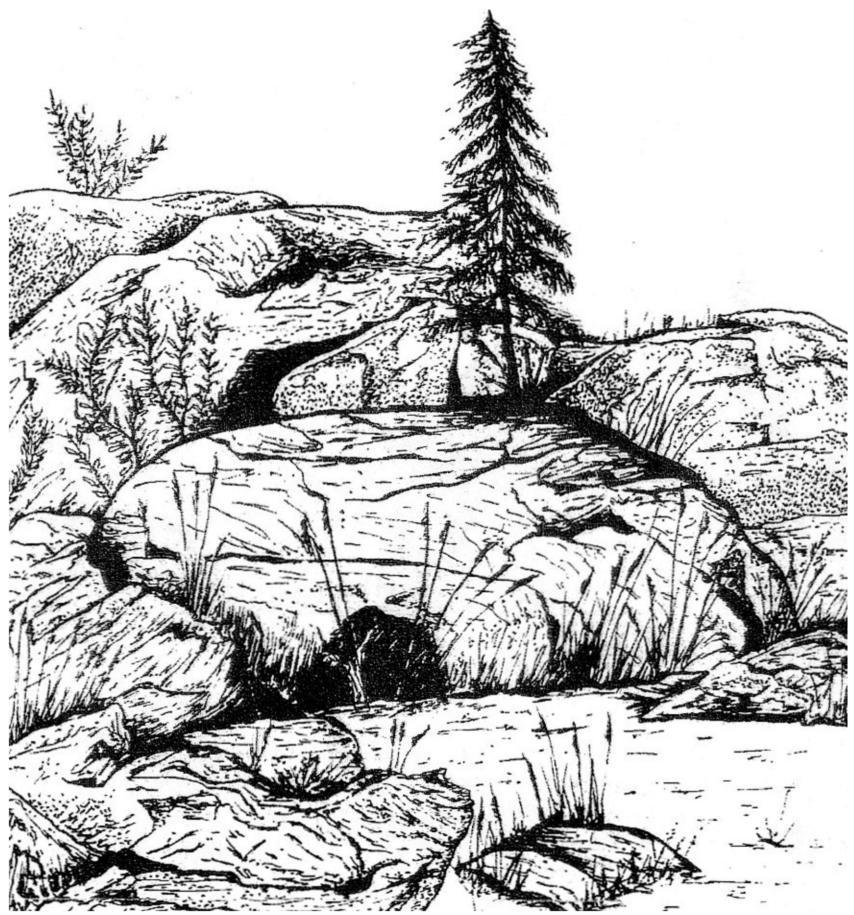
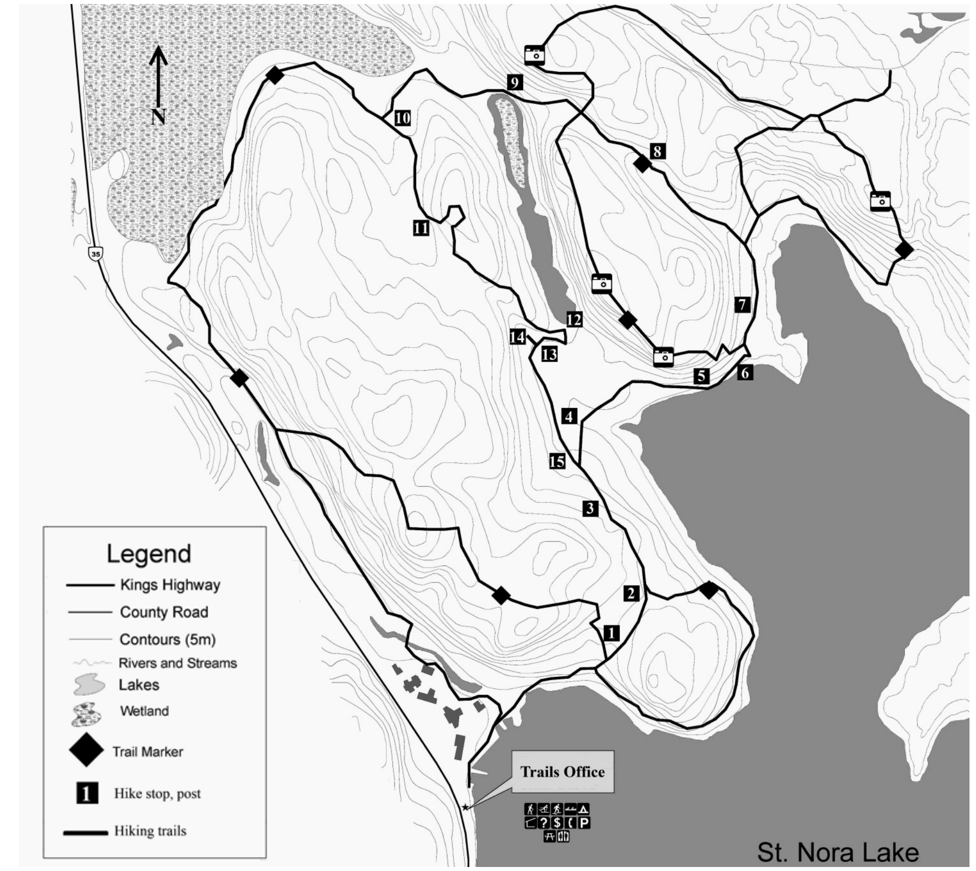
Geomorphology Hike



This self-guided hike is managed and maintained by the Township of Algonquin Highlands Trails Office at the former Leslie M. Frost Natural Resources Centre located at 20130 Hwy 35 (12km South of Dorset).

Township of Algonquin Highlands

Ontario's HIGHLANDS COME TO KNOW US



The Geomorphology Hike is a 3.5km self-guided loop through the scenic lake and upland country of the Haliburton Highlands. Allow at least 2 hours for the hike. The numbered sections of the guide correspond to the numbered posts along the trail.

NOTE: The hike follows along two different trails, the Acclimatization Trail and the Steep Rock Trail. All trails are marked with blue diamond markers and trail junction signage, watch for the "Geomorphology Hike" directional signs at trail intersections.

Sections of the trail can be rugged but should pose no special difficulties for hikers. Footwear with good support and some water resistance is suggested. Bug repellent is strongly recommended in the late spring and summer months. *Happy Hiking!*

Frost Centre

Geomorphology Hike

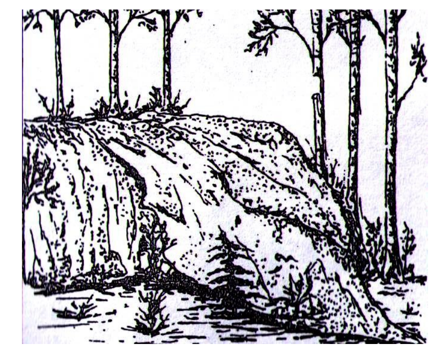
The landscape affects us in many important ways, from our water supply to how forests grow to the building of our highways.

Geomorphology is the study of the landscape and the forces that give rise to the different terrains we see around the globe. The land often appears to be a random arrangement of hills, valleys, plains, rivers and lakes; however these features are not random at all. They are the results of natural forces acting at different times or together giving each shoreline and each cliff its unique shape.

With the help of this guide, the hike will introduce you to geomorphologic features typical of this part of Ontario and the forces that shaped them. What you will discover applies not only here in the Haliburton Highlands but also wherever you might travel on our planet.

Post 1 THE NAKED EARTH

Imagine for a moment what the land would look like if all the lakes and rivers were emptied and all soil and vegetation were removed. What would you find underneath? Just look at the exposure of rock before you.



After the earth's formation 4.6 billion years ago, this is how the surface appeared for millions of years before the oceans, soil and vegetation evolved. You are looking at the Earth's **crust**; a continuous shell of rock which encases the entire planet. Where the crust, or **bedrock**, is exposed, it is called an **outcrop.**

This ancient surface can be up to 50 kilometres thick in the middle of the continents, or as thin as 10 kilometres under the oceans. It encases the Earth's hot, partially molten interior, much like the solid shell of an egg.

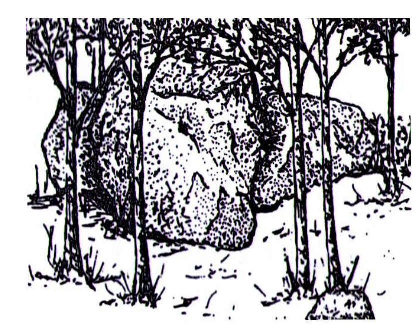
The crust of most of Ontario belongs to a large area of Canada known as the **Canadian or Precambrian Shield**. This area includes the original foundation of our continent featuring some of the oldest rocks on Earth. The rocks found in and around the Frost Centre are about 950 million years old. This means that the minerals and texture of the rock were determined at or before this time.

Along the trail, you will see many outcrops. The landscape around the Frost Centre and much of the Canadian Shield is mostly an expression of bedrock contours as soil cover is generally very thin. Geologists can determine much of the Earth's history by studying the mineral content, texture and structure of the crust in outcrops.

Post 2 ROCKS THAT FLOAT

Is this chunk of rock an outcrop or just a boulder sitting on top of the ground?

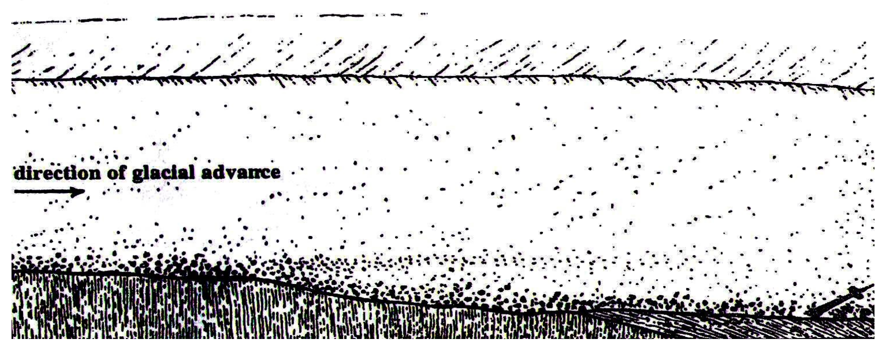
Known as **glacial float**, this boulder, along with the others beside the trail have been left by **glaciers** which covered nearly all of Canada four times in the last million years. Imagine ice 3 kilometres thick! Ice such as this exists today on top of Greenland's bedrock.



Between 12, 000 and 80, 000 years ago, it is believed that the Earth's climate was locked in a perpetual winter. Thousands of meters of snow and ice accumulated across Canada. The tremendous downward pressure of this large volume of snow turned the older, lower layers to ice. The pressure also caused the ice to flow outward from centres of greatest accumulation. Eventually, the glacier moved as far south as the northern U.S.A. burying most of Canada under ice over three times the height of the CN Tower.

Boulders can be 'ice-rafted' only a few metres or in some cases up to several hundred kilometres. Glacially transported boulders containing valuable minerals can sometimes be traced back to their source using the direction indicated by glacial striae. "Boulder tracing" has led to the discovery of more than one mine in northern Canada.

Assisted by **glacial melt water**, finer material broken up by the glaciers has washed down into low lying pockets in the landscape.



The weight and movement of the ice easily scraped the lands surface down to bedrock, crushing and carrying millions of tonnes of sand, gravel and rock with it. Scratches and grooves in outcrops were left behind by these boulders while being pushed along by the glacial ice. Called **glacial striae**, the scratches show that the glacial advance was north to south in this area.

As the climate warmed up at the end of the most recent ice age, the melting glacier deposited all the debris it had been carrying. The large boulders in front of you were transported by the ice from somewhere to the north before they were dropped at this site.

These deposits include the valuable sand and gravel which we use for concrete and road building.

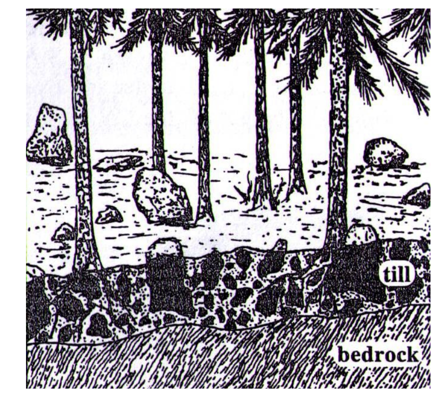
Glaciers are good examples of the two main mechanisms that change a landscape. **Weathering** is the disintegration or breaking apart of rock. The mineral dissolving action of water is another element that weathers rock. But glaciers also move this broken material by both the advance of the ice and the flow of glacial melt water. The movement of a weathered material is known as erosion. Another erosional force is gravity which constantly pulls loose material downward.

Post 3 GLACIAL GARBAGE

The exposed pit in front of you shows the material you are standing on. This unsorted mixture of clay is called **glacial till**. This is material that was dumped by the glacier upon melting without being 'sorted out' into separate sizes by the washing action of glacial melt water.

The shape of the boulders tells us about how far this material has travelled. Material transported only short distances will still have jagged edges and an angular shape. When tumbled over a great distance, the shape is usually more rounded. The round boulders here indicate that the glacier carried this material far from its source.

Glacial till makes up much of the soil in southern Ontario. It is the reason farmers complain about rocks in their fields. Most of Ontario's mineral soils were deposited by glaciers.

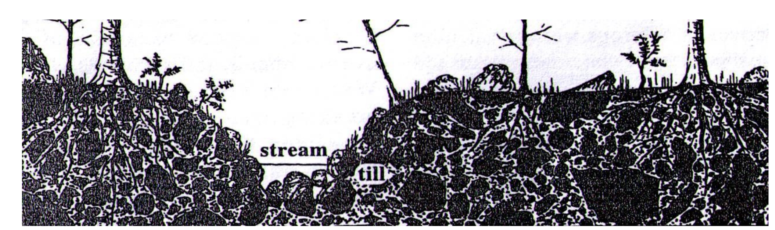


Post 4 ALL WASHED UP

Erosion is the movement of loose material from one place to another. Enormous rivers such as the Mississippi and the Amazon transport millions of tonnes of material yearly. This small stream erodes material in the same way.

enough to move the gravel and boulders which you see here in the stream bed.

Meanwhile, as the stream flows out into the lake, the coarse sand drops



At this stop the running water drained from the hillsides and wetlands to the north has eroded away much of the till. The flow of water was sufficient to wash away the clay, silt and sand but not great

out first, then the finer-grained silt, and then the lighter clay farther out. This process is called **sorting.** The stream water is doing what the glacial melt water did not have a chance to do.

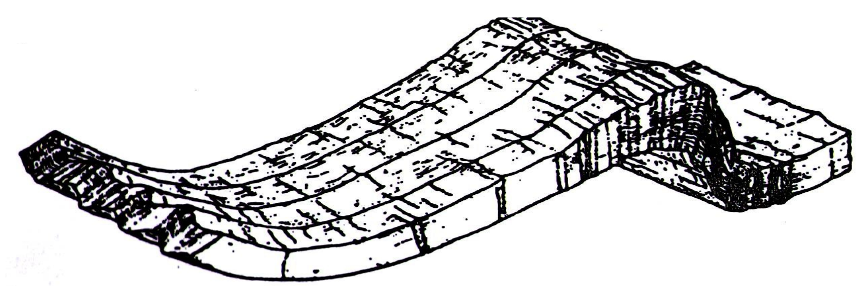
Post 5 SLOW TORTURE

Thank goodness rock isn't alive. The wave-like **fold** structure in the outcrop here tells a story of brutal temperatures and pressures, and burial to great depths.

To this day, the Earth's crust is divided into several large segments called **plates**. The North American continent for example, is embedded in a large plate which includes half of the Atlantic Ocean's floor. These plates move around on top of the Earth's molten **mantle**. Where plates collide, all sorts of nasty things happen to rocks. This sets the stage for this fold's tortured history.

On their way down, the soft sediments were first squeezed into **sedimentary rock**. For the next billion years, extreme **temperatures** and **pressures** changed the texture and the minerals making up the rock. This created what is called **metamorphic rock**. Most of Ontario's bedrock is metamorphic.

The **layering** you see throughout the outcrop is a result of the metamorphism. These are true layers made up of minerals pinched into alignment by the pressure applied to the rock. The **folding** of the layers occurred afterwards by another set of forces squeezing from the sides.



It is believed that this rock was born from sandy **sediments** in the bottom of an ancient sea up to 2.5 billion years ago. This material weathered and eroded from what might have been an original land mass created just after the Earth's formation.

At the time when this material was piling up, the plates were very mobile because the molten rock underneath was still extremely hot and turbulent. The sediments were caught in a **collision** between two plates and were forced down to a depth of at least 15 kilometres.

The high temperature and pressure allowed the rock to behave like plasticine. Slowly over time, the layers flowed and folded instead of fracturing. So, this rock was metamorphosed at least twice; once to produce the layering and again to fold the layering.

Eventually, the rock cooled and became brittle as weathering and erosion brought the rock up toward the surface. This continued until the feature you see here was exposed in outcrop. If you look closely along this cliff face, you will find a much smaller fold.

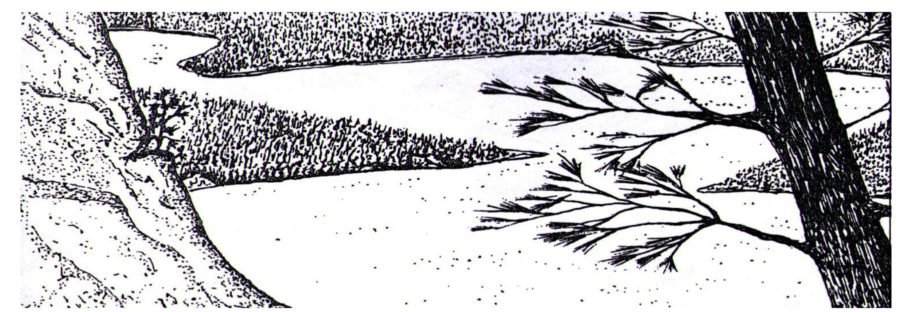
Post 6 MAKE A LAKE

Have you ever looked at a map and wondered why the shape of lakes makes no sense at all? If so, this stop is for you.

The size and shape of lakes depend on the contours of the land. As you will discover throughout the hike, many different forces intertwine to give the landscape an infinite variety. It is this variety that gives lakes their seemingly random shape. What shapes the land is also what shapes the lakes.

just like the grain of wood. A layered metamorphic rock will break according to the layering when a stress, such as a glacier, is applied to it. Even if the layering has been folded, the rock will break the following curve of the layers.

A second process that weakens the rock is faulting. A **fault** is where the earth's crust breaks, shifts and crushes rock where the motion occurs. This process will be explained in detail at Post 9.



The Glaciers have been the most recent, large-scale influence on the land. They have bullied the landscape by picking on the weak and already broken rock. Where the digging has been easy, we find depressions in the landscape. If these fill with water, lakes are formed. However, what decides how and where a rock breaks? What makes a chunk of bedrock vulnerable to be carried off by a glacier?

One feature that makes the rock break in a certain way is the metamorphic layering discussed at Post 5. Rock is weakest along layers of minerals

The rock-weakening processes of faulting and the metamorphic layering of minerals set up a template of where and how bedrock will break. Faults and mineral layering occur at all different angles and directions through the bedrock, and in a great number of combinations. These variations in the bedrock allowed the glaciers to carve out a landscape where no two lakes have the same shape.

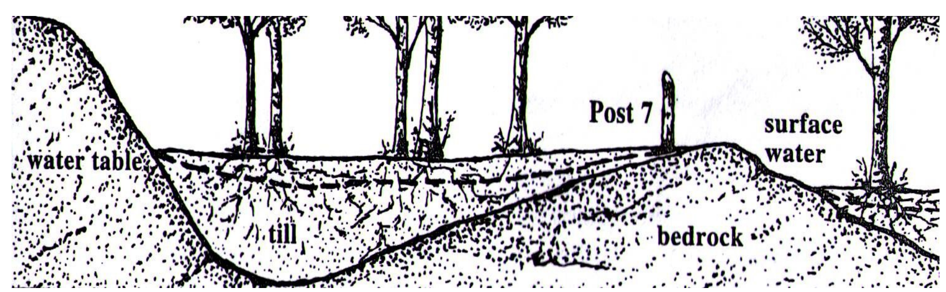
Post 7 WATER FLOWS...UPHILL?

This section of the trail is almost always wet even though it is higher than the trail in either direction. Can you see why?

The reason lies with the bedrock beneath your feet. Some rock types such as sandstones are full of small open spaces and allow water to pass through them. Metamorphic rocks, however, are **non-porous**, soaking up little water.

Water spilling down the hill beside you **percolates** into the thin soil. It then meets the metamorphic bedrock and goes down no further. The water is eventually forced to the surface with the rock in this outcrop.

The **impervious** character of the rock explains why wells drilled in bedrock in this area often exceed 75 metres to reach a dependable source of ground water.



Post 8 THE GRAND CANYON IT ISN'T

The ability of water to weather and erode rock is a well known natural phenomenon. The Grand Canyon is an impressive example that has been carved out by the Colorado River in Arizona.

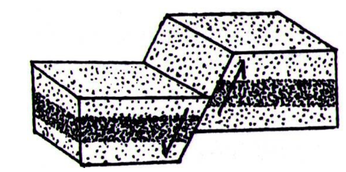
River valleys are not as spectacular here because the bedrock is very much harder and resists the effects of weathering and erosion. Because of this, deep river valleys like the Grand Canyon are absent in the Haliburton Highlands. Any deep river valleys here are generally along fault zones

You can see that this stream running down the bare bedrock has not worn any material away. The stream is of the same volume and speed as the stream at Post 4, but it hasn't cut as deep a channel. This is because the metamorphic rock is very hard. At Post 4, the stream has cut through loose glacial till.

Post 9 IT'S NOT YOUR FAULT

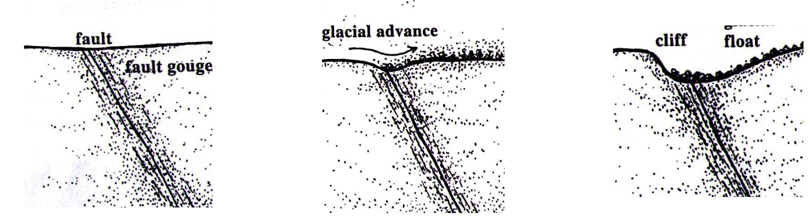
The steep cliff before you is the result of a geological process called **faulting**. A **fault** is where movement occurs along a fracture between two portions of the earth's crust. Movement may occur in different directions; up, down, or sideways. The San Andreas Fault in California has moved sideways 400km over the last 70million years causing an untold number of earthquakes. What causes the earth's crust to break in this manner?

When rock is deep within the crust, it is hot and can bend as shown by the fold at Post 5. As surface weathering and erosion bring deeply buried rock toward the surface, it cools down and becomes more brittle. Stresses within the earth's crust such as the force of plate collisions cause rock that is cool and brittle to break and shift. But how were the cliffs formed?



pits in the landscape often have steep sides or cliffs, such as the one beside you.

The swamp here is an excellent example of a fault/glacier partnership. Facing the swamp, notice the cliff on your left that forms the swamp's eastern shore. This cliff and swamp are aligned almost in a north-south manner. This is because a fault runs under the swamp in that direction. The direction of the glacier's advance was also north to south. Because the fault and the glacial advance directions coincide, the glacier



The movement of two masses of rock against each other crumbles rock along the fault line. This leaves a zone of loose, broken material known as a **fault gouge**. This is surrounded by more resistant, unbroken rock that was unaffected by the faulting. Enter the glaciers, stage....north.

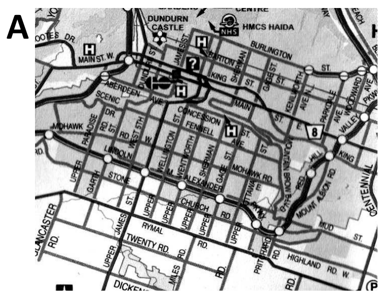
The fault gouge was easy pickings for the glaciers. As glacier after glacier dug out the loosened material, deep channels were created along the fault line. These

was able to dig deep into the soft fault gouge carrying away large blocks of faulted rock. This is what formed the depression that the swamp is occupying. The glacier may have carried the material for only a few metres or for several hundred kilometres creating glacial float. These cliffs and the glacier-carved basin were probably the source of the boulders you saw earlier on the trail. In fact, the trail map shows that this swamp and associated cliffs are directly north of posts 2 and 3.

Post 10 ROLLER COASTER ROADS

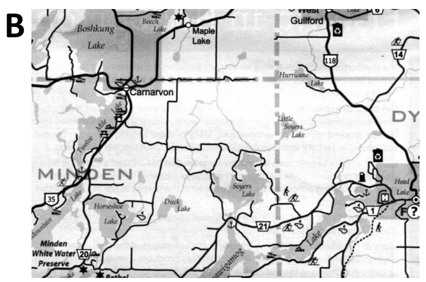
While driving in the Haliburton Highlands, have you noticed how winding and hilly the roads are compared to the more southern regions of Ontario? Just compare the two maps below: **A**, from near Toronto and **B** of an area near this trail.

A



Notice how the roads on Map A are straight and regular while on Map B the roads meander without pattern. This is due to the differences in geomorphology of these two parts of Ontario. The gentle, rolling contours of the land to the south allow roads to follow straight courses. However, in Haliburton/Muskoka, the jagged cliffs, towering bedrock uplands and frequent lakes present obstacles which the roads must go around. This demonstrates that the design and layout of highways, roads and even trails are dictated by the topography of a given area. For instance, the Frost Centre Trail system is largely governed by the high faulted cliffs you have seen.

B



The trails have been routed so that the best of the local scenery is taken advantage of while keeping each hike an enjoyable length and level of difficulty. All of the above hinge on this areas geomorphology.

Post 11 REAL PUSHOVERS

What might cause trees in this area to fall over? They can be toppled not only by wind but also by the thin soils. Notice the bedrock you are standing on. Growing on rock or in thin soil, trees cannot become properly anchored to withstand strong winds.

When trees are first sprouting in thin soil a small root system provides enough support. As trees grow taller, the roots cannot develop adequately to support the tree. The roots you can see on the surface along the trail are testimony to the difficulty they have encountered trying to penetrate the bedrock.

Thin soils can stress trees in other ways. Deep soils hold more moisture than rock does. Trees growing on rock or thin soils must be resistant to periods of drought. Also, deep soils contain more available nutrients. Trees growing in little or no soil may face a nutrient-starved existence and as a result, grow more slowly.

Post 12 ROOM WITH A VIEW

Niagara falls, the Rocky Mountains, and the Grand Canyon: when you think about it, most natural scenic attractions are special because of some spectacular landform or geomorphologic feature.

Although not nearly as awesome as those natural attractions, the high steep cliff in front of you offers a stark contrast to the low swampy beaver pond in the foreground. Do you remember what formed this cliff and swamp?

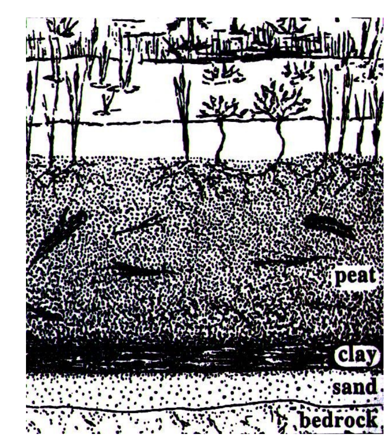
Post 13 MEET THE PEAT

After the last ice age, another landscape altering process began in this wetland which continues today.

As the climate warmed up and the ice retreated, plants reappeared across the land. This shallow basin scoured out by the glaciers hosted water-loving plant species. As plants died, more plants grew quickly because of the abundance of water.

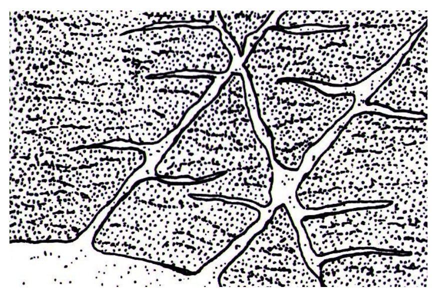
Although the basin held lots of water, it was stagnant. The stagnant waters contained very little dissolved oxygen allowing only a small amount of bacteria to survive. Without bacteria, the dead plants decomposed very slowly. As a result, the plant remains piled up faster than they could decompose. This is how peat is created. About four metres of peat has formed here over the last 10 000 years. This will continue until the wetland is filled, creating a meadow.

Peat is used as a fuel in Ireland, Russia, Scandinavia and China. In North America, peat is used mainly to improve garden soils.



Post 14 QUARTZ WATCH

The rock in this outcrop is known as **pegmatite**. The name refers to the very coarse grain of rock. The pink mineral is feldspar and the white mineral is quartz. ***Please be careful handling the quartz. It is razor-sharp.***



This rock formed in a completely different manner than the other rocks you have seen. At the end of the period of burial when the metamorphic rock was cooling, its upper reaches became more brittle and cracks began to develop. From below, the rock in the molten state flooded up into the cracks. As the liquid rock, or magma, slowly cooled, it solidified forming large crystals of quartz and feldspar. Rock created directly from molten mixtures of minerals is called **igneous rock**.

Quartz is the primary source of silicon which is used to make computer chips. Silica from quartz is also the main ingredient in the making of glass.

Post 15 THE LAST POST

The Geomorphology hike ends here at Post 15. We hope that you now have a better understanding of the processes that have shaped the landscape here and elsewhere around the world.

From here you may continue along the trail back to the parking area. On the next page, the geomorphology of the area around the old 'Frost Centre' campus is described in terms of the processes explained during your hike. Take a moment to see if you recognize the geomorphologic features that define the campus.

If you do not wish to keep your trail guide, please place it back in the trail guide box for reuse. *Thank you!*

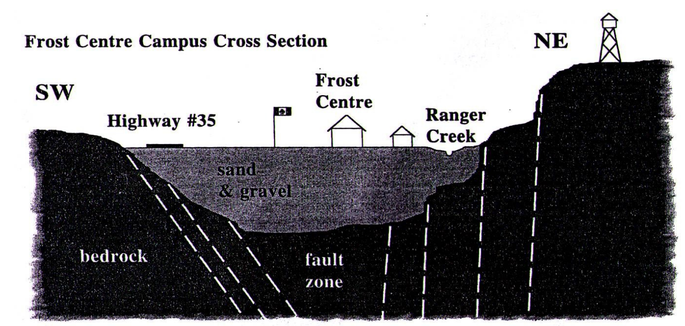
FROST CENTRE FACILITY

When you arrive back at the Frost Centre Facility, notice how relatively smooth and flat it is while the surrounding area is steep and jagged. This is not because of people shaping the land.

The ongoing processes of weathering and erosion drastically reduced what may have been tall mountains down to the low rugged hills we see today. An unknown number of periods of glaciation greatly altered the landscape. The glaciers were able to pluck out a lot of material where faulting had broken up rock along the **fault zones.**

If the glacier had moved south to north, we would see the high cliffs on the other side of the highway instead.

When the glaciers melted, they produced such large volumes of water that Lake St. Nora's level was much higher, flooding the campus valley. A fast moving glacial river carried sand and gravel toward Lake St. Nora through the valley. As the river approached the lake, the flow slowed down in the Frost Centre valley and the sand and gravel dropped out.



The Frost Centre facility valley is an example of a fault zone. Beneath the facility are probably many individual faults running in the same direction. Glaciers carved out the loose, faulted material creating the valley while leaving the surrounding ground undisturbed.

Why is the cliff so much higher on the north side of the campus? This is because the glacier approached from the north. The glacier crept over the north side of the fault zone and began plucking material out. As the glacier kept moving to the south, it was forced to move out of the fault zone and grind up unfaulted rock of the south valley wall.

This describes the formation of a **delta**. The Frost Centre is built on the sand plain of an ancient river delta explaining why the campus is generally flat. The buildings are on top of 20 metres of sand and gravel.

Ranger Creek, which runs through the campus, shows that these processes are ongoing. It will continue to cut a channel into the soft sand and gravel probably until the next glacier comes along.

ABOUT THE FROST CENTRE

In 1974 the Frost Centre was established by the Province of Ontario as a learning and education facility where many people came to gain a better understanding of natural resources and the environment. Until 2004 the facility hosted organized groups, schools, as well as training programs for the Ministry of Natural Resources.

Since 2002 ***The Township of Algonquin Highlands*** has, through collaborative partnerships, managed camping and canoe routes within the traditional 'Frost Centre' area. Camping in the Frost Centre area is regulated under a permit/reservation system effective 2006, to enhance and protect outdoor recreational values.

In 2007 the Trails Office expanded to include the management of 38km of hiking trails throughout the area. As of 2011, the 26km of Frost Centre Cross Country Ski Trails, located on the West side of Hwy 35, is being managed by the Township. Assistance on the ski trails is provided from a volunteer organization known as the 'Ski Friends of the Frost Centre', who have worked to help manage and maintain the ski trail system since 1997.

FOR MORE INFORMATION

Contact the ***Township of Algonquin Highlands Trails Office***:

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Trail/Office Location Address:
20130 Hwy 35N

Phone: 705-766-9033

Email: trails@algonquinhighlands.ca

Website:
www.algonquinhighlands.ca

Hours

May 1st – Labour Day

Sun-Thurs – 9am-5pm

Friday – 9am-9pm

Saturday – 9am-7pm

After Labour Day – October 31st

9am-5pm 7 days a week

November 1st – April 30th

10am-3pm 7 days a week

Ontario's HIGHLANDS COME TO KNOW US

OHTO Ontario's Highlands Tourism Organization

This project was funded in part by the Ontario Highlands Tourism Organization

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