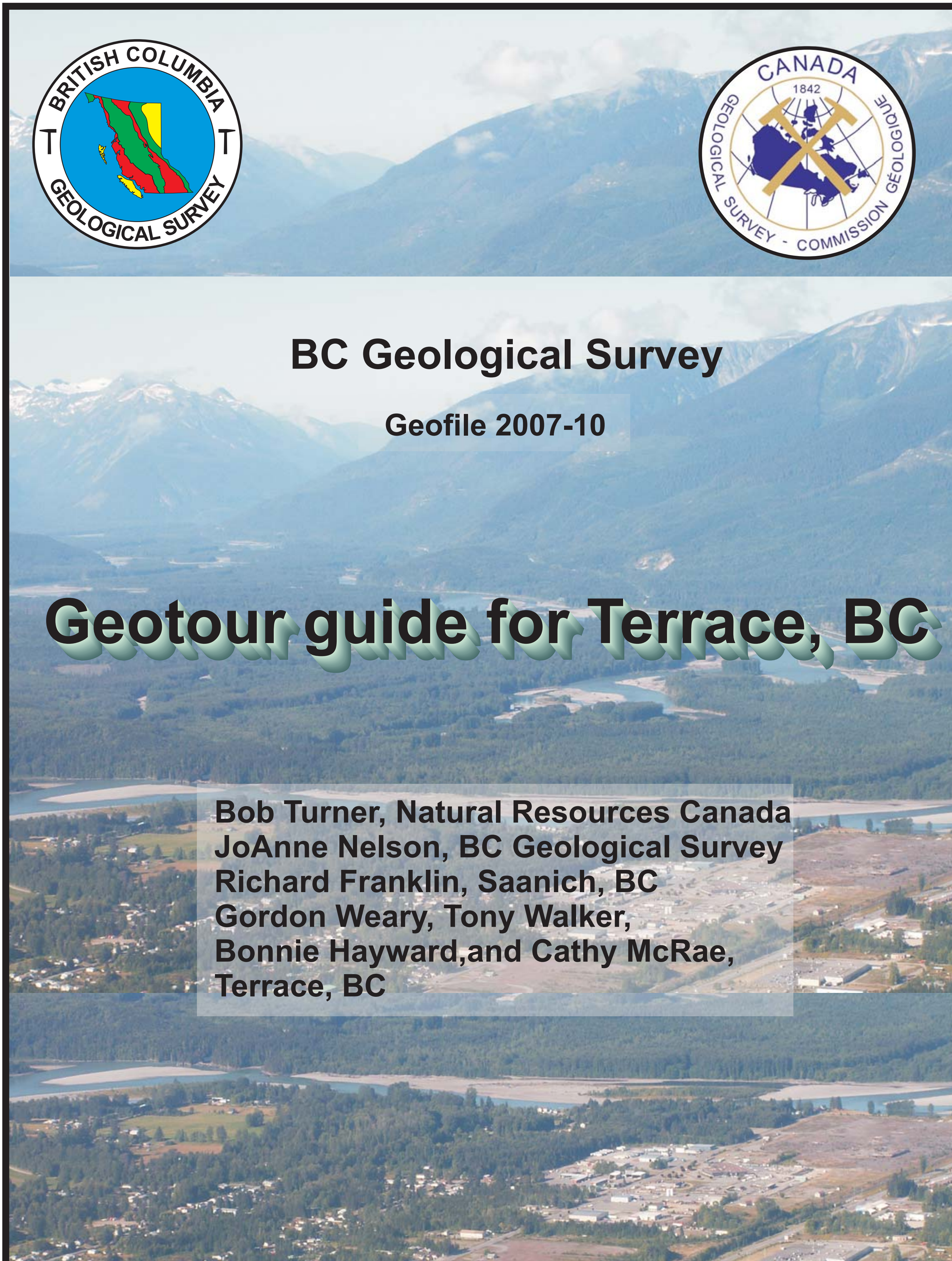

BC Geological Survey

Geofile 2007-10

Geotour guide for Terrace, BC

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JoAnne Nelson, BC Geological Survey
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Gordon Weary, Tony Walker,
Bonnie Hayward,and Cathy McRae,
Terrace, BC

GeoTour Guide for Terrace, B.C.

Our land. Our Community.

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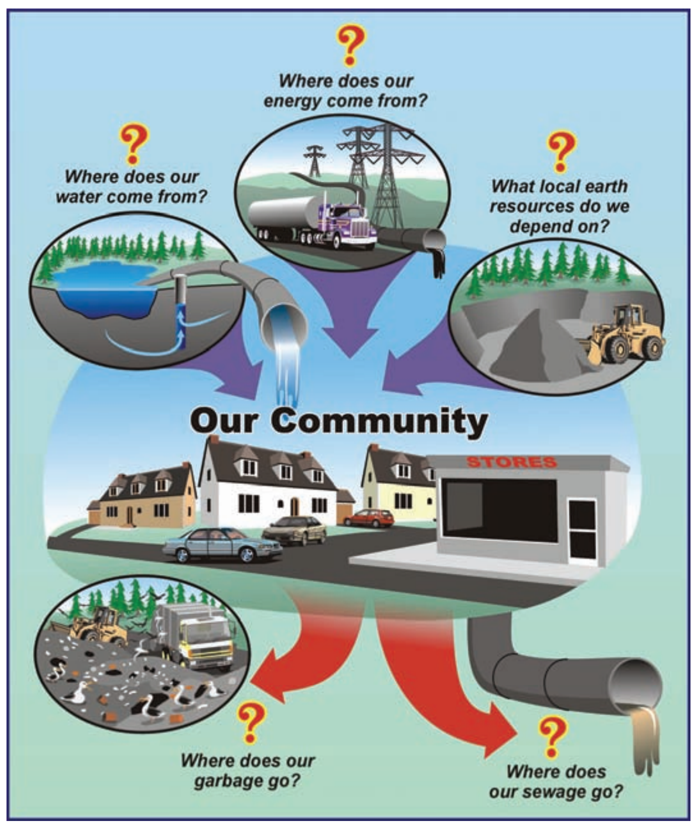
Figure 1. *View from Birch Bench subdivision looking southwest across the eastern end of Terrace, the Skeena River, Ferry Island (left), and the Coast Mountains (back, right). The Terrace Airport is located on the flat bench on skyline to the left.*

We live within the great Coast Range where the Skeena River flowing west to the Pacific crosses the wide north-south Kitsumkalum-Kitimat Valley. This region is underlain by diverse geological materials and is continually shaped by earth processes. Terrace, like other communities, is dependent on the Earth for water, food, materials and energy. Not only does the Earth provide resources, but it accepts our wastes. This *GeoTour* fieldguide explores how our community of Terrace 'lives off the land'. What earth materials underlie this landscape and how do they affect us? How has the local landscape shaped human use of our area? What local earth resources do we depend on? Where does our supply of drinking water come from? Where does our sewage go? Where does our garbage go? Where does the energy which fuels our lives come from? Are we sustaining the land that sustains us?

This guide tours the geological landscape of Terrace and reveals its story. These *GeoTour* locations will be familiar to many, but this guide may inspire you to look with new 'landscape eyes'.



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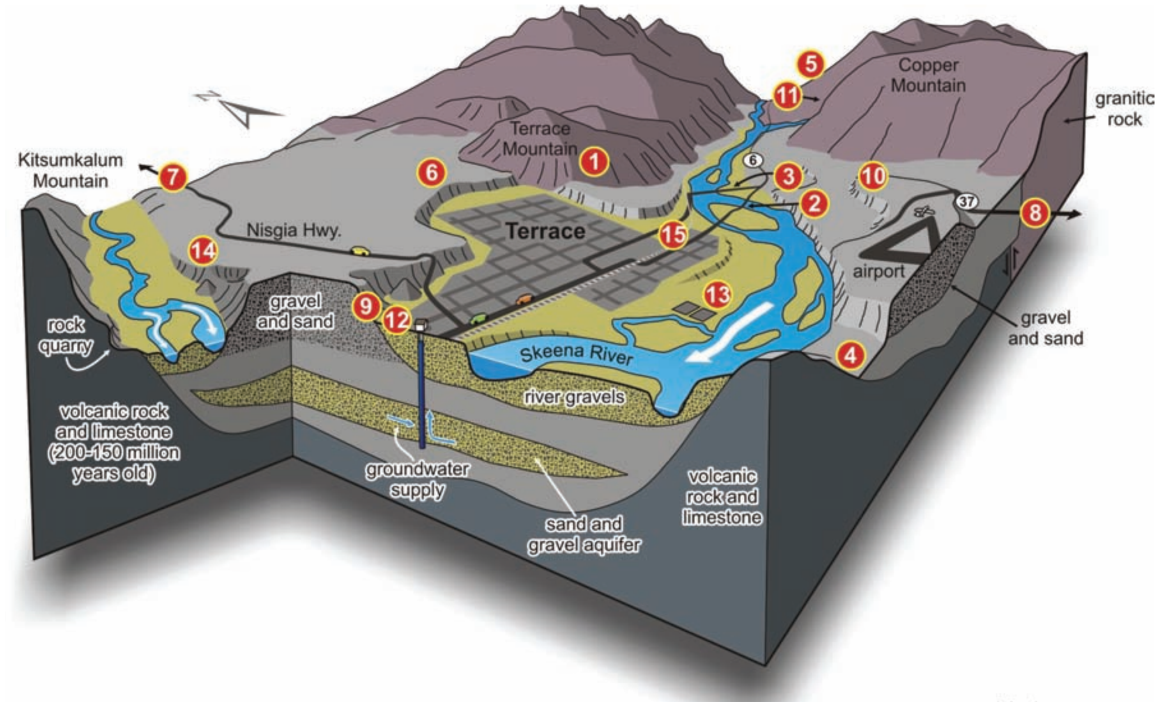

