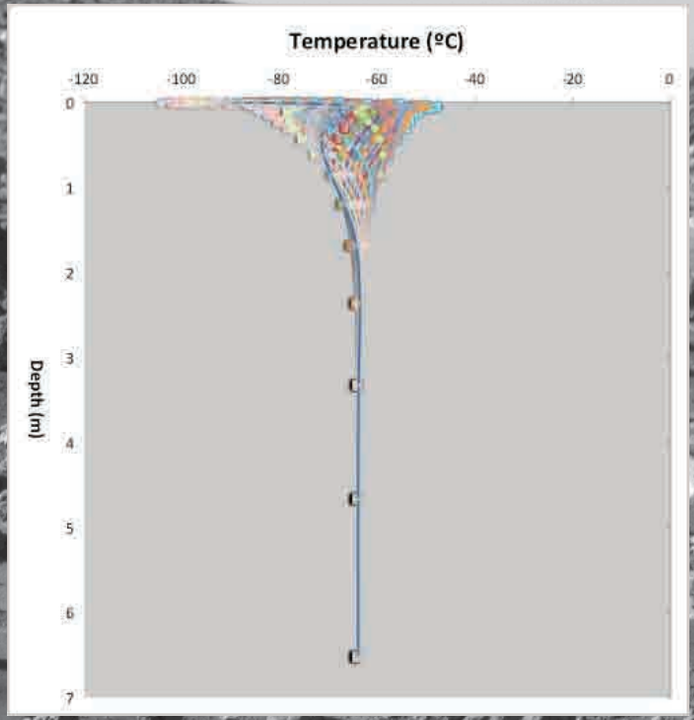
Utopia Planetia

Mars



Unknown directional polygonal ground discovered in Utopia Planetia. These polygons are unlike ice wedge polygons, but appear to be a somehow related geological structure.

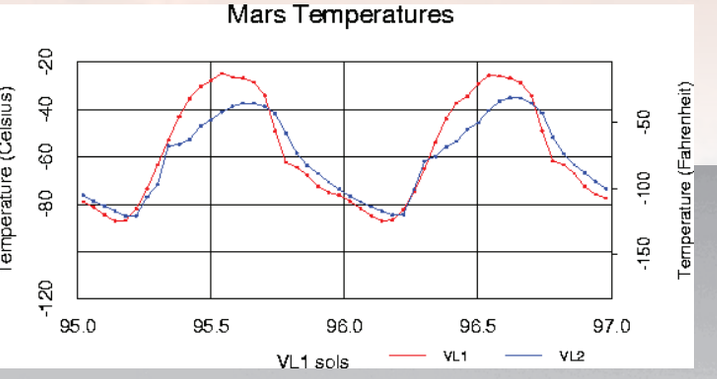
Utopia Planetia is one of the oldest and higher attention sites in the history of Mars exploration. Viking Lander 2 landed in 1976, taking first color frost picture from here at 48º North latitude.



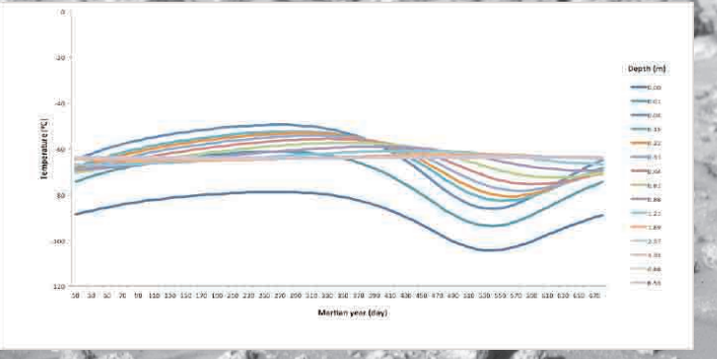
This trumpet curves were developed through model simulation of up to 6.5m depth at 35 degree North (south of Utopia Planetia). Amplitude of the ground surface temperature is similar like polar region drop to -126 °C during winter months and -50 °C in summer months. However, length of the warmer temperature periods longer that making zero anual amplitude permafrost temperature increasing about 40°C warmer. Model works are operated by M. Mellon (Icarus 169, 2004, 324–340)

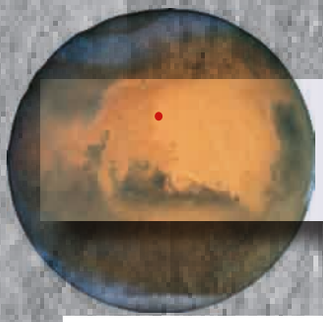
Ground temperatures and air temperatures generally differ, perhaps more so on Mars because the air is much thinner than Earth's (about 140 times thinner). The surface of a planet absorbs much of the solar energy, where the atmosphere lets the sunlight pass through it. So daytime high temperatures are usually higher for the ground than the air. An extreme example might be walking on the sidewalk or a beach, barefoot on a hot summer day. The air is hot, but the ground is much hotter and you could even burn your feet. Similarly the ground can cool at night, more efficiently than can the air, by infrared radiation. On Earth this can result in a dew or frost forming on the ground where warmer wet air contacts the colder ground (much like water droplets forming on the outside of a glass of ice water).

As for seasons, Mars experiences seasons like the Earth because of a similar tilt in its spin axis. The Martian year, however, is about 687 Earth days long. The average temperature on Mars is about -70ºC (-94 ºF). At the poles, night time temperatures can fall as low as -125ºC (-193ºF) at which point the carbon dioxide atmosphere starts to condense on the ground as frost. At the equator in the summer ground temperatures can rise above freezing and even be quite comfortable (to sit on - the air is still quite cold). But the dry atmosphere prevents liquid water from collecting (Mike Mellon).



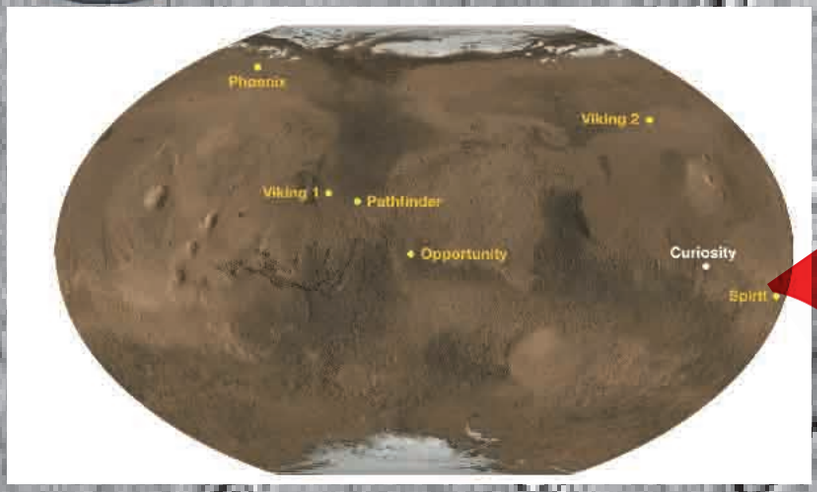
Actual daily temperature observations from Viking Lander 1 (VL1) and Viking Lander 2 (VL2) (above), and annual simulation results (bottom).





Equator regions and Elysium Planitia

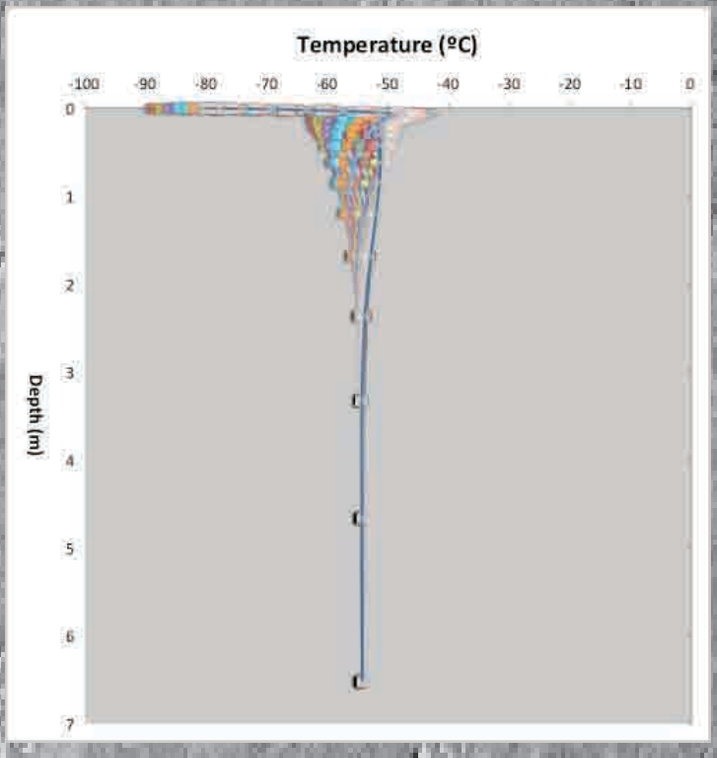
Mars



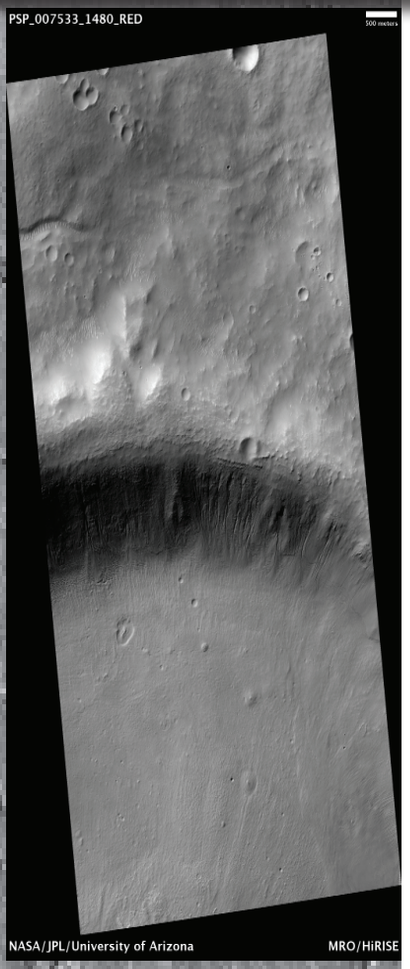
The Mars Science Laboratory spacecraft launched from Cape Canaveral Air Force Station, Florida, on Nov. 26, 2011. Mars rover Curiosity landed successfully on the floor of Gale Crater on Aug. 6, 2012, Universal Time (evening of Aug. 5).

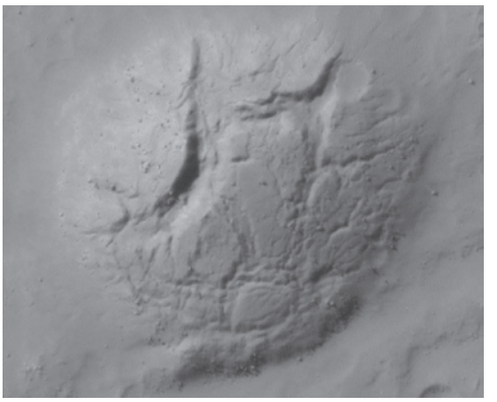
Image credit:
NASA/JPL-Caltech/MSSS

This is first 2cm deep borehole on Gale Crator, Martian ground.



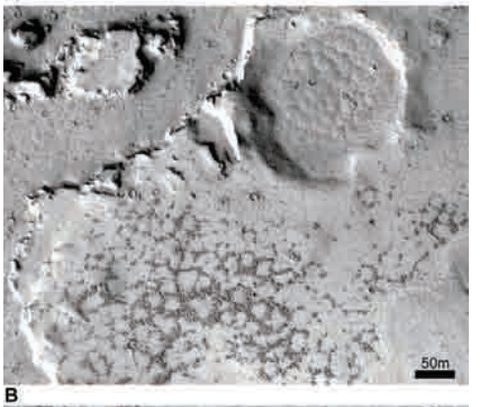
Mars is farther from the Sun than is the Earth; it receives less light from the Sun and it is colder. The average surface temperature on Mars is about 220K (-53°C). During the middle of the day at the equator, however, the temperature of the surface can rise to above the melting point of ice (273K, 0 °C, or 32° F); it occasionally will get as warm as a pleasant spring day on Earth. Of course, during the long polar night, when the Sun doesn't rise for half a year, the temperature can drop to as low as 140 K (-133 °C, or -207 °F).



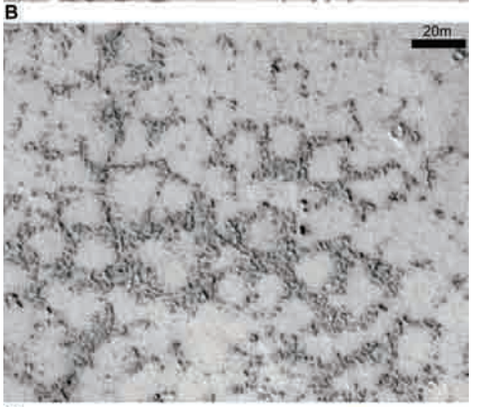


We can observe more active freeze-thaw cycles and fluvial processes in Mars' warmer equator regions. Pingo-like features are seen at the crator bottom (above picture). Stone circles (right picture, A) are seen similar to some terrestrial patterned ground (right, picture B, C). Many actual liquid movements (fresh gullies) are observed in crator walls as well (see D, E).

A



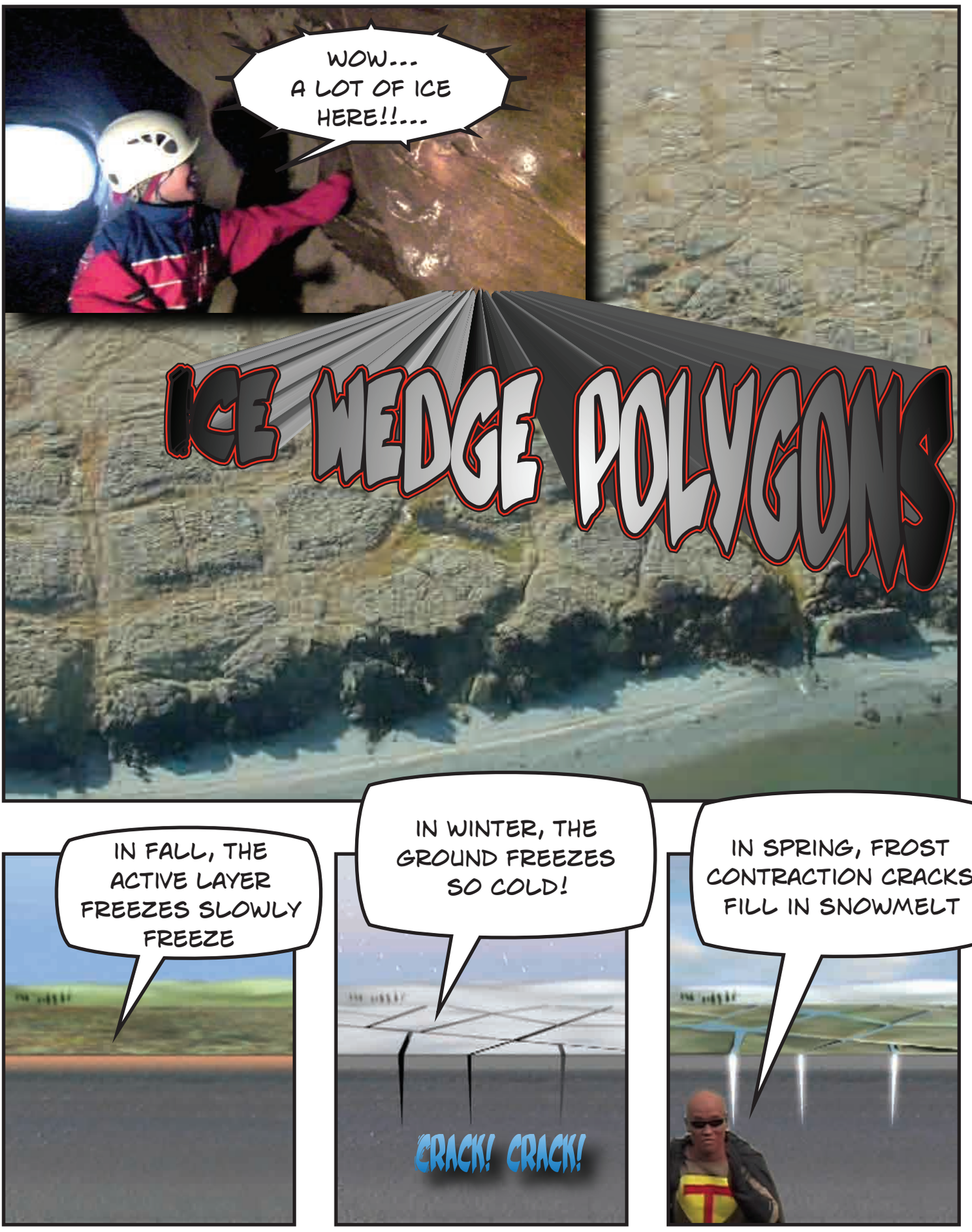
B



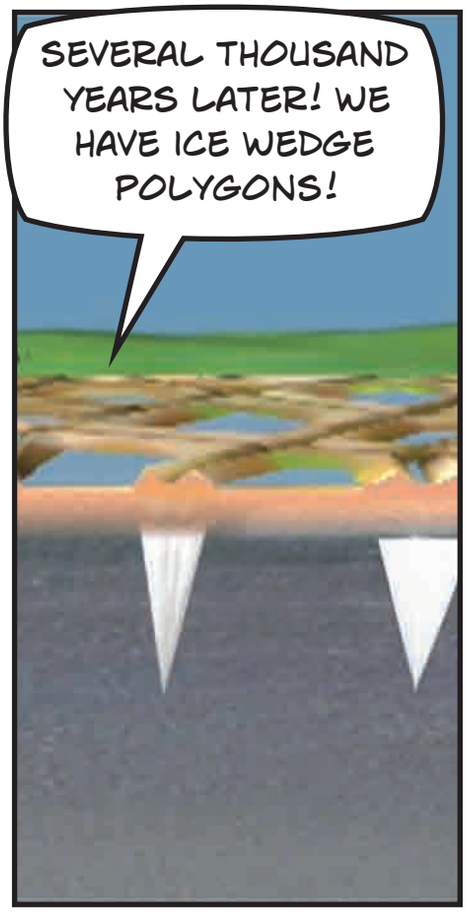
C

D

E


WOW... A LOT OF ICE HERE!!...
ICE WEDGE POLYGONS
IN FALL, THE ACTIVE LAYER FREEZES SLOWLY FREEZE
IN WINTER, THE GROUND FREEZES SO COLD!
CRACK! CRACK!
IN SPRING, FROST CONTRACTION CRACKS FILL IN SNOWMELT

MAKING TINY ICE WEDGES...
A FEW MILIMETER
IN WINTER, CRACK AGAIN!
CRACK! CRACK!
IN SPRING, SNOWMELT REFREEZE AGAIN IN THE CRACK
YEAR AFTER YEAR...

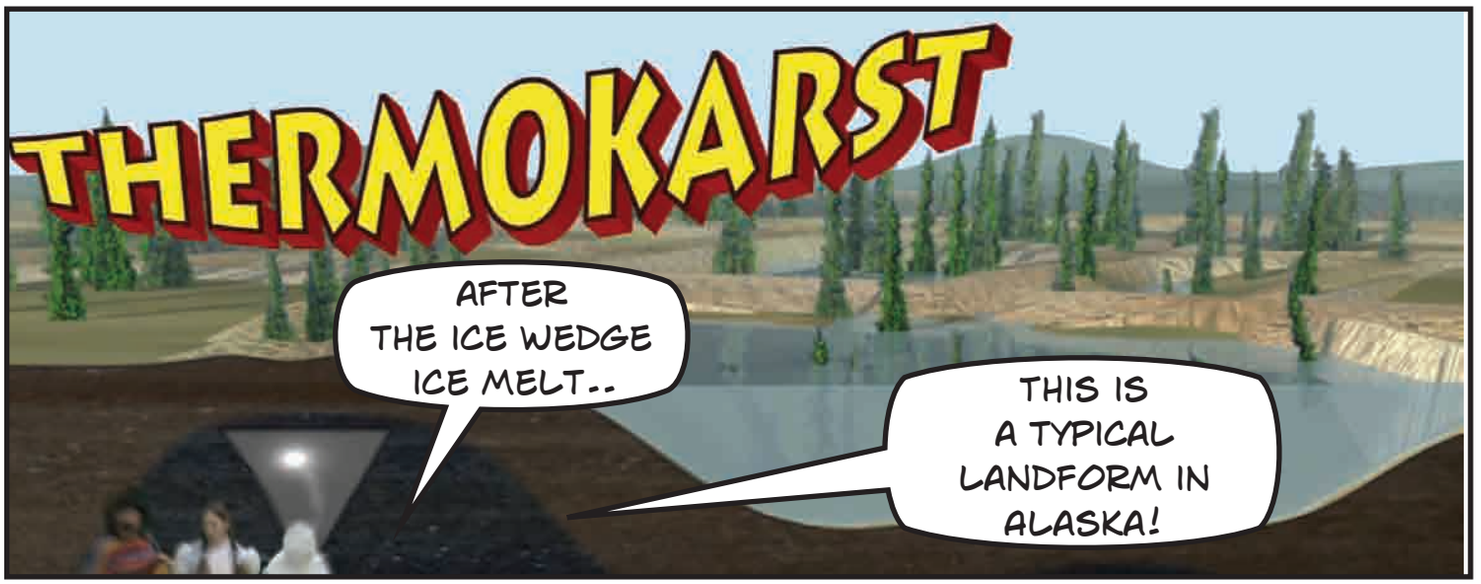

SEVERAL THOUSAND YEARS LATER! WE HAVE ICE WEDGE POLYGONS!

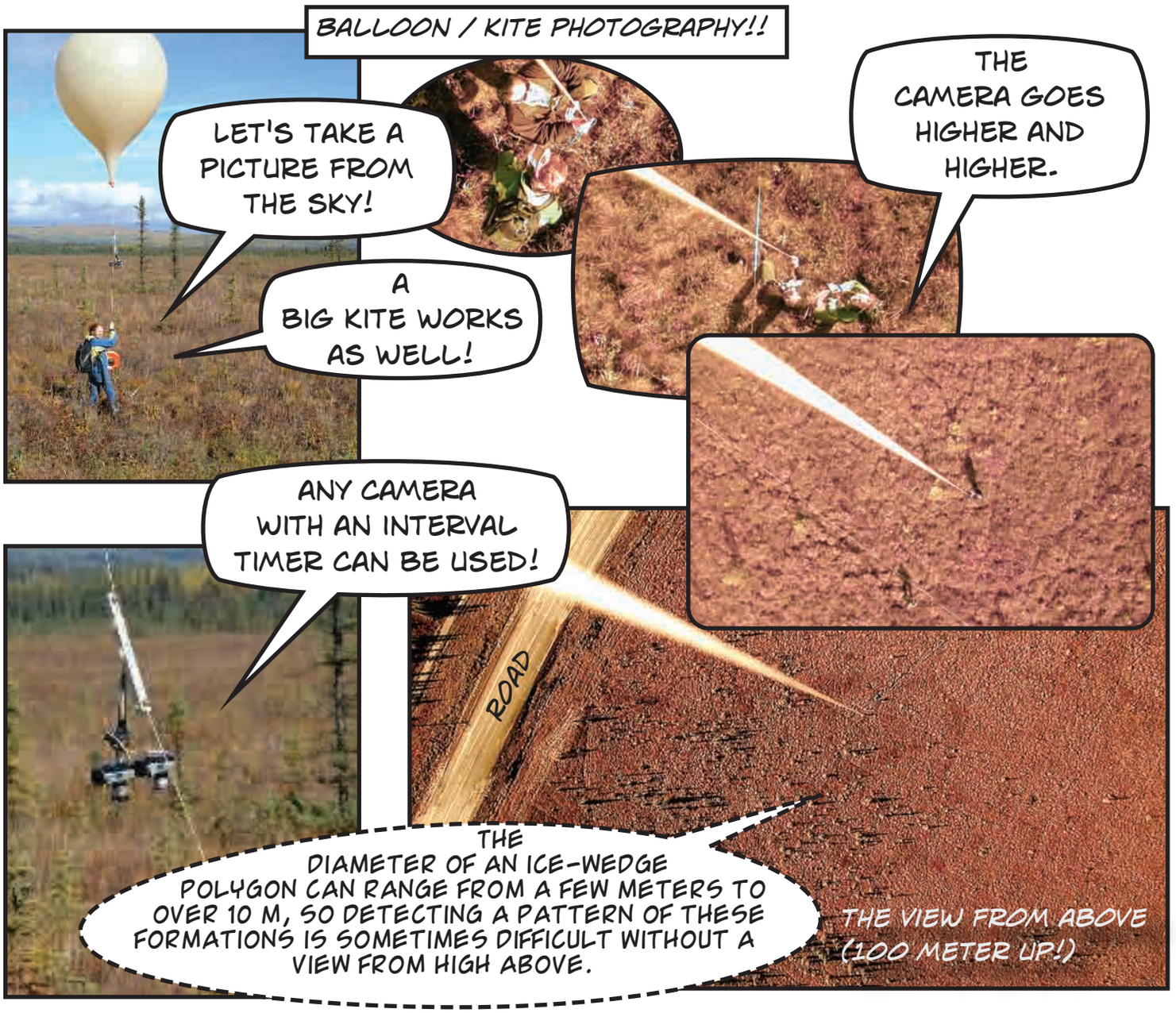
IF WE CLEAR THE LAND...
Active Layer
Ice Wedge
Permafrost

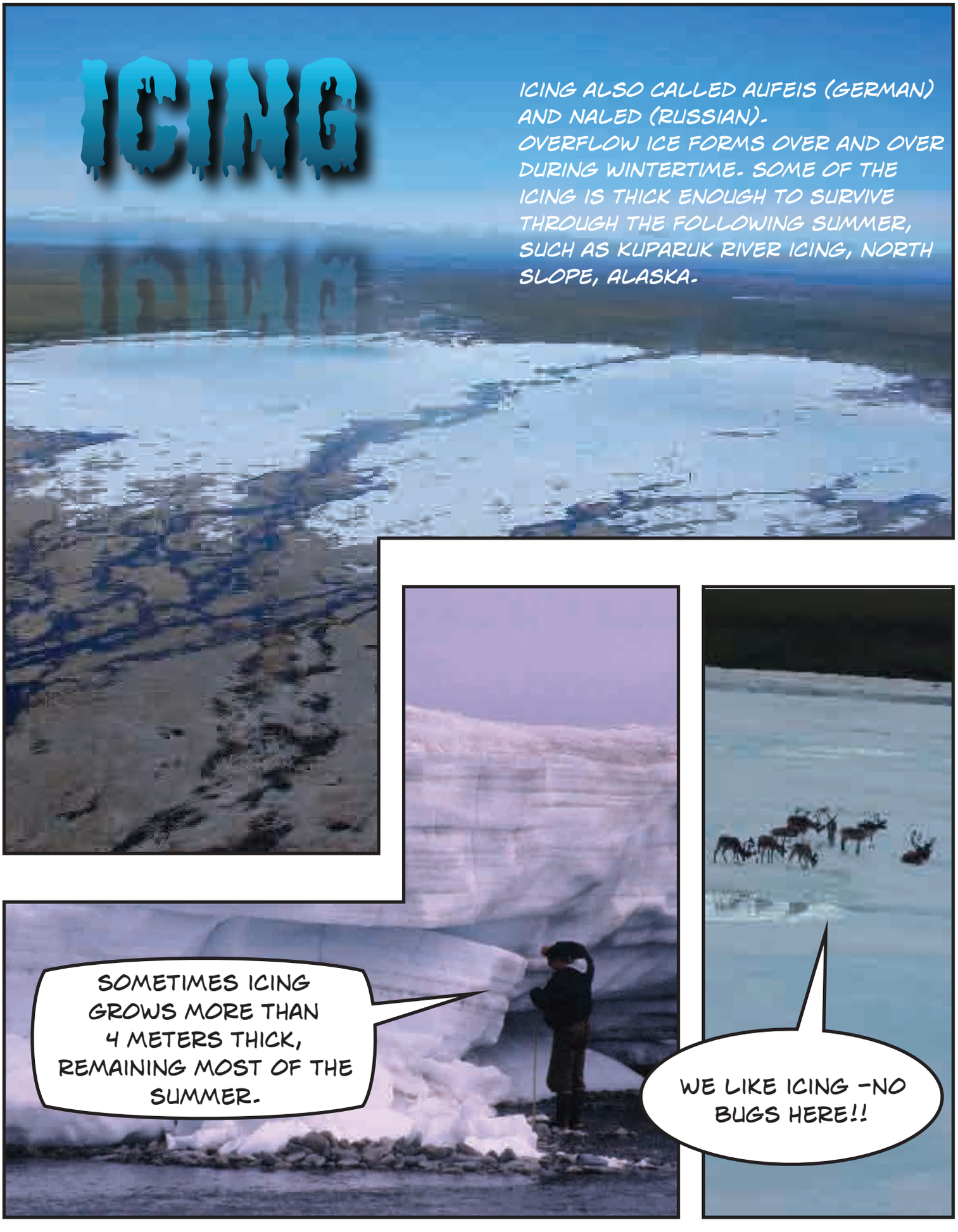
THE ICE SLOWLY MELTS

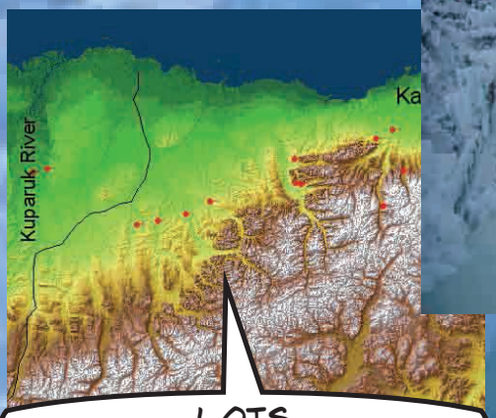
THEN THE GROUND COLLAPSES!

AS WE SEE TODAY!!

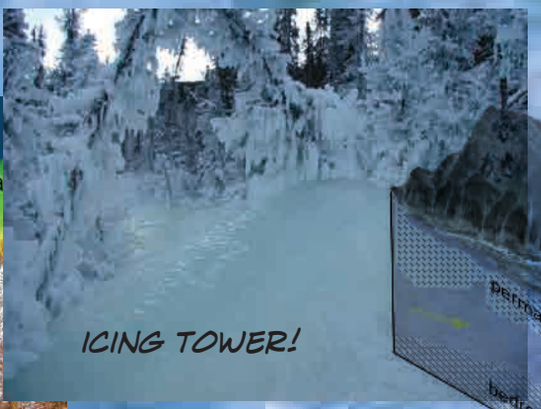

THERMOKARST
AFTER THE ICE WEDGE ICE MELT..
THIS IS A TYPICAL LANDFORM IN ALASKA!

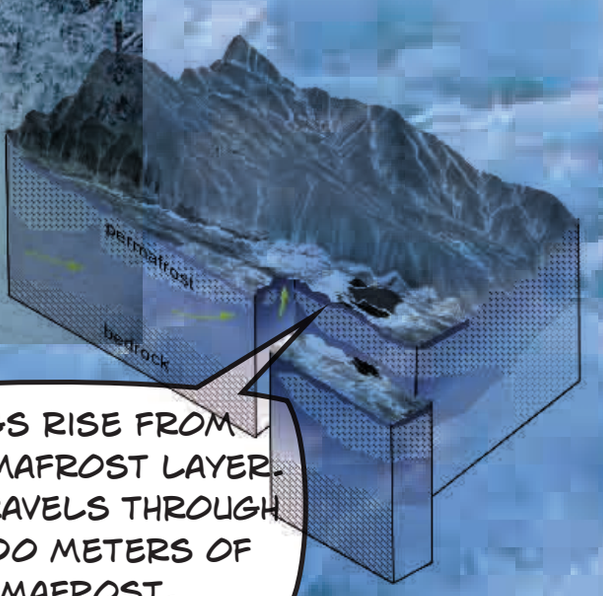

BALLOON / KITE PHOTOGRAPHY!!
LET'S TAKE A PICTURE FROM THE SKY!
A BIG KITE WORKS AS WELL!
THE CAMERA GOES HIGHER AND HIGHER.
ANY CAMERA WITH AN INTERVAL TIMER CAN BE USED!
ROAD
THE DIAMETER OF AN ICE-WEDGE POLYGON CAN RANGE FROM A FEW METERS TO OVER 10 M, SO DETECTING A PATTERN OF THESE FORMATIONS IS SOMETIMES DIFFICULT WITHOUT A VIEW FROM HIGH ABOVE.
THE VIEW FROM ABOVE (100 METER UP!)


ICING
ICING
ICING ALSO CALLED AUFEIS (GERMAN) AND NALED (RUSSIAN).
OVERFLOW ICE FORMS OVER AND OVER DURING WINTERTIME. SOME OF THE ICING IS THICK ENOUGH TO SURVIVE THROUGH THE FOLLOWING SUMMER, SUCH AS KUPARUK RIVER ICING, NORTH SLOPE, ALASKA.
SOMETIMES ICING GROWS MORE THAN 4 METERS THICK, REMAINING MOST OF THE SUMMER.
WE LIKE ICING -NO BUGS HERE!!



LOTS OF ICINGS (SPRINGS) IN NORTH-FACING FOOTHILLS OF EASTERN BROOKS RANGE.

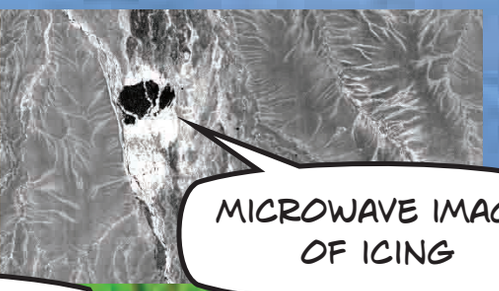




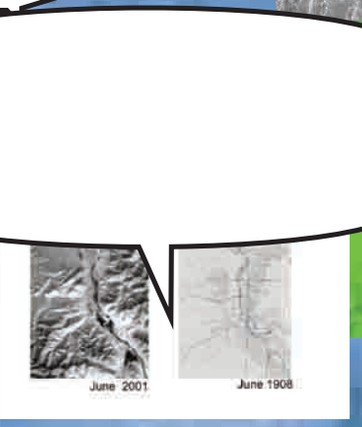
SPRINGS RISE FROM SUB-PERMAFROST LAYER. WATER TRAVELS THROUGH OVER 300 METERS OF PERMAFROST.

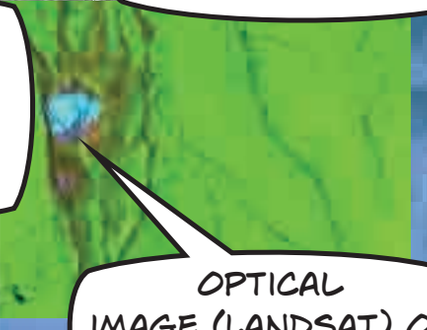
TIME SERIES OF MICROWAVE (SAR) SATELLITE IMAGES AT HULAHULA RIVER ICING NEAR KAKTOVIK. THIS IMAGE SHOWS ICE FORMATION (BLACK) AND SHRINKING. A SAR SATELLITE CAN OBSERVE ANYTIME THROUGH THE CLOUDS, DAY OR NIGHT.

ICING CAN BLOCK ROADS AND DRIVEWAYS, OR INVADE HOUSES! A STEAMER IS THE BEST WAY TO THAW ICING!!

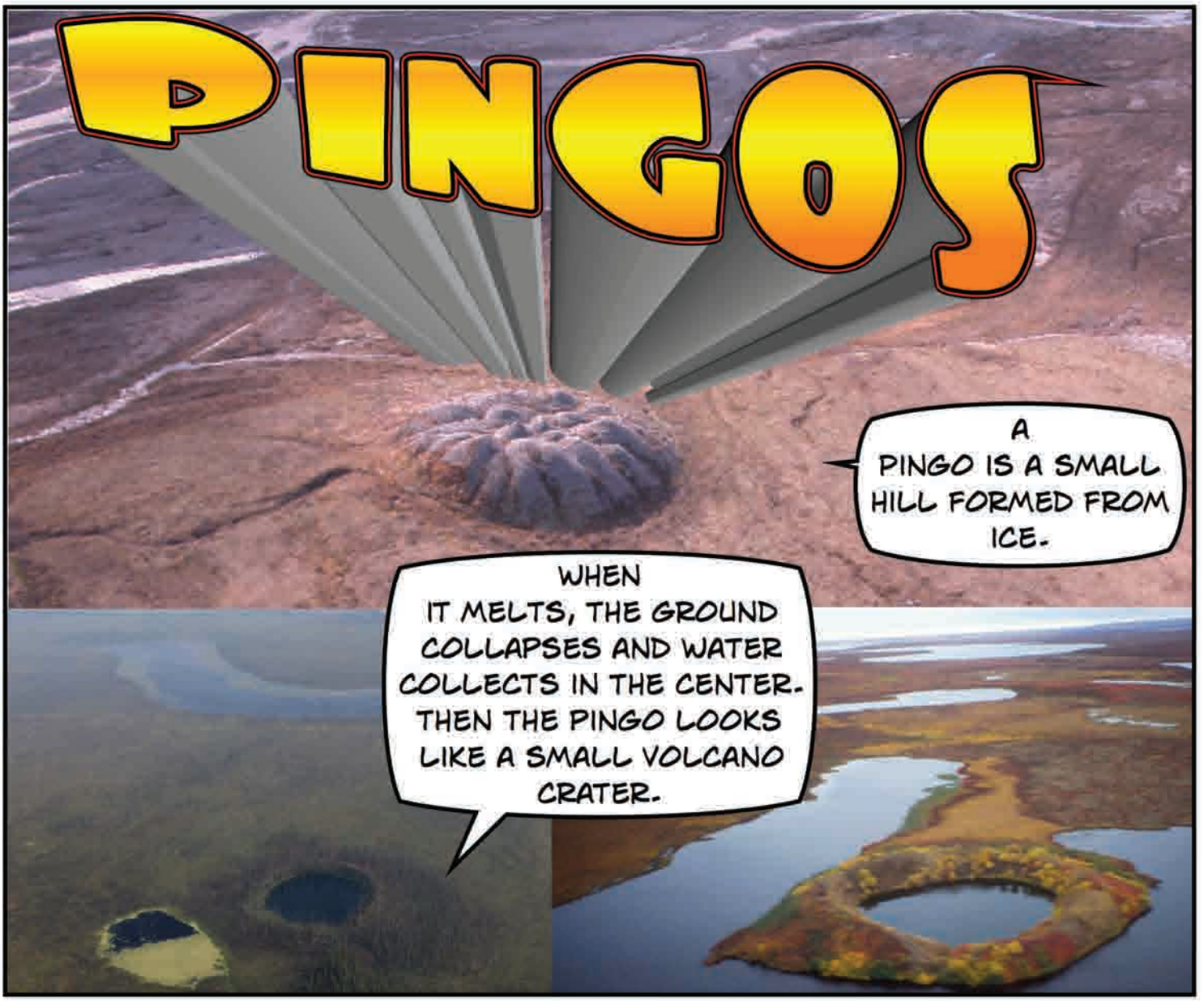


MICROWAVE IMAGE OF ICING

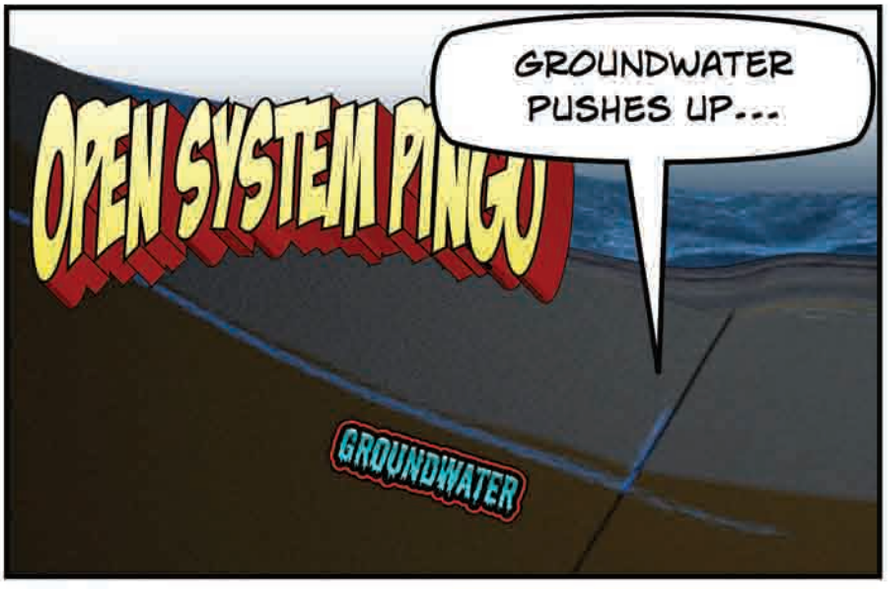


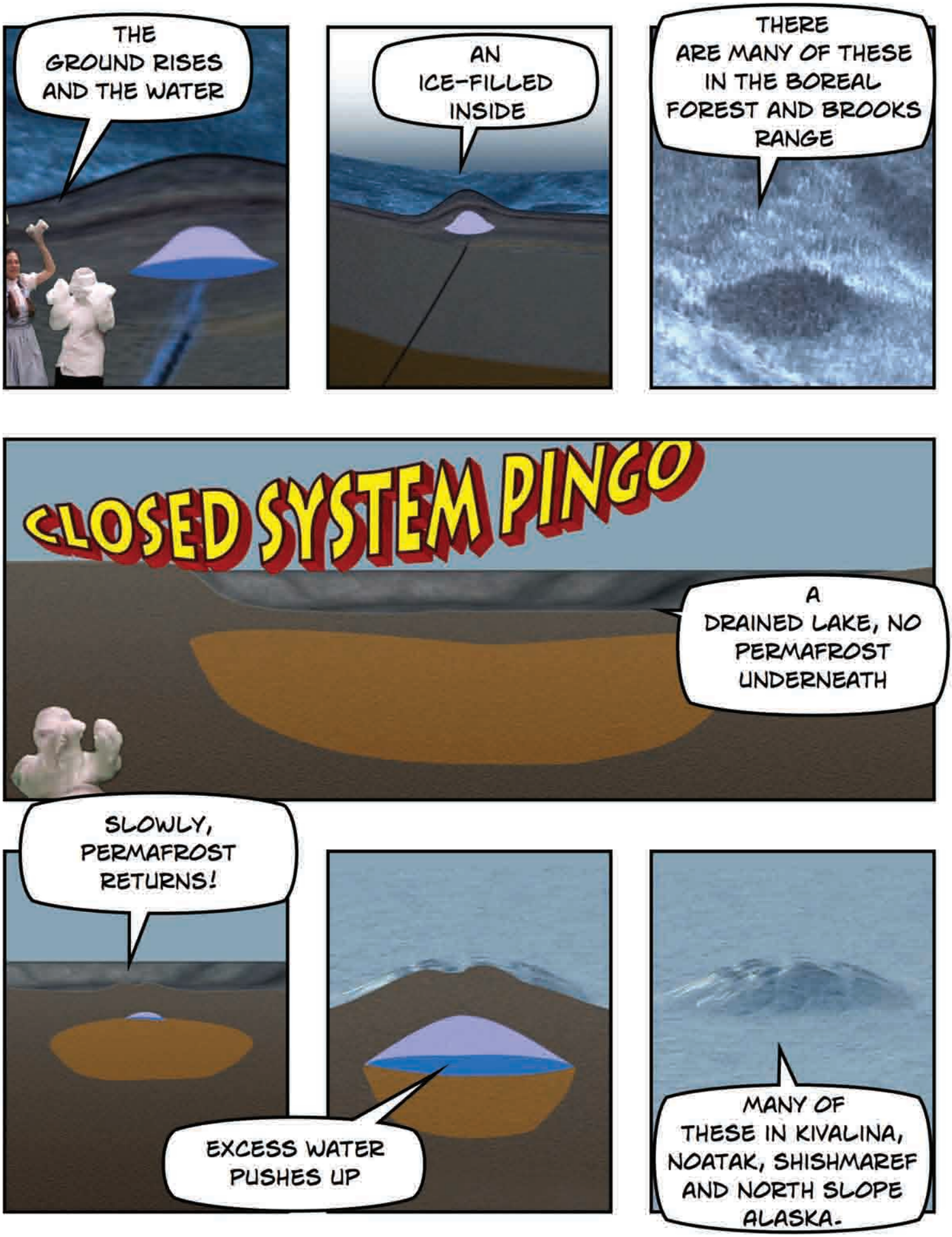


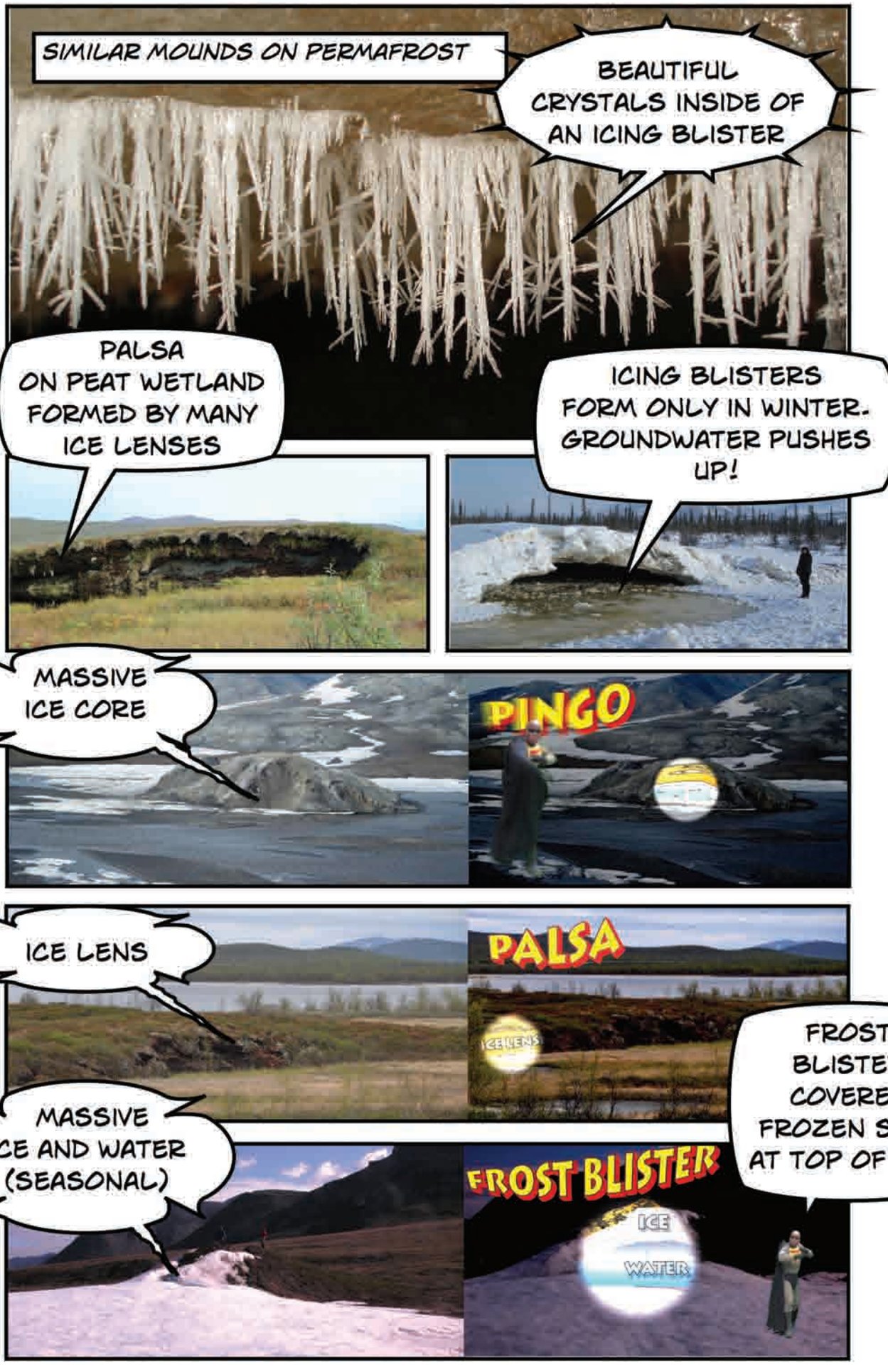
OPTICAL IMAGE (LANDSAT) OF ICING

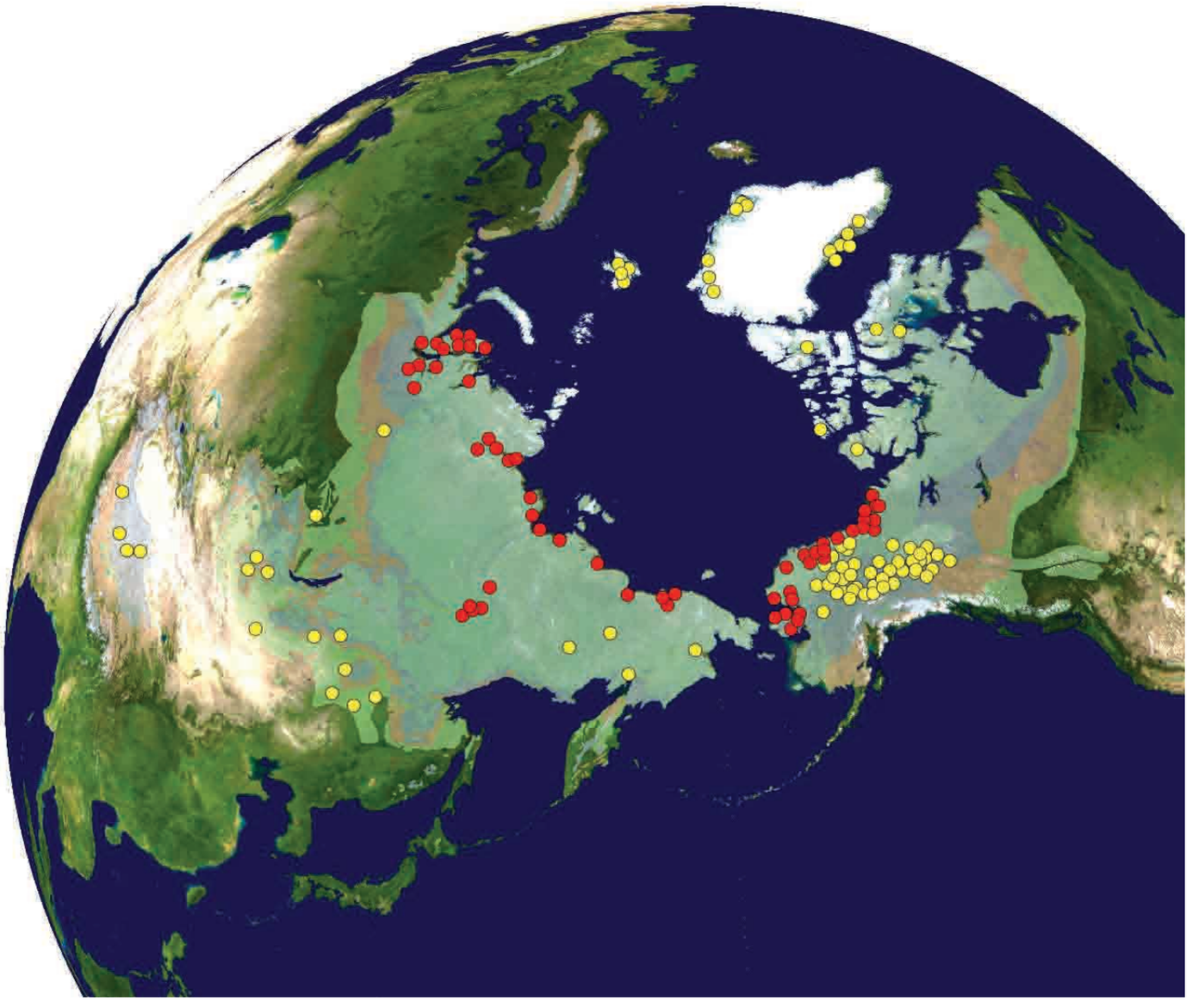

PINGOS
A PINGO IS A SMALL HILL FORMED FROM ICE.
WHEN IT MELTS, THE GROUND COLLAPSES AND WATER COLLECTS IN THE CENTER. THEN THE PINGO LOOKS LIKE A SMALL VOLCANO CRATER.

OPEN SYSTEM PINGO
TWO TYPES OF PINGO IN ALASKA!
CLOSED SYSTEM PINGO


GROUNDWATER PUSHES UP...
OPEN SYSTEM PINGO
GROUNDWATER


THE GROUND RISES AND THE WATER
AN ICE-FILLED INSIDE
THERE ARE MANY OF THESE IN THE BOREAL FOREST AND BROOKS RANGE
CLOSED SYSTEM PINGO
A DRAINED LAKE, NO PERMAFROST UNDERNEATH
SLOWLY, PERMAFROST RETURNS!
EXCESS WATER PUSHES UP
MANY OF THESE IN KIVALINA, NOATAK, SHISHMAREF AND NORTH SLOPE ALASKA.


SIMILAR MOUNDS ON PERMAFROST
BEAUTIFUL CRYSTALS INSIDE OF AN ICING BLISTER
PALSA ON PEAT WETLAND FORMED BY MANY ICE LENSES
ICING BLISTERS FORM ONLY IN WINTER. GROUNDWATER PUSHES UP!
MASSIVE ICE CORE
PINGO
ICE LENS
PALSA
ICE LENS
FROST BLISTER COVERED FROZEN SOIL AT TOP OF ICE.
MASSIVE ICE AND WATER (SEASONAL)
FROST BLISTER
ICE
WATER



Pingos of the world!! (yellow dots: open system pingos, red dots: closed system pingos)

Solifluction

Solifluction lobes are commonly seen in permafrost region. This is the freeze-thaw process taking over thousands years to downslope flow over permafrost. It is visible on some mountain slopes in a pattern of connected lobes of vegetation.

BEAUTI FUL SOLIFLUCTION

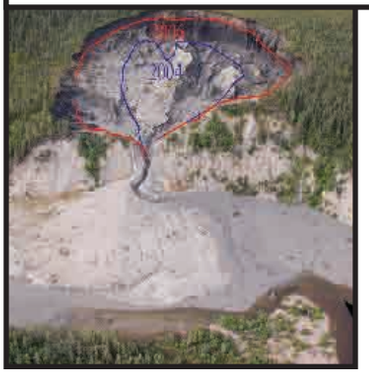
DURING FREEZING PERIODS, ICE LENS LIFT SURFACE MATERIAL.

AT THE SLOPE, AFTER MELTING ICE, SURFACE MATERIALS DOWN SLOPE.

Retrogressive Thaw Slump

Retrogressive thaw slump is large scale land slide caused by thawing permafrost.

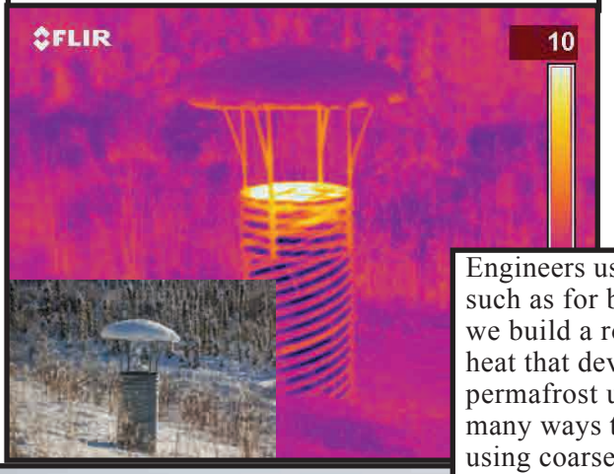
THIS SLIDE CONTINUED TO IMPACT THE RIVER SYSTEM FOR SEVERAL YEARS.



Once buried glacier ice or massive ice melts out and flushes away the thawed materials make this landscape.

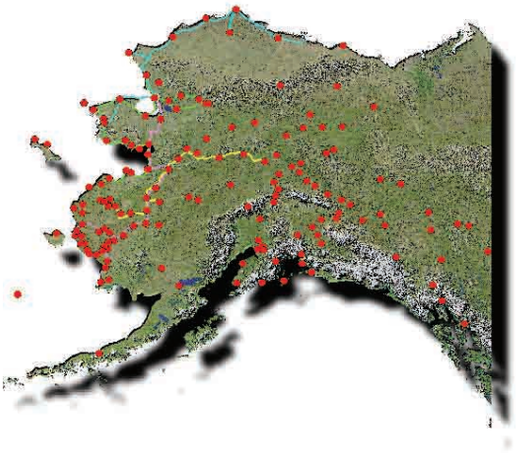
Rock glaciers are made up of boulders and big rocks that have been transported by former glaciers or avalanches. Ice is bonded in spaces between the rocks. Rock glaciers form and creeping down ward. Their movement is due to the flow of ice within them.

In Alaska, rock glaciers develop at the southernmost point of where we find permafrost. For example, we don't find permafrost in Valdez, but we do find rock glaciers there. Why? Because Valdez is not cold enough to form permafrost, but in a rock glacier, even in summer, these underground air spaces stay cool. During winter, any warmth leaves the rock glacier and cold air sinks into it, making the rock glacier several degrees colder than the surrounding terrain.



Engineers use cooling system principal same as rock glaciers, such as for building **road embankments** in permafrost regions. If we build a road embankment with angular rocks, the convective heat that developed between the rocks keeps the road cold so that permafrost underneath the rock won't thaw. Though there are many ways that roads can be built to stay cool, this method of using coarse gravel is easy, inexpensive, and efficient. The method was used in Tibet to build the Tibet Railway

Riding the wind...



Snowmachine travel took place in spring of 2007, 2008, 2009 and 2013. We visited 96 communities, traveling 7000 miles (12,000 km) to set up monitoring sites. We used trails between communities—snowmachine trails, dogmushing trails, the Iditarod trail, and the Iron Dog trail, but not always. Sometimes we had to break trail. In the forest, snow was deep and it was difficult to make trails because of trees, but on the tundra, hard-packed trails made travel easier.

4 steps at each community

1. Contact community
2. Drill
3. Install
4. Meet students

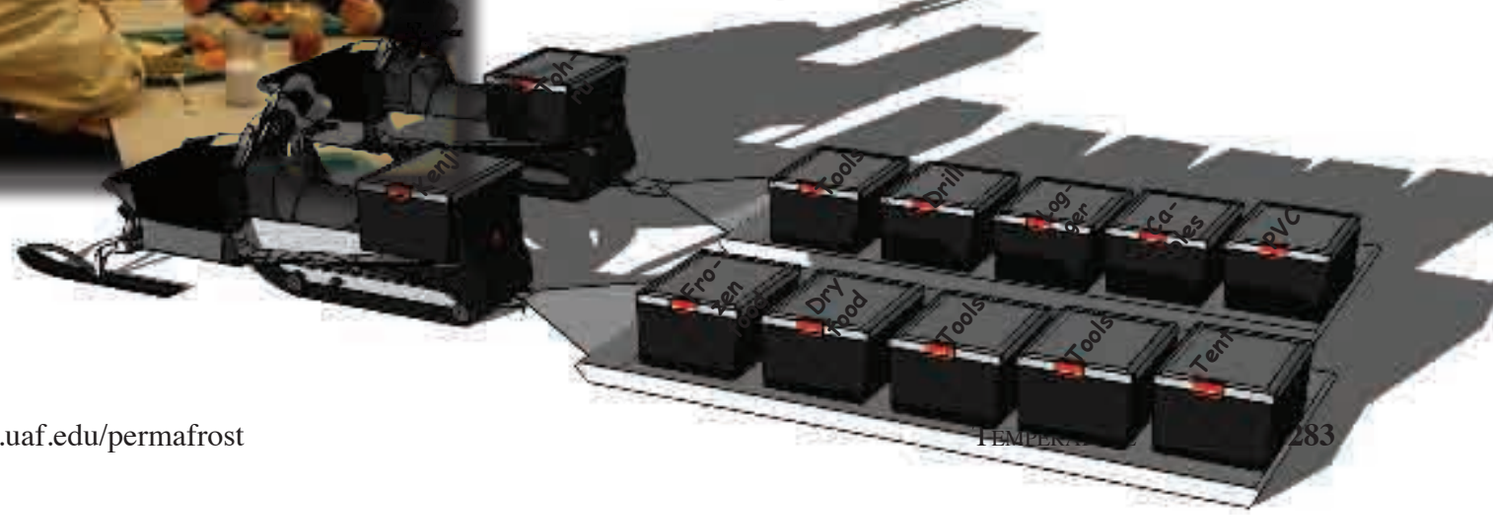
Warmth and shelter: An Arctic Oven is in the sled for emergency shelter, but in the communities, we stay at the school building. We dress for cold climate: long underwear, work clothes, insulated overalls, warm socks and boots, parkas with polar bear and wolverine fur ruffs, goggles, and face masks. Heat from the snow machines' driving handles warm our gloved hands, though we also bring warm mitts. High windshields on the snow machines block the wind.

This snow machine is a liquid-cooled, 4-stroke, 800 cc, wide-track luxury model: heavy, powerful, quiet, not smelly, but it must be plugged in in extreme cold. This workhorse is never stuck; it gets good gas mileage--about 10 mpg. We thaw and heat food in a metal container attached to the hot muffler, so we always have warm food for the trail.

Travel takes place in late winter, when daylight grows longer: two travelers, two snow machines, two loaded sleds. Sleds are made of high-density polyethylene; each sled carries about 1200 pounds of supplies—drilling and monitoring equipment, food, spare parts for repairs, emergency gear, and fuel.

We travel on frozen rivers, land, and coastline, navigating by map. Trail conditions can be smooth, rough, wind-blown, and even sandy, but travel only stops for windy snowstorms. In case of emergency, we bring a SPOT, GPS, cell phone, satellite phone, and emergency beacon. These important tools were not available to us 20 years ago. Then we would have used a sextant to determine our location. Sextant and...we need know stars!! I used to use sun for position (moon is difficult to calculate!). The accuracy was within 1-2km. This is very good at the middle of nowhere! But I always (still now) practice recognizing names of bright stars. This is important, because weather is not always clear. You might see only one star between the clouds. If you know the name and successfully measure, you got position! Navigation was a great fantasy; you need to talk with a star somewhere on Earth. Then you know your destination. We have lost this romantic navigation today...

Nourishment: We bring food that can freeze—ice cream is perfect!—and thermoses of hot water.



Challenges on the Trail

No Snow ?!

Snow machines are made for riding on snow, but frequently there is no snow because wind blows it away or covers it with sand. Riding over sandy snow, bare tundra, and exposed ice often means trouble because snow machines are not designed for such conditions. We try to avoid driving on sand because the engine has to work so hard. It feels like the breaks are dragging, and sand can damage the engine if too much gets in the snow machine's air intake and past the air filter. Travel on sand wore out one of our sled keels, causing it to bend and come apart.

Controlling a snow machine on bare ice is difficult, especially when towing a 1200-pound sled. If a snow machine slides sideways, the momentum of the sled behind it can cause both to jackknife and slide out of control—never a good idea near open water! It is hard to get traction on bare ice. In Bethel, where there is lots of exposed ice, I saw a smart solution to this problem. Snow machiners put spikes in their snow machine track. and the spikes dig into the ice. Traction problem solved! Rough trails are hard on snowmachine parts, which loosen and sometimes break. Sometimes the front runners get loose and don't track well. We lash a pole between the runners to keep them parallel.

Snowmachine is not the perfect vehicle. We have to pay attention to any changes in the way the machine drives or sounds while on the trail, otherwise we do serious damage.

The connection between the snowmachine and the sled is the greatest stress point. The heavy sled connects at only one point, and this is a problem especially on a long, rough trail. If the metal eye-bolt and J-hook have different hardnesses, the connector with softer metal wears out quicker. Even with a brand new sled, this happened within 1000 miles.

In general, the difference in water level between high and low tide in northern coastal areas is not great, but not so in Bristol Bay, where sometimes there is a difference of over 10 feet between high and low tide. When we travel on sea ice or along the shoreline in Bristol Bay, we go during low tide, and we carefully pick our route out on the ice so that we avoid open water when traveling back to shore.

Open water and overflow make me nervous. Overflow is not such a problem because the water is shallow; we just keep moving. Open water is another story! Open water in a big river is a worry because when ice is bare of snow, it is hard to see the dark open water. A snowmachine might safely skip over a narrow crack of open water, but not when pulling a sled. The first is risky; the second is impossible and unwise.

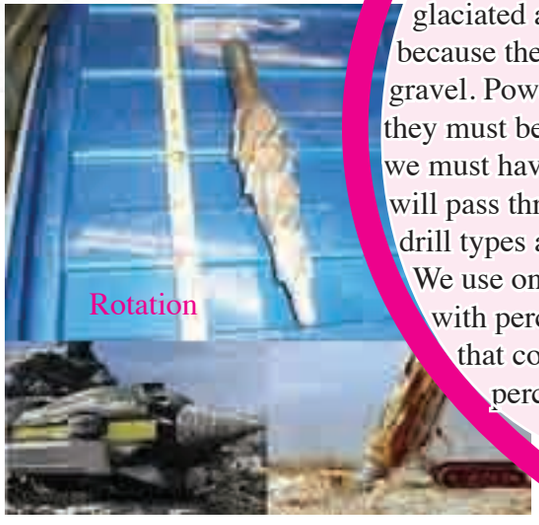
When overflow refreezes, it sometimes creates a thin sheet of ice that covers a hollow space beneath. This air pocket can be 3 feet deep. If the snow machine breaks through this ice and drops into a hole, the driver can get hurt. To get the snowmachine out of the hole, the sled, which carries nearly 1200 pounds of supplies and equipment, must be unloaded to unhitch it from the snow machine. We must be careful because we're walking on thin ice. Then we must get the heavy snow machine—about a 1000 pounds fully loaded— out of the hole.

Wind always blows along large rivers and coastal Alaska, but it is not as big a problem as no snow, open water, and tides. Sometimes the wind builds ice ridges that are often difficult to cross. I noticed that dogmushers have problems in the wind because they have no windshield for protection, but snowmachines have windshields and warm hand grips. The wind direction helps us navigate, but we must pay attention to the weather, too, because wind direction can shift with a change in weather and throw us off course.

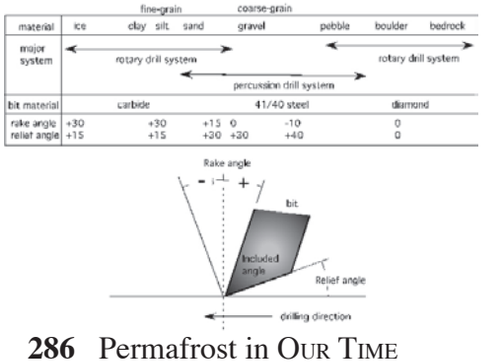
The drill bit is one of the most important parts of the drill system. It must be hard enough and have the best shape for passing through boulders and frozen gravel. We tested many different bits for dry rotary drilling. Some worked great; some, not so great.

Portable Drill

We drill through permafrost in many types of conditions. Icy silt and sand are easy to drill, but glaciated areas are harder to drill because there are lots of boulders and gravel. Powerful drills are needed, but they must be light enough to carry, and we must have a well-designed bit that will pass through rock. Several different drill types are needed for this work. We use one with rotary action, one with percussion action, and one that combines rotary and percussion.



Designing a drill bit is one of the fun parts of this work. I remembered a 1960s kids' TV program about an underground vehicle that could go amazingly fast into the ground, like a mole. I asked Jon Holmgren from Jon's Machine Shop to build a "mole"-like bit. Jon is a brilliant mechanical engineer living in Fairbanks. He has helped me for over 10 years to create new drill systems. Jon designed the mole bit and it works well, though it doesn't move through the ground as fast as the fantasy underground vehicles on TV.



The auger bit moves easily and fast through ice and frozen silt. It's good for making the hole for temperature monitoring, but has difficulty going through gravel layers. The core bit is used for core sampling; it drills through gravel layers better than the auger bit. We have several different shapes of the core bit using carbide or diamond.

A jackhammer is a powerful tool for breaking rock, ice, and permafrost. Its greatest limitation is how deep it can go—usually only 5 to 10 feet. We tested a gas-powered Swedish rotation jackhammer that could go 20 feet deep to bedrock, even through granite. When we tried it in rocky permafrost, it did not work! Its strong percussion power was absorbed by the wet, silty material and meltwater that was created by the impact. So this jackhammer works wonderful for dry bedrock but not for frozen silty gravel!

Jet/ Wet/ Air

Water/air swivels are a great idea for removing cutting chips at the bit. These systems require a large air compressor (>100 CFM) or high-pressure water pump (2GPM), and work great with our portable drill system. The swivel connects the water or air line during rotation (drill power head). In general, the actual ground drilling system includes three major actions: (1) rotation drilling, (2) high-pressure forced water/air that pushes away cutting chips, and (3) impact shock. Once we begin drilling in permafrost, we like to keep everything frozen for minimum disturbance. To do this, we chill the swivel system, using super cooled water or chilled air.

Purcussion

The electric drill is easy to use and works great in cold temperatures, but requires at least a 2K generator to power it. The mechanical drill is more powerful, but is harder to start in cold temperatures.

A percussion drill is an ideal drill head for a portable drill system. We use a heavy-duty electric percussion drill for drilling in permafrost. In general, this works better than just a rotation drill, but it's not a super great system. More improvement is needed!

WE DECIDE ON A DRILL SITE, A LOCATION THAT IS UNDISTURBED.
IN THE FIELD...
THE AUGER IS 1 M LONG. TO DRILL DEEPER, WE MUST EXTEND IT.
SOMETIMES WE HIT SOLID ICE. A PIECE OF CAKE!
WE HAVE TO CLEAN THE AUGER BEFORE EXTENDING IT SO IT WON'T GET STUCK.

SOMETIMES A PLUG OF FROZEN SOIL STICKS TO THE AUGER.

WHEN THIS HAPPENS, THE POWER HEAD CAN'T ROTATE. WE HAVE TO USE A WRENCH TO PULL THE AUGER FROM THE GROUND; THEN WE BREAK THE PLUG OFF THE AUGER.

IMMEDIATELY AFTER THE HOLE IS DRILLED, WE INSERT A SMALL PVC PIPE AND ...

CUT THE PIPE.

WE PUT TEMPERATURE SENSORS IN THE PIPE AT DIFFERENT DEPTHS.

WE CONNECT TEMPERATURE SENSOR TO THE DATA LOGGER, WHICH SITS IS IN A LARGER PIPE ABOVEGROUND.

WE START THE DATA LOGGER AND...

CAP THE PIPE. AFTER ALL IS DONE, TIME TO EAT!!

Up, up, and away...

Our pilot, Ricky Yuguchi, was originally a fighter pilot for Japan's defense force. He first visited Alaska when training with other pilots from the U.S. and Japan at Eielson Air Force Base. When Ricky returned to Japan, he quit working as a fighter pilot, and began to fly a small 2-person airplane, called a Husky. This Husky's best selling point is its big tires; it can land almost anywhere. Three years ago, Ricky joined our program. He travels to villages to maintain data loggers and download data.

Calcurating payload and gas milage (by hour) is the life line for a bush pilot!

Husky landing on beach near Kivalina

FLYING ALON IS LONLY BUT VILLAGE KIDS MAKING ME HAPPY!

ALASKAN DEEP BLUE SKY!
SO SPECIAL! WE LIKE TO UP, UP AND AWAY BEYOND THE HORIZON...

WHEN FLYING TO VILLAGES, RICKY BRINGS HIS BICYCLE TO GET AROUND.

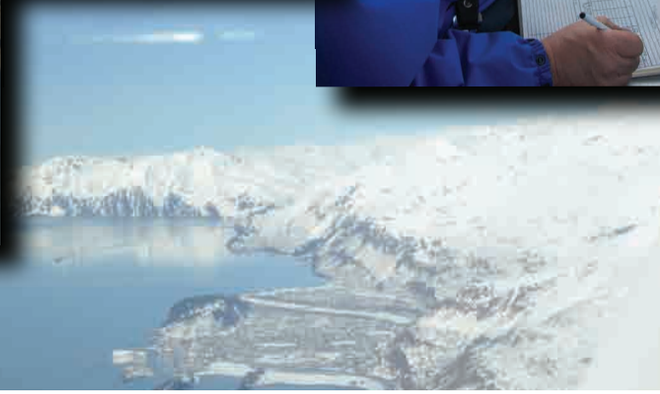
flyng over communities, day and night...
photo: Isao Yuguchi
PHOTOS:ISAO YUGUCHI

Sometimes we use a charter flight. Wright Air Service helps us get to remote communities, such as on islands or across large fjords. Our pilot, David Lorring, is a great person to work with; he's interested in education outreach and is an excellent pilot. We fly in a Cessna 206 or a Navajo. Both planes can

We used a thermal camera to take village picture!

Chenega Bay, beautiful village

Windy Wales!

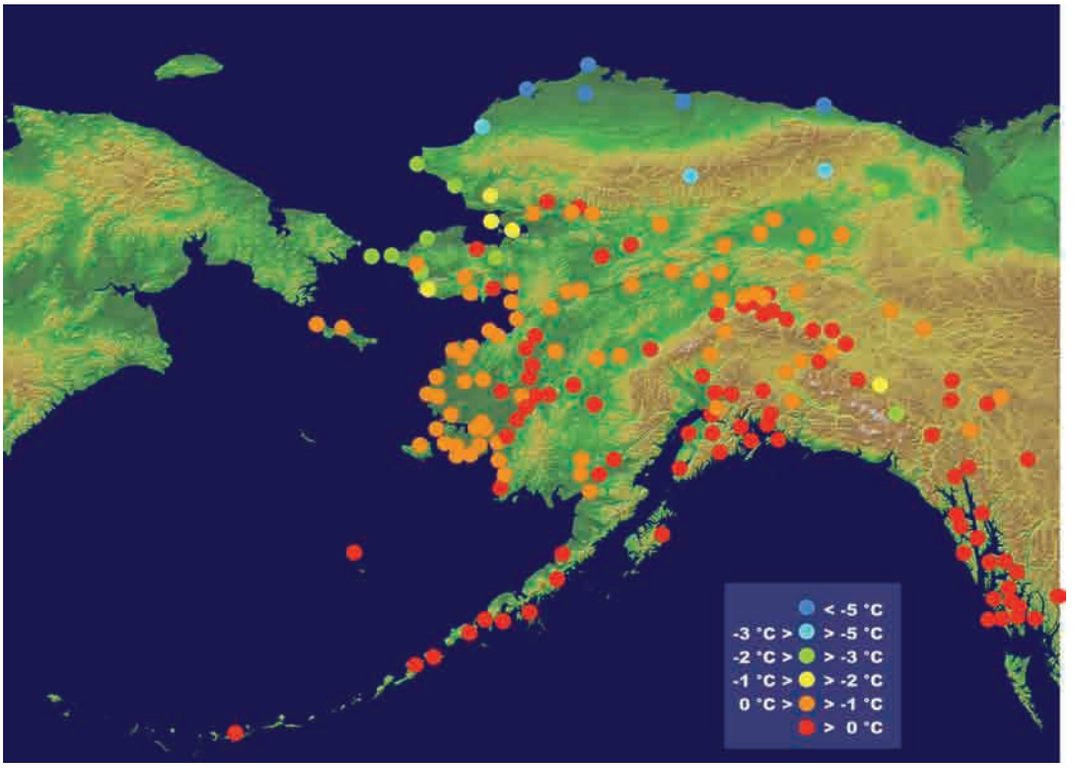


Epilogue

Life is too long if we don't do anything. But it's way too short if we try to do challenging things. We will regret things we didn't do, but it's better to not regret what we did do. We should keep going. This magazine is the first step of our results from our travels around the north. I have dreamed about crossing the snowy tundra, finding routes through thick boreal forests, or boating to coastal moisture-rich fjords with a goal of traveling to all Alaska's remote villages. Honestly, I always feel fear when planning these trips, and sometimes I could not sleep thinking of the next new adventure. But my passion overwhelms this fear. I really enjoyed planning these trips, going on them, meeting you and retrieving data. These are wonderful dreams that I'm always looking for. There is no reason to stop. I feel I can relate to explorers of the old days like Dr. Fridtjof Nansen. He wrote in 1897, at the end of his Fram expedition, in "Farthest North":

The ice and the long moonlit polar nights, with all their yearning, seemed like a far-off dream from another world-a dream that had come and passed away. But what would life be worth without its dreams?

At the very end of this story, I show here one of the great results of our program — the annual mean ground surface temperature map of Alaska and Yukon Canada. You will see most of the communities are located in regions warmer than -1 ºC. We should definitely keep monitoring temperature for future study. I hope many of the students from these villages study permafrost in the future.



The annual mean ground surface temperature map of Alaska and Yukon Canada

Future data will be updated by monthly. Many sites have available data, but time constraints did not allow for calculation of the mean annual temperature and freezing/thawing degree days by the time of this publication. Please check for further information at the following link:

http://www.uaf.edu/permafrost

or contact: kyoshikawa@alaska.edu

Data citation will be
K. Yoshikawa, 2013. “community name” Pages XX-XX in K.Yoshikawa edit, *Permafrost in Our Time*, University of Alaska Fairbanks, Valencia, California, USA, pp 1-300.

We appreciate your interest in the data set. Please take a moment to contact us and let us know if this data was helpful to you and how it applies to your project.

Aknowledgements

Since 2005, I have met so many people who have helped and supported this program. Especially I deeply appreciate the principals and science teachers in each community, the local tribal government leaders, and my friends living in remote communities. Thank you for working with me and my team, granting us a chance to share our lives together. This program was definitely impossible to run without all your support.

Our science team also provided great information and visited schools with me. I would like to thank all our colleagues and friends, especially Isao Yuguchi (a great pilot and photographer), Ryota Kajita (Tunnelman editor, cameraman), Tohru Saito, Ned Rozell, Akio Hachinohe, Miho Aoki, Matt Irinaga, Shuko Nishiyama, Jon Holmgren, Dave Lorring, Andrea Pokrzywinski, Mike Mellon and Sandra Boatwright (project and outreach support); and Drs. Koichiro Harada, Vladimir Romanovsky, Sarah Laxton, Panya Lipovsky, Julia Stanilovskaya, Zhao Lin, and Sharkhuu Natsagdorj (field companions); also Drs. Larry Hinzman, Dan White, Doug Goering, Syun-Ichi Akasofu, Doug Kane, Elena Sparrow, Martha Kopplin, Kathy Bertram, Melina Draper, Alexander Kholodov, William Cable, Thomas Ingeman-Nielsen, Hanne Christiansen, Toshio Sone, Atsushi Ikeda, Dario Trombotto, Mikhail Zheleznyak, Dmitry Sergeev, Paul Overduin, Bob Bolton, Margaret Darrow, Jeremiah Drage, Richard Mitchells, Craig Boeckman, David Campbell, Marin Kuizenga, Polar Field Services, Inc., and Duane Miller Associates (for providing us with wonderful support — financial, creative, and otherwise — and data sets). Finally, I deeply appreciate Fran Pedersen for improving the English grammar throughout and for editing the community information.

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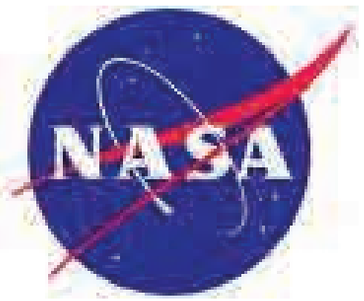
This material was based in part upon work (http://www.uaf.edu/permafrost.html) supported by several grants; in addition to DRL-0731739 and EPS-0346770, we received support from the Green Network of Excellence, Japanese Polar Institute and the National Science Foundation under AON: "Thermal State of Permafrost (TSP) in North America and Northern Eurasia: The U.S. Contribution to the International Network of Permafrost Observatories (INPO)" (ARC- 0856864), GEO-0627941 (GLOBE Seasons and Biomes), "Resilience and Sustainability in a Rapidly Changing North" (EPS-0701898), "Alaska Adapting to Changing Environments (Alaska ACE)" (OIA-1208927), the ARCSS Thermokarst project (ARC-0806465), and the Bonanza Creek Long Term Ecological Program (BNZ LTER) (DEB 1026415).

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.



ALASKA EPSCoR
EXPERIMENTAL PROGRAM TO STIMULATE
COMPETITIVE RESEARCH

Appendix:
Video collections

The following media is available via our website (http://www.uaf.edu/permafrost) :

Snow mobile trip to the Alaskan Communities
GLOBE Kilimanjaro expedition
Peruvian Andes permafrost expedition
40 below world
TunnelMan series Episode 1 to Episode 5
TunnelMan Episode 3 Russian version
TunnelMan Episode 3 Southeast Alaska version
TunnelMan bloopers and trailers

TunnelMan Episode 1 – Ice on permafrost

This first episode of TunnelMan is a story, a process-type movie. After TunnelMan emerges from an ancient permafrost tunnel, he explains about ice (ice wedges) in frozen ground. Animation and music (Alicia Keys' "No One") are important aspects. In 2008, this song was popular among teenage students and its lyrics helped provide a memorable learning experience. At the same time, educationally, we are concerned with thawing of ice-rich permafrost. Dry permafrost or frozen bedrock also exists in Alaska but is not of concern, since it would not undermine structures if it thawed. Almost all infrastructure damage from thawing ice-rich permafrost is due to inadequate building design for the conditions. At the kickoff of this series in 2008, the video worked great in all of the communities and in university permafrost classes including classes in Russia, Germany, Japan, Spain, Argentina, England, and Norway. It seemed, though, that this movie was not cool enough for boys (mainly high school senior students) and was hard to watch repeatedly.

TunnelMan Episode 2 – Hop-pop TunnelMan

After releasing Episode 1, we focused on including music popular with teenagers and making the videos captivating enough to watch repeatedly. The topic of Episode 2 is permafrost monitoring; that is, why it is important to monitor temperature. We chose music with a rap beat and changed images and topics faster for students who might not understand the contents at a single viewing. We created original tunes with a rap beat and scientific lyrics. Screen shots are ten times longer than in Episode 1, but are compressed into four minutes of show time. Some of the words are slang that is not generally used in classroom instruction, which could be a problem in certain schools or with elementary-age students. Using slang was successful for catching the attention of most teenage students. Some students even downloaded and installed this episode on their own devices.

TunnelMan Episode 3 – Active layer monitoring

Episode 3 is probably the favorite of teachers, though not of students, because of the song "Volare" by the Gipsy Kings, popular in the late 1980s, the teachers' generation. The contents of this episode are classic, more like a typical educational video: how to install the monitoring equipment, what can be observed, the importance of the frost tube, etc. This instructional video aids the teacher somewhat. Since there are many educational videos online today, we felt that this approach was not exactly our aim. However, the episode served well in teaching about frost tubes and other equipment, all explained within 3 minutes. Also this episode was "rebuilt" for exporting to Russia as well as permafrost-free regions.

TunnelMan Episode 4 – Geomorphology

Episode 4 music returns to using rap beat, and combines a classical movie idea (Wizard of Oz). This combination seems to appeal to all generations, even with the switch to rap beat. The purpose of this video is to help viewers understand permafrost and cold region landforms, especially those landforms near the students' communities. After watching Episode 4, some students have developed an interest in flying over their village to see the landforms, which means that part of the production has been successful. Still, we feel that using a different media or class lesson to increase their knowledge of periglacial geomorphology and landscapes is beneficial.

TunnelMan Episode 5 – Permafrost Chronology

Episode 5, released in June 2012, is the last episode in the video series. This episode explains the last 140,000 years of Earth's climate and permafrost history. The key goals of this video are to help students understand that climate is always changing (never stays the same) and that most of the permafrost in Alaska was established during the last glaciation (for example, that thawing occurred during the last interglaciations). During the last glaciation, humans migrated across Beringia from Asia, becoming the ancestors of Alaska Natives. Filming for this episode was done at Africa's Rift Valley (the cradle of humankind), Western China, the Peruvian Andes, and several Alaska locations.

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We also developed several videos related to our program: "-40°C World," "Ice Fog," "Snowmobile Trips in This Program," "Boat Trips for Southeast Alaska," "Mongolian Borehole Hunting," "Peruvian Andes Permafrost Drilling," and "Kilimanjaro Trip." Our Kilimanjaro permafrost expedition was a successful trip that included two science teachers and two students from Alaska. We traveled in 2009, 2010, and 2012 to the summit of Kilimanjaro. More than 700 questions arrived by e-mail during this expedition from 95 countries. Our fellow travelers, the students and teachers from Alaska, were helping to answer all questions during the ascent of the mountain.

Manga – TunnelMan cartoon

The Japanese cartoon, "Manga," is becoming popular in the U.S., including the rural communities of Alaska. This cartoon idea presents a great media opportunity for Alaska Native students. We developed "TunnelMan Return in 2058," a 32-page manga story. This story takes place in Alaska in year 2058 (following an International Polar Year!). People are looking for proof of climate change, likely in temperature. Our 50-year-old vintage instrument, installed in 2008, helps the world to understand world climate. We hope this message underscores the importance of the program's work and helps us avoid vandalism of existing monitoring stations.

Overview

- The Permafrost/Active Layer Monitoring Program is an ongoing project that builds on work begun in 2005 to establish long-term permafrost and active layer monitoring sites adjacent to schools in Alaska and in the circumpolar permafrost region (Russia, Norway, China, Mongolia, Japan, Canada and Greenland).
- Over three hundred schools (red dots in Globe)are involved in the project. The monitoring sites collect temperature measurement data on permafrost and the length and depth of the active layer.
- This information is important because changes in permafrost conditions affect local ecosystems and hydrological regimes, and can influence the severity of natural disasters.

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