Figure 2. *A schematic cut-away view of the Terrace area looking to the northeast, and showing the underlying geological materials. Circled numbers indicate the location of* ***Geotour*** *stops discussed in the guide.**1.** Terrace Mountain lookout.* ***2.*** *Ferry Island Park river gravels.* ***3.*** *Old Bridge and Skeena River.* ***4.****Old Remo Road Limestone.* ***5.*** *Kleanza Creek Provincial Park.* ***6.*** *Heritage Park Museum mining displays.* ***7.*** *Nass Valley lava flow.* ***8.*** *Mount Layton hotsprings.* ***9.*** *Sand and gravel quarry.* ***10.*** *Concrete plant, Thornhill.* ***11.*** *Copper River landslide.* ***12.*** *Frank Street municipal water well.* ***13.*** *Municipal wastewater treatment plant.* ***14.*** *Municipal landfill.* ***15.*** *Gasoline rail terminal.*

But first… how our land came to be!
A quick tour through Geologic Time

So, how old is Terrace? Well, European settlement of the Terrace area goes back to the mid 1800s. On the other hand, First Nations settlement in the region is much older and goes back at least 5000 years. But the land itself is much, much, much older. What follows is a brief summary of the geological history which geologists have pieced together for the region.

(1) Ancient volcanoes and the seafloor: The oldest rocks in the Terrace area are volcanic lava and limestone that formed 270 million years ago. Many of the Terrace mountains result from erosion of these rocks. The volcanic rocks erupted from ancient volcanoes on oceanic islands, similar to those in modern-day Japan or the Aleutian Islands. Limestone reefs typically formed in shallow waters surrounding these islands (**Stop 4)**. Another mass of volcanoes built on top of the first one at about 200 million years ago.

(2) Crunch! These volcanic islands collided with the western edge of North America, starting 180 million years ago, as the Atlantic Ocean started to open, and North America moved westwards like a giant bulldozer. This collision welded the lavas, limestone, and other rocks to the western edge of North America, adding to its landmass and moving the coastline westwards from east of Prince George (near the present site of McBride and Mackenzie) to the present - day Terrace area. The collision caused mountains to rise as the lavas and limestones were deformed into folds and broken by faults.

(3) Shallow seas, dinosaurs, and coal: Over time, the mountains eroded and a shallow sea spread eastwards to cover a large area from what is now Terrace and Smithers to Dease Lake and Spatsizi Plateau Park. Rivers flowed into the sea from the east, creating thick deposits of sand,; while mud and dead vegetation –peat - accumulated in backwater areas. Dinosaurs roamed the coastal swamps. Today, widespread sandstone and mudstone rocks contain coal deposits, natural gas, dinosaur footprints and fossils.

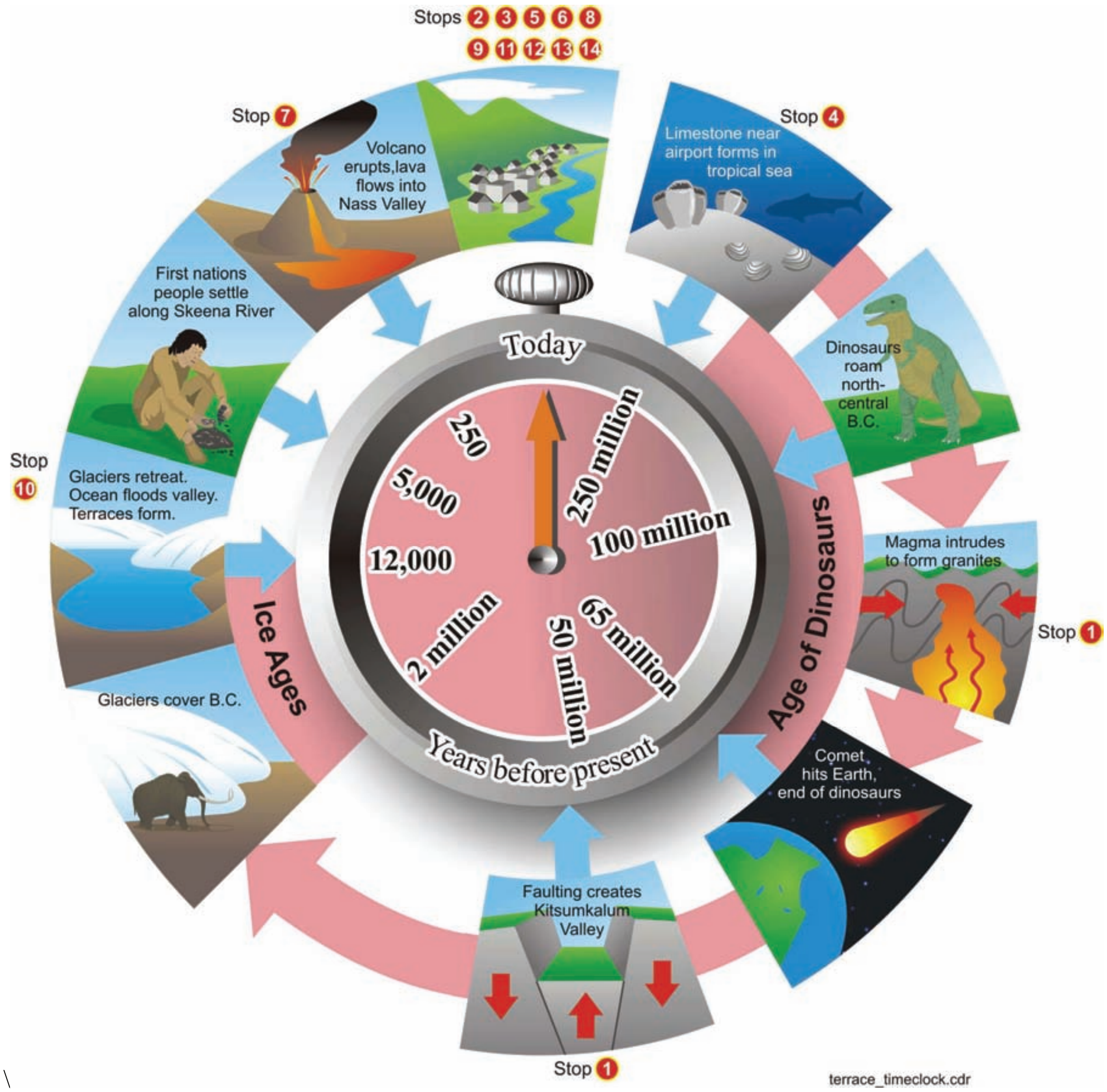

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Figure 3: Geological history of the Terrace area presented as a clock showing how the Geotour stops fit into this period of geological time.

(4) Crunch again! And granites intrude: Another giant volcanic ocean island, referred to as 'Wrangellia' by geologists, slammed into the western margin of North America, extending the continent westwards to the Queen Charlotte Islands. This collision folded and faulted the region and caused the Coast Mountains to rise. Along the coast, a subduction zone formed as the crust of the Pacific Ocean slid, conveyor-belt-style, deep into the earth's mantle below the Coast Mountains, causing rocks to melt as they reached tens of kilometres below surface. Some of this melted rock (magma) crystallized deep in the earth to form great volumes of granitic rock (**Stop 1**) which make up much of what you see as the Coast Mountains today.

(5) The land pulls apart: About 50 million years ago, as the mountain-building compressive forces relaxed, much of British Columbia started to pull apart. The land broke into fault blocks, and the great Kitsumkalum-Kitimat valley formed (**Stop 1**). Rocks beneath the valley subsided while the flanking Coast Mountains to the west, and Hazelton Mountains to the east rose along faults. These faults can still be traced today and they act as conduits for hot waters which circulate deep below the valley floor, and then rise to the surface at the Mt. Layton hotsprings (**Stop 8**).

(6) The Ice Age: Two million years ago, great continental ice sheets started to form in northern North America. Ice Ages came and went. The last great Ice Age reached its maximum about 25 000 years ago when the ice sheet was two kilometres thick over the Terrace area and most parts of British Columbia. The slow-moving ice flowed from the BC Interior, where it was thickest, down the Skeena and Kalum-Kitimat valleys to the ocean, deepening the valleys. At the end of the Ice Age, the front of the glacier retreated northwards up the Kalum-Kitimat Valley. Several times the glacier paused in its retreat, and muddy water flowing from beneath the ice laid down thick plains of sand and gravel at the glacier snout (**Stop 10**).

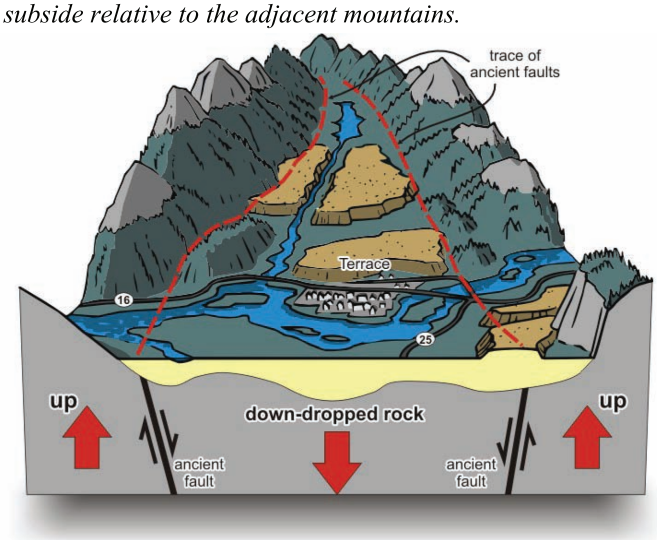
(7) Today - the rivers carve their valleys: The modern Skeena River was born as the glaciers retreated, carrying waters from the central interior westward to the Pacific Ocean. The Skeena and Kitsumkalum rivers cut down through the thick glacial deposits that filled the valleys, forming riverside cliffs which expose the layers of glacial gravels and sands that are important earth resources (**Stop 10**) and aquifers (**Stop 12**) for the community. As the rivers cut downwards, they also migrated back and forth, forming river plains. Today the City of Terrace is built on a staircase of flat terraces or 'benches' which mark abandoned, older river plains above the present river plain. The city is named after these geological features. A good example of a former river-plain surface, now left high and dry, is the 'Horseshoe' area on the north side of Terrace. The cliffs around the Horseshoe were cut by the Skeena River during an earlier time.

(Stop 1) Terrace Mountain lookout:
the big valley, its 'faulty' history, and granite foundations

Figure 4: *View from Terrace Mountain looking west across the Kitsumkalum-Kitimat Valley to Sleeping Beauty Mountain and Coast Mountains. Terrace is in the foreground. Curiously, the Skeena River flows across, rather than down, the valley. Photo by Bonnie Hayward.*

Take a look at the view! So, with our geological history in mind, let's head out and take a look at the landscapes of Terrace. The first stop is the viewpoint on Terrace Mountain above the eastern side of town. From the viewpoint, a landscape unfolds to the west and southwest.

Figure 5: *The Big Valley – a faulty history. The Kitsumkalum Valley formed by movement along faults that caused the valley to subside relative to the adjacent mountains.*



Terrace lies within the north-south Kitsumkalum-Kitimat Valley, bound to the west by the Coast Mountains and to the east by the Hazelton Mountains. This is one of the largest coastal valleys in British Columbia. The Skeena River flows in its own narrower valley from east to west, crossing the broader north-south valley.

Geologists find this curious – the Kitsumkalum and Kitimat Rivers seem too small to have carved the big valley. It is likely that at some time in the geological past, a much larger river flowed down the Kitsumkalum-Kitimat Valley, eroding its great width.

How thick was the glacier during the last Ice Age? You can answer this question by observing the shape of the mountains. Most of the Coast Mountains to the west have rounded summits which indicate that glacial ice flowed over the tops of them. Only the very highest peaks are sharp and irregular, indicating they poked above the highest limits of the glacier. So as you look at the view, imagine the valleys filled with glacial ice with only the highest, sharp peaks sticking through!

Take a look at what's at your feet! At the lookout, you are standing on a light grey coloured granitic rock. The rock has a salt-and-pepper texture reflecting the intergrowth of light (feldspar, quartz) and dark minerals (hornblende, black mica) which crystallized from molten rock (magma). The Coast Mountains, from Vancouver to Alaska, have been referred to as 'Granite Country' because of the tremendous abundance of granitic rock relative to other parts of British Columbia. Granitic rock is usually pretty massive and contains fractures which tend to be widely spaced. Because of these characteristics granite resists erosion, and as a result, often forms very stable, steep cliffs such as the western face of Copper Mountain. These kind of features also make it a favourite for local climbers.

***Figure 6**. Granitic rock with salt and pepper texture. The alignment of dark mineral grains (foliation) shows that this rock was deformed - i.e. squished –while it was still deeply buried. Photo by Bonnie Hayward.*

__Go take a look:__ Drive east from downtown on Park Street up to Birch Bench. Turn left on Johnstone Street. The trail head is on the right. The trail to the lookout rises about 200 metres and takes about 45 minutes to an hour and a half to climb**.**

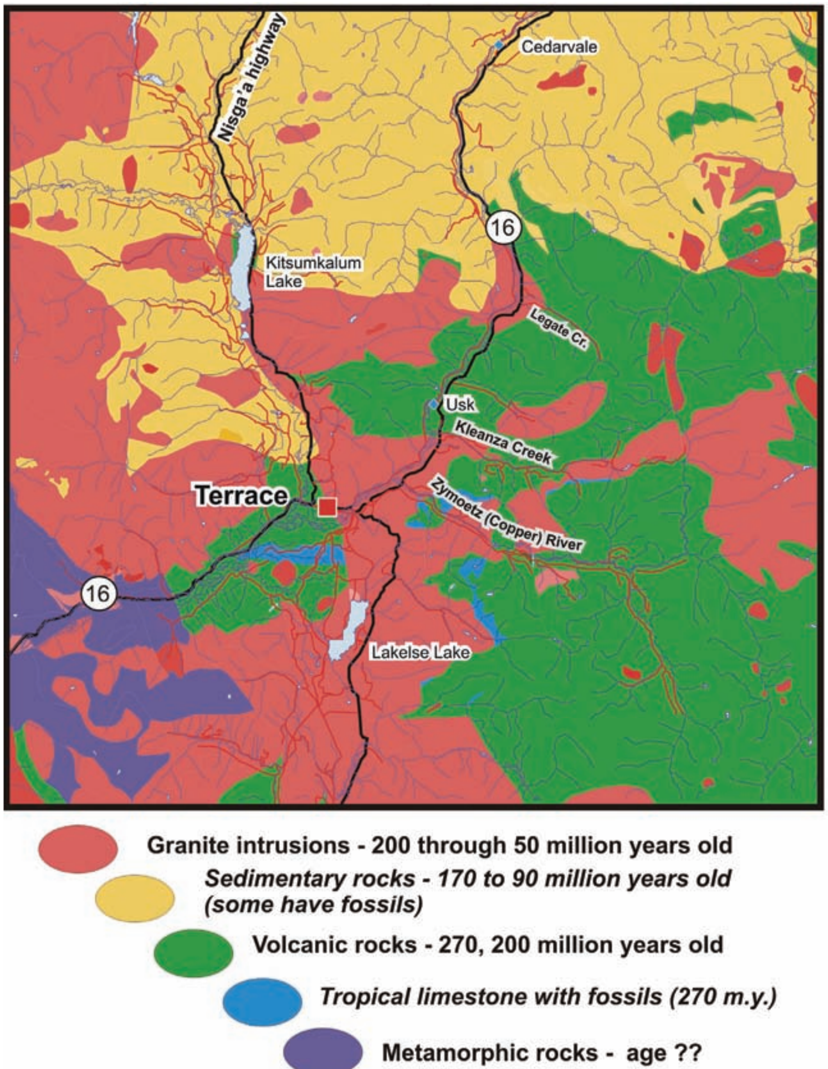
(Stop 2) Ferry Island Park and Skeena River gravel bars:
diverse rock types, nicely polished

***Figure** 7. Gravels exposed on the gravel bar at Ferry Island. Photo by Bob Turner.*

Ferry Island is just one of many islands in the Skeena River near Terrace. Upstream of Terrace, the Skeena River is fast flowing within a narrow valley and then as the river enters the broad Kalum-Kitimat Valley, the river slows. Currents which have pushed gravel along the river bed from high in the mountains weaken, and the gravel accumulates, forming mounds on the river bed that make bars and islands. Ferry Island is an example of a large island that is old and stable enough to have an established forest. Islands fill the Skeena River all the way to the sea – this is the final dumping ground of the Skeena River as it meets the Pacific Ocean.

Many different rock types underlie the Terrace region. If you drive toward Hazelton, the dominant rock types are sandstone and shale. Kitsumkalum mountain is composed of volcanic rock. If you drive west of Terrace to the Coast Mountains, the dominant rocks are granite and gneiss. Geologists compile maps showing the distribution of different rock types and sediment types, or 'geological maps'.

These maps are used in the search for mineral and energy resources such as copper, sand and gravel, oil and gas (see Figure 8). They also offer hints as to where different kinds of river pebbles may have come from.



Gravels are fragments of rock that have been worn smooth by bumping, grinding and sand blasting which takes place in rivers over long periods of time. The smooth surfaces of pebbles, particularly if they are wet, reveal detailed textures and colours that help in their identification. The diversity of pebble types reflects the extensive network of streams over all landscapes. The streams then carry the scavenged materials eroded from rock, glacial gravels and glacial tills,. and concentrate them in their beds.

***Figure 8**. Map of rock types underlying the Terrace region (by JoAnne Nelson).*

***Figure 9.** Different types of pebbles found on a bar in the Skeena River. Clockwise from lower left corner: 1) Brick red to purple volcanic lava;*
2) grey green lava with white rectangular feldspar crystals; 3) green lava (metamorphosed); 4) grey layered sandstone and mudstone; 5) white 'salt and pepper' granitic rock. Photo by Bob Turner.

River bars such as those around Ferry Island offer an excellent opportunity to inspect gravels, at least when the river levels are low (not during spring runoff and during heavy autumn rains!). Try to give each rock type a name based on your observations of its colour, luster, or texture. For example, you might decide you would call one the 'grey dull swiss cheese rock' because it is full of holes, another 'white, shiny, harder than knife rock', and another ”grey and black speckled ’salt and pepper‘ rock”. Good luck! Here is what a geologist might call those same rocks.

- Grey dull Swiss cheese rock = volcanic lava
- Brick red and purple rock, with some holes = volcanic lava
- Light grey and dark grey layered rock = sandstone (light grey) and mudstone (dark grey)
- white, shiny, harder than knife = quartz from quartz veins
- Grey green to pistachio green rock = metamorphosed volcanic rock
- Purple-brown or red-brown shiny speckled rock = volcanic lava
- Grey and black speckled ’salt and pepper‘ rock = granitic rock
- Layered grey and black speckled ’salt and pepper‘ rock = gneiss

Go take a look: Ferry Island. Drive east from Terrace on Highway 16 to Ferry Island. Turn south (right) into the parking lot at the access road to the Ferry Island Campground. Take the trail east from the parking lot, under the highway bridge, and down to the gravel bar. At low water, the bar is large. At high water in spring and early summer the bar may be completely submerged.

(Stop 3) Old Bridge and Skeena River

Figure 10. *View of the Skeena River and Old Bridge from Lakelse Road park. Stop 3 is at the north (right) end of the bridge at a small beach and rock point. Copper Mountain granite cliffs in clouds behind. Photo by Bob Turner.*

At the south end of the Old Bridge (Skeena Bridge) over the Skeena River is a fisherman’s access to a small beach and a rock point. The rock ridge of Terrace Mountain meets the Skeena River here and the river has only partly cut a channel through these hard granitic rocks. The footings of the Skeena Bridge take advantage of the low ridge of granitic rock which crosses the Skeena River. Most of the river’s flow is forced through a narrow, underwater canyon which is over 20 metres deep below the main span of the bridge.

Walk out on the rock point. During floods, this rock ridge is submerged by the Skeena River. Can you see evidence that the river has flowed over these rocks? Look for potholes in the rock created by pebbles driven by swirling river water.

Go take a look: Drive east from the downtown on Highway 16. Turn north (left) at Highway 37 and east (left) at Queensway just before Skeena Bridge. A gravel road leads down towards the river about 100 metres west of the bridge.

(Stop 4) Tropical Terrace? Terrace’s oldest residents?

Local limestones tell the story

Who are Terrace’s oldest residents? One might argue that some clams, sponges, and other small creatures that have left us their fossilized remains in limestones near Terrace deserve that title. Geologists will tell you that they are about 270 million years old! And, lived below a tropical sea! Things sure have changed since then!

Figure 12. *270 million year old fossil of a tropical clam in limestone.*

Figure 13: Cliff of limestone 270 million years old. Grey fossil-bearing limestone is interlayered with a hard white quartz-rich rock. Photo by JoAnne Nelson.

Go take a look: Drive west on Queensway from Skeena Bridge to Old Remo Rd. Turn west (right) and drive about 4 km. Pull off the road near the horse sign. Look for a small trail on the north side of the road leading down the slope. A short walk through the forest brings you in sight of a cliff rising out of the forest. The rock rubble at the base of the cliff is a good place to look for fossils, such as brachiopods, pieces of coral and crinoids, fusilinids (they look like rice grains). If you are adventurous, climb the rubble to the layered rock in the cliff. More small fossils are there, but please, leave them so others can admire them too!

(Stop 5) Kleanza Creek: there's gold in them thar hills

***Figure 14**. Kleanza Creek at the Provinical Park picnic site where the creek flows out of the canyon. Photo by Bob Turner.*

Kleanza Creek Provincial Park is situated 15 km northeast of Terrace on Highway 16, next to the beginning of a logging road which continues on the north side of the creek. During the late 1800s and early 1900s, placer gold was mined from the gravels of Kleanza Creek. '*Kleanza*' is a Gitxsan word for gold. Now the creek is highly valued as a salmon run, and forest growth and natural erosion have mostly hidden the evidence of the century-old workings.

If you want to try out gold panning for yourself, go outside the park to the upper reaches of Kleanza Creek or try any of the other streams that flow into the Skeena. All you need is a pie tin or frying pan. Fill it about half full of wet sand and half full of water. Hold it under the surface of the stream; rock it to settle the heavy grains to the bottom and then wash the lighter grains off the top. Repeat until you have a little bit of dark-colored residue in the bottom. Swirl this around and look for shiny, pinprick-sized gold grains. Chances are you won't find any - the early prospectors were very thorough in their work - but you may be rewarded with a little train of black metallic grains (magnetite) or pink ones (garnet).

(Stop 6) Heritage Park Museum: The hard life of early miners

The Skeena River valley has been a well-travelled transportation corridor probably since the first peoples arrived. Until the late 1800s, getting there required a canoe and a team of strong, determined paddlers to negotiate the rapids, and riches were mainly trade goods running between the coast and the interior. The coming of sternwheelers in 1890, and the railroad in 1914 brought a new kind of explorer to the region: hardrock prospectors and miners. They plowed through thickets of devil's club and scrambled up the highest peaks in search of gold, silver and copper. They threaded trails through precipices: one of these climbed in sixty-four dizzying switchbacks to a high pass at the head of Chimdemash Creek. The Bornite Mountain hiking trail north of Kleanza Creek once led to the Singlehurst property, one of the busiest mining operations in the Terrace area. Sixty-five men worked there in 1900. They drove a shaft into the gold-bearing quartz vein by hand, constructed a headframe, and used a horse-powered winch (a 'whim') to haul ore and rock waste out of the shaft.

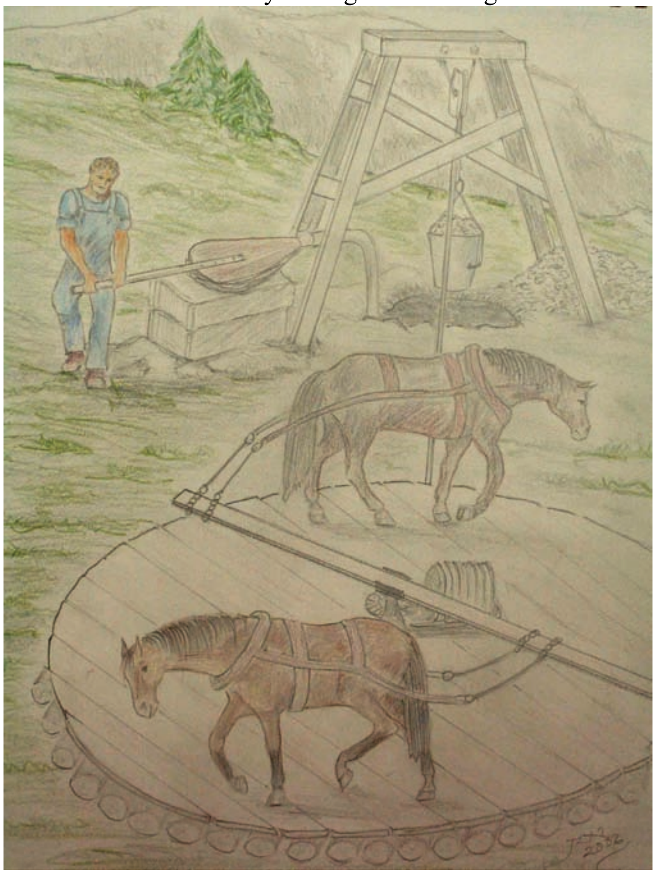
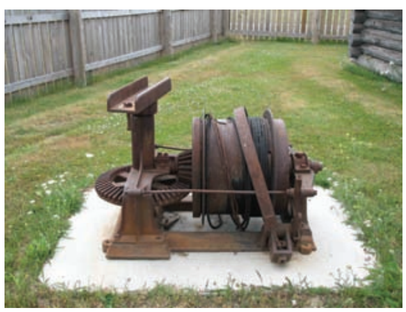


Figure 15 *'Air in. Ore out' Life at the Singlehurst mine. A horse-powered winch (whim) lifts a bucket of ore from the shaft of the Singlehurst mine. Miners at the bottom of the shaft work in tunnels which follow the ore. They depend on their co-worker with a giant bellows on surface to pump fresh air into the mine down a long pipe. (Drawing by JoAnne Nelson).*

Go take a look: There's a miner's cabin at the Heritage Park Museum on Kalum Drive north of Terrace where you can see the whim and ore bucket from the Singlehurst mine. Go inside the cabin and check out the ore and fossil specimens and hand-forged miners' tools. Pick up the hand steels and imagine drilling a hole into the rock, hammer blow by hammer blow, one chip at a time. Think: maybe this blast will be the good one, maybe it will reveal a glittering fracture face of free gold or, maybe not. Or, maybe next week you can pack down the mountain for the winter, enjoy a little piano music or a dance for the bachelors hosted by one of the families at Kitselas. Across the lawn at the historic park, the Kalum Lake Hotel gives a glimpse at what civilized comforts a weary miner could enjoy after a season working his claims. (*Also see* www.heritageparkmuseum.com)



Figures 16 and 17*. The bucket and whim from the Singlehurst mine are on display at the Heritage Park Museum. Photos by Bob Turner.*

(Stop 7) Nass Valley lava flow: a natural tragedy

An hour north of Terrace up the Nisg'a' Highway is an amazing sight where the highway leaves the wet, forested landscapes typical of the Coast Range and enters an open expanse of bare rock and rock rubble which extends along the valley floor for more than 20 kilometres. This is a lava flow that erupted into the valley only 250 years ago. So recently that little grows on the lavas except for a bit of moss and lichen. The lava flow destroyed several Nisga'a villages with great loss of life and temporarily blocked the Nass River. The lavas permanently blocked Tseax River, flooding the valley and forming Lava Lake. It transformed a lush forested valley to a rocky desert landscape. The lava flowed from a fracture in the Earth near Tseax Cone, a 100 m high cone of volcanic cinders which erupted and piled up while the lava flowed.

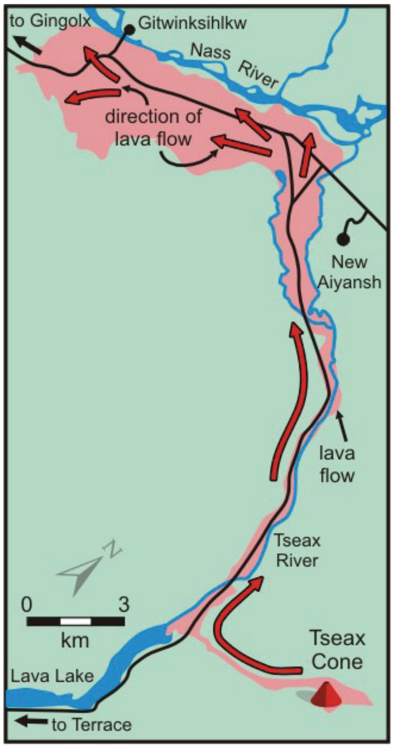


***Figure 18**. Map of Nass River lava flow.*

***Figure 19**. A close up of dark lava, filled with gas-bubble casts. Gas was 'fizzing' from the lava as it flowed, much like a soda drink. As the lava cooled, these bubbles were frozen into the rock and are still there today. Photos by Bob Turner.*

***Figure 20**. Near Gitwinksilk, the lava surface is made up of lava rubble. The surface of the lava 'froze' into a rock crust while underlying lava remained liquid and continued to flow, causing the crust to break into rubble.*

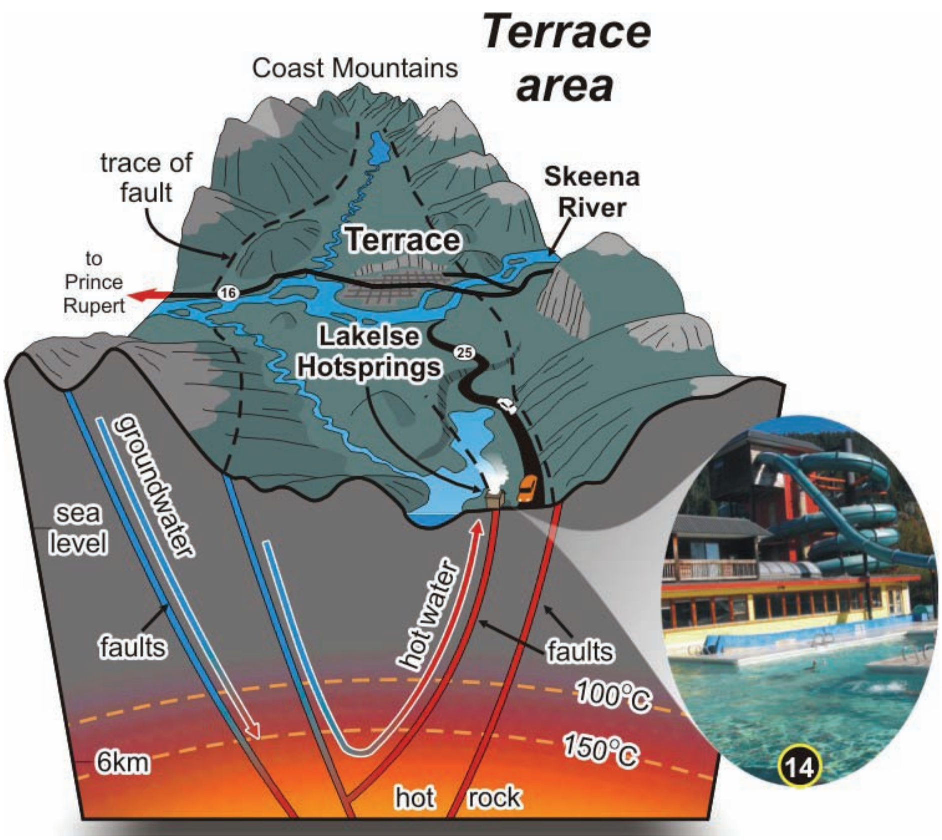
(Stop 8) Mount Layton Hotsprings: Water from deep in the earth

The hot waters that flow to the surface at Mount Layton Hotsprings, south of Terrace, remind us that deep within the Earth it is very hot. These hotsprings are the hottest in Canada with water at 89 degrees Celsius, and have been developed into a resort and water park. So, as you soak in the hot tub or pool, remember you are being warmed by the Earth, literally!

***Figure 21 and 22**: (left) Swimming pool at Mount Layton hotsprings. (right) Unused concrete pool built around one of the hotsprings. Photos by Bob Turner.*

Mount Layton hotsprings, also known as Lakelse Hotsprings, include at least half a dozen warm seeps that straddle Highway 37 and flow into wetlands which surround the resort area. Warm springs may also occur on the floor of Lakelse Lake, as local residents have noticed soft spots in the lake ice during the winters.

The Kalum-Kitimat valley formed millions of years ago by movement on faults which made it possible for the rocks under the valley to sink, while the adjacent rocks rose to form the Coast and Hazelton Mountains. Geologists refer to the Kitsumkalum-Kitimat valley as a fault-bounded valley. It is likely that the molten rock magma that erupted as the Nass Valley lava flow, 250 years ago, rose along these same faults.



How do faults create hotsprings? Faults are the pathways which provide a pathway for hot waters to move quickly to the surface before they have a chance to cool down! Snowmelt and rainwater which fall on the mountains percolate down, along faults. As the waters descend, they are warmed by the Earth, which increases in temperature with depth. Earth heat comes from heat generated by pressure and radioactive decay of elements, such as uranium, in very tiny amounts spread over the vast earth interior. Deep below the valley, down perhaps 6 or more kilometres, the waters reach temperatures of 100 degrees Celsius or more. Some of these hot (less dense) waters rise along other faults, pushed to the surface by the weight of cool (denser) descending water. Hot waters cool somewhat as they rise, mixing with cool, shallow groundwater, and reach the surface at temperatures near 89 degrees Celsius.

Figure 23. *Schematic view of the geothermal "plumbing system" that feeds the hotsprings*

Go take a look: Mount Layton Hotsprings
The hotsprings resort is about 30 kilometres south of Terrace along the Highway 37.

(Stop 9) Highway 16 sand and gravel pits:
vital resources from ancient glacial rivers

Figure 24. *(right) A gravel pit in an Ice Age bench along Highway 16 just east of the Kitsumkalum River bridge. The cliff exposes thick sand and gravel deposits (grey) overlain by a 3-5 m layer of clay and silt (tan). Photo by Bob Turner.*

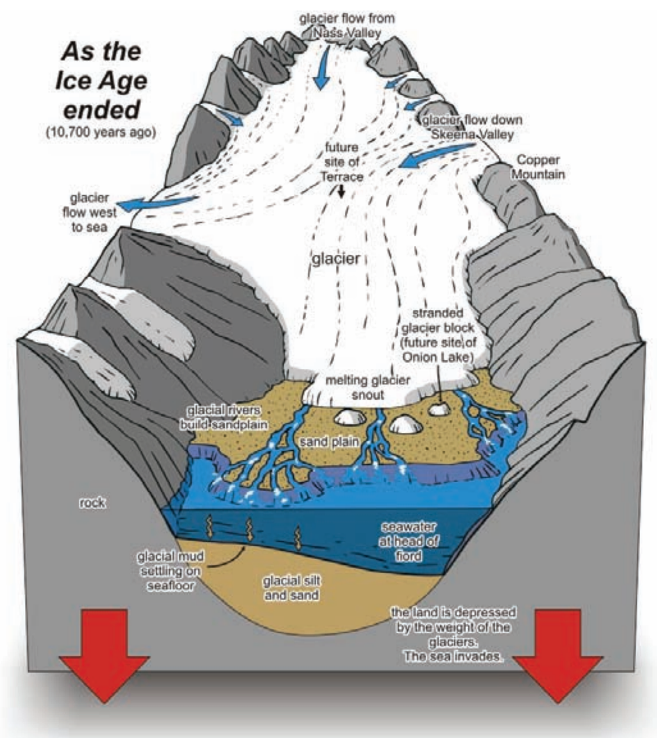
The Terrace area has extensive deposits of sand and gravel. You might be surprised to learn how important these earth materials are to the community. Gravel and sand layers buried below Terrace contain 'aquifers' –

natural zones of underground water in the pore spaces between sand and pebbles. - They supply the City of Terrace with its high quality drinking water (**Stop 12**). Gravel and sand are also essential components of concrete and asphalt (**Stop 11**).

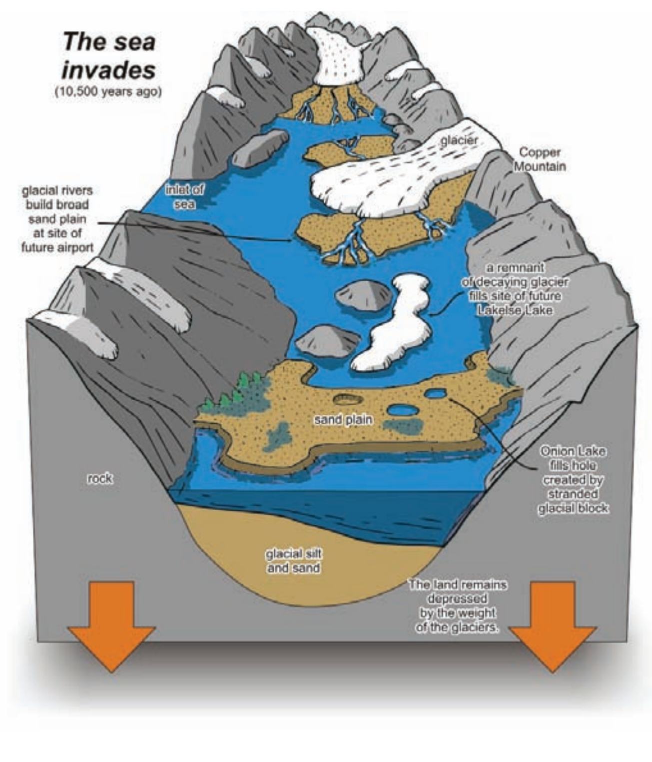
Figure 25. *(below) A gravel pit along Highway 16 near the Kitsumkalum River. Sand and gravel deposits are sorted by screening into separate piles of gravel and sand, and each is sold for different purposes. Photo by Bob Turner.*

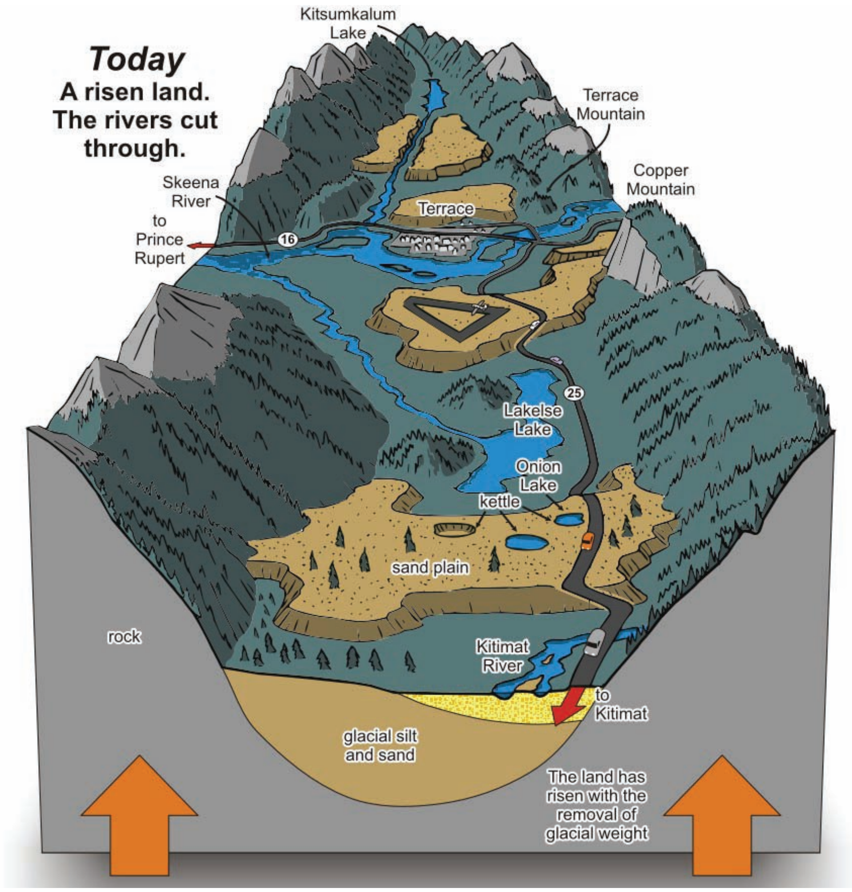
<u>Go take a look:</u> Drive west from downtown along Highway 16. A large gravel pit operation is on the north side of the highway just before the bridge over the Kitsumkalum River.

So where did all this gravel come from? The answer: ancient rivers. Sand and gravel deposits form the flat benches north of town and south of the river at the airport. These benches are flat because they formed as ancient river plains at the end of the last glaciation. The Skeena and Kitsumkalum rivers have cut down through these thick deposits, forming their own gravel deposits as lower terraces such as the 'Horseshoe' area of north Terrace. The gravel banks, bars, and islands of the Skeena River, visible when river levels are low, remind us that rivers create sand and gravel deposits as they flush the finer materials such as silt and clay downstream, leaving behind clean gravels and sand.



Figures 26 a, b and c. *An interpreted history of the Terrace area at the end of the Ice Age illustrating the formation of sand plains that today are the flat elevated benches (or terraces) that host the airport, the Heritage Park Museum and cemetery in northern Terrace, and Onion Lake south of Lakelse Lake.*





(Stop 10) Making concrete and asphalt:
Digging our local gravel and sand

Try to imagine Terrace without concrete. No Highway 16 bridge. No multistory buildings downtown. No basements. No house foundations. No curbs. Now try to imagine Terrace without asphalt. No sealed or paved roads. No paved parking lots. Roads sure would be dusty in summer and muddy in winter. Hundreds of thousands of tons of concrete and asphalt are made and used each year in the Terrace area. It might surprise some to know that over 80% of all the asphalt and concrete used in the Terrace area is made of local sand and gravel.

***Figure 27**. Concrete plant on Old Lakelse Lake Drive in Thornhill. The plant makes concrete aggregates, septic tanks, highway barriers, brick, block, paving stones, slabs, chimney blocks, and premixed sack products.*

Concrete is the most widely used construction material worldwide. Twice as much concrete is used in construction than all other building materials combined, including wood, steel, plastic and aluminum. Concrete is made by combining nine parts sand and gravel with one part cement. Sand and gravel make up the bulk of concrete; cement is the glue that holds it together. To make the cement 'glue', limestone, shale and sand are mixed and ground to a fine powder, and then roasted at high heat. Cement necessary for Terrace's concrete must be imported because the necessary type and quantity of limestone and shale are not available locally. Terrace has several plants that combine locally quarried sand and gravel with imported cement to make concrete.

Go take a look: Drive east from Terrace on Highway 16 across the Skeena River to Thornhill. Turn south on Old Lakelse Lake Drive. As the road climbs up the bench, note the abandoned and active quarries along the west side of the road. The Skeena Concrete Products Ltd plant is on the west side at the top of the bench.

Figure 28. *Asphalt plant on along Highway 16 east of Thornhill. Sand and gravel are quarried from Ice Age deposits, sorted, and combined with liquid asphalt at the plant.*

Asphalt is similar to concrete in that it is largely made up of local gravel and sand. It differs by using a different 'glue'. Rather than using cement, it uses liquid asphalt, a tar-like substance which belongs to the hydrocarbon family that includes petroleum, natural gas, and gasoline. The liquid asphalt is brought to Terrace by rail car from a petroleum refinery in Lloydminster, Alberta. This refinery processes heavy oil extracted from the Earth below Alberta.

Go take a look: Asphalt plant, Highway 16, east of Thornhill: Drive east on Highway 16 from Terrace through Thornhill to the Terrace Paving access road on the south side. Call ahead if you would like to arrange a tour.

(Stop 11) Copper River Slide:
A Natural Disaster in Our Backyard!

The forces that shape our landscapes are of colossal power, and sometimes they directly impact our lives. On June 8, 2002, a very large landslide occurred approximately 30 km east of the city of Terrace. The rock and soil debris traveled about four and a half kilometres and descended about 1250 metres. The slide ruptured a gas line, triggered a forest fire, dammed the Copper River (also known as the Zymoetz River), flooded a Forest Service road, and destroyed a bridge.

Figure 29. *A view up the valley of Glenn Falls Creek. The source and flow of the grey landslide is visible on the partly snow-covered mountain slope and upper valley. Glenn Falls Creek is visible flowing in a barren denuded strip, scoured by a rock-mud-snow slurry (debris flow) that was set in motion by the landslide that descended Glenn Falls Creek to the Copper River (not visible). Photo by Gordon Weary*.

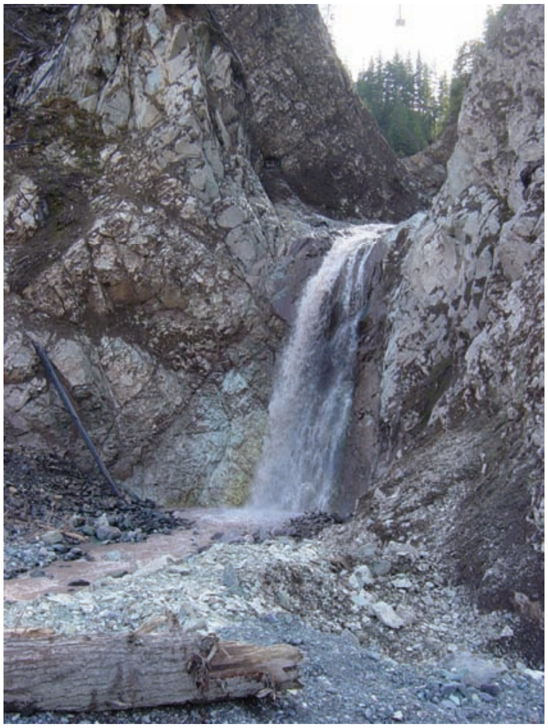


Figure 30. *The lower part of Glenn Falls Creek. Prior to the landslide, this creek flowed through a forest. Most of the bare rock was covered with soil and trees. The rushing slurry of rock, soil, and water (debris flow) scoured the stream banks, adding all this material to its flow. So the slurry grew in volume as it descended the creek. Geologists estimate that the debris flow reached a speed of 120 kilometres an hour. Photo by Gordon Weary.*

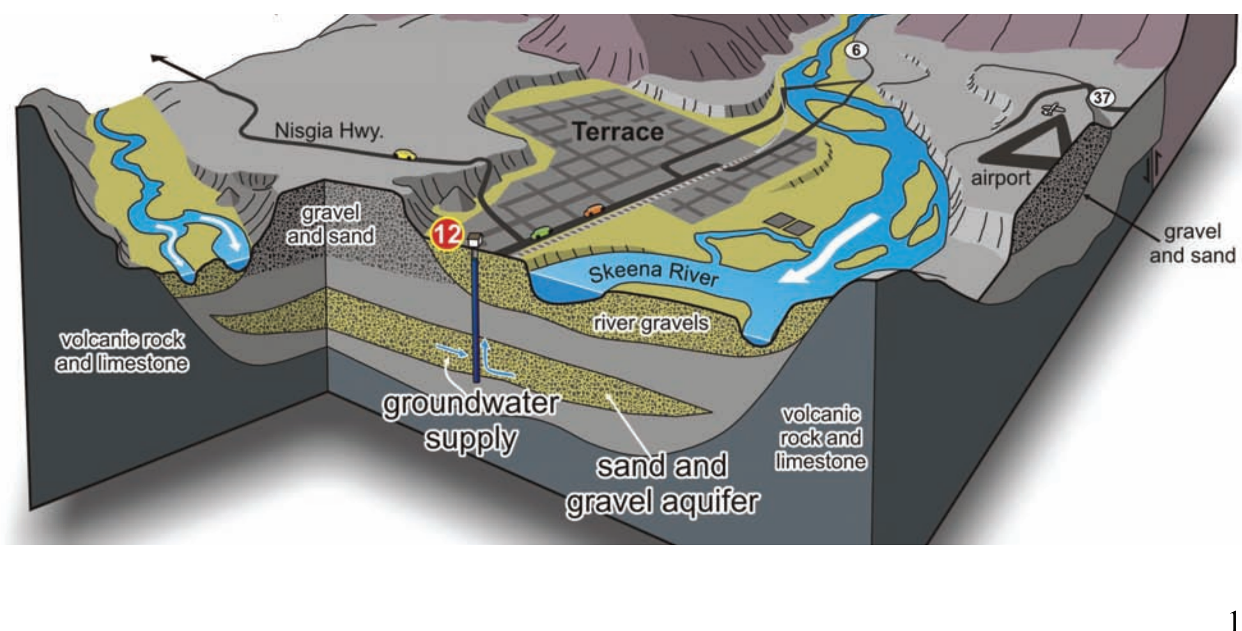
The landslide began as a rock avalanche on a steep slope in the cirque basin at the head of Glen Falls Creek. Rapid melting and runoff let loose a mass of rock, soil, snow and ice. The material became saturated with water and the resulting debris flow reached an estimated speed of 122 kilometres an hour, while both eroding and depositing a large amount of material within the gully. The flow finally came to rest in the Copper River, where it deposited a large amount of debris. This material dammed the river, flooding the valley and a major forestry road upstream. The debris flow severed the PNG natural gas pipeline from Terrace to Smithers which runs along the Copper River valley. The leaking natural gas then compounded the problems by igniting a forest fire.

(Stop 12) Where does our water come from?
The river? The mountains? Try under your feet!

Water supply is a vital resource. The City of Terrace is supplied with water from a well within the town limits. The well is drilled into a deep sand and gravel deposit, which contains abundant groundwater and which lies below silt and clay.

Figure 31*. (to left) City of Terrace wellhouse on Frank Street. Photo by Bob Turner.*

Figure 32. *(below) A schematic cut-away view of the underground below Terrace. Sand and gravel bodies act as aquifers that contain the vital water supplies for Terrace.*



Terrace's sand and gravel aquifer is about 15 metres thick and lies 40 metres below the surface. The spaces between the sand and gravel grains are full of very clean water and the sand and gravel provides natural filtration as the groundwater moves slowly through the aquifer. Separating this underground water supply from all the human activity in Terrace is a layer, 20-30 metres thick, of silt and clay. Water does not readily flow through these fine materials and so this layer acts as a barrier against contaminants that might otherwise trickle downwards from the streets of Terrace. However, because the City is built on top of its water supply, it is possible that a spill one day could infiltrate to the aquifer and contaminate it. Once contaminated, it would likely take years to decades to 'flush out the aquifer. Therefore, it is very important that businesses and homeowners use 'best practices' to protect this water supply.

Water use in Terrace averages 10 000 to 11 000 cubic metres per day, or 10 to 11 million litres per day. Per capita consumption is about 1000 litres per person per day, enough to fill a small hot tub. Water use doubles in the summer to over 20 000 cubic metres per day. To meet this demand, the City of Terrace uses additional water drawn from a reservoir on Deep Creek, north of town. The source of water in Deep Creek is snowmelt and rainfall within the Deep Creek Watershed on the north side of Terrace Mountain. As a backup supply, we occasionally may use water taken directly from the Skeena River.

Curious about groundwater?
Here's a website that explains many aspects of groundwater
(http://www.ec.gc.ca/water/en/nature/grdwtr/e_gdwtr.htm)

(Stop 13) Where does our wastewater go?
After treatment, into the Skeena River

So, where does our sewage go when we drain the sink or flush the toilet? The answer, for most parts of the town, is the City of Terrace wastewater treatment plant on Graham Avenue near the Skeena River on the southwest side of town. The facility treats the waste water to all the requirements set by BC Environment and then discharges it into the Skeena River.

Wastewater treatment combines three major steps:

Step 1 (Primary treatment): Solids, rags, sticks, plastics and other large objects greater than 25 mm are removed from the sewage flow using a screen. This debris is bagged and sent to the landfill.

Step 2 (Secondary treatment): After screening, the remaining sewage flow enters and flows through two aerated lagoons (*see* picture below) where bacteria breakdown organic matter within the sewage. Air bubbled from a pipe system on the floor of the lagoon, and surface water sprays, ensure the bacteria have sufficient oxygen to thrive. The wastewater circulates for about 3 weeks through the two lagoons before it is ready for release into the river.

Step 3 Once treated, the sewer flow is discharged into the Skeena River through an outfall pipe.

Figure 33. *A secondary treatment lagoon at the Graham Avenue wastewater treatment plant, City of Terrace. Small fountains within the lagoon mix and circulate oxygen into the wastewater. This oxygen is essential to bacteria that feed on and digest the organic matter, converting it to non-harmful products. Abundant green algae and plants on the surface reflect the nutrient-rich nature of the wastewater. Photo by Bob Turner.*

Go take a look: The City of Terrace wastewater treatment plant is at the west end of Graham Avenue southwest of town. Tours of the plant are available if arranged in advance through the City of Terrace.

(Stop 14) Where does our garbage go?
To landfills near town

How well do we manage our solid waste? How effectively do we reuse materials? Or recycle what we do not reuse? Dealing with garbage is a major challenge for local governments. Most garbage from the Terrace area goes to the municipal landfill about 4 km north of town on the Kalum Lake Road/Nisga'a Highway. There is also a landfill in Thornhill on Old Lakelse Lake Drive. Both landfills bury garbage within old sand and gravel quarries. Leachate (the mix of water soluble substances that comes from discarded items), is often a problem associated with landfills. The city of Terrace is monitoring and attempting to contain the leachate produced from their landfill sites. A proposed new landfill currently under consideration by the Regional District of Kitimat-Stikine is to be constructed in the near future. It will be designed to prevent leachate from entering the environment. As well, the Terrace Bottle Depot on Kofoed Drive manages the recovery of beverage containers, residual paints, solvents, and other flammables. It also accepts corrugated cardboard, office paper, and plastic milk jugs.

***Figure 34:** Garbage at Thornhill Landfill looking north toward Copper Mountain. The landfill is within an old sand and gravel quarry. Can you spot anything in this garbage pile that could have been recycled? Photo by Bob Turner.*

Go take a look

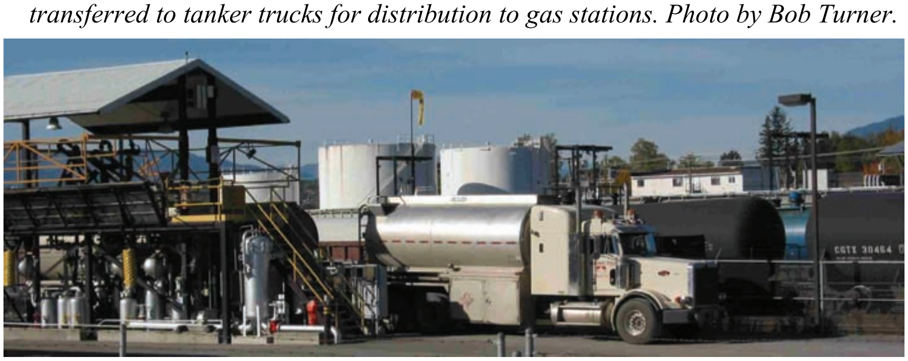
The Thornhill Landfill is located on Old Lakelse Lake Road, half way up the Airport Bench. Batteries, appliances, and automobiles are separated from mixed garbage.

(Stop 15) Natural gas. Gasoline. Diesel. Heating oil. Aviation and jet fuel. Propane. Where does it all come from?

Gasoline, other petroleum products, propane, and natural gas are vital energy sources for transportation, industry and homes. They reach Terrace in a variety of ways. Natural gas travels by pipeline from gas plants in northeastern BC. Gasoline, diesel fuels, heating oil, aviation and jet fuel are transported to Terrace by rail car and truck from refineries in Prince George and Edmonton. These are part of a broad range of products, which along with asphalt and plastics are refined from oil and natural gas.

***Figure 35**. Natural gas pipeline in Thornhill.Photo by Bob Turner.*

***Figure 36.** Rail terminal for petroleum products, Terrace. Gasoline and diesel brought in by rail car is stored and transferred to tanker trucks for distribution to gas stations. Photo by Bob Turner.*



Oil and natural gas come from the Earth. Most natural gas used in British Columbia comes from deep reservoirs below northeastern

BC. Oil and natural gas are referred to as 'fossil fuels' because they are derived from ancient animals and plants which were buried within sediments on ancient seafloors. Later, this organic material became trapped within rock reservoirs. Oil and gas are extracted from these reservoirs by drilling wells, often to depths of 1000 to 2000 metres below the surface. Natural gas occurs in tiny holes in the rock, millimetres to centimeters in size, which occur within sandstone or limestone layers. Oil, which may occur with natural gas, largely comes from reservoirs that lie under various parts of Alberta and from the giant deposits of tar sands in northeastern Alberta.

Go take a look

The Petrocan rail terminal is on the north side of Highway 16 in eastern Terrace.

Uh, oh. What about climate change?

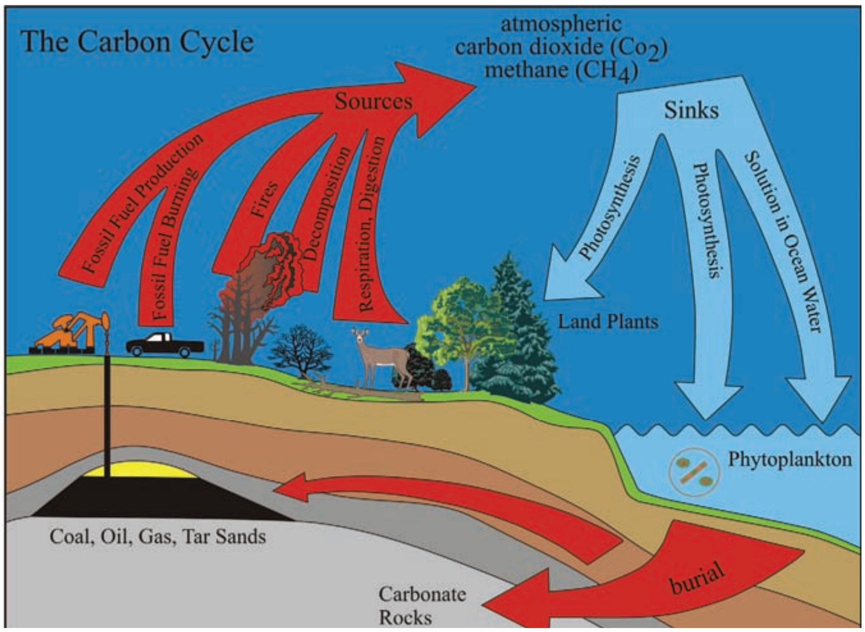


***Figure 37**. The carbon cycle. Fossil fuel production and burning is rapidly adding carbon that was long ago stored in the Earth. This is upsetting the natural balance of the carbon cycle.*

In spite of the tremendous benefits and convenience of fossil fuels, a clear consensus has developed in the scientific community that the greenhouse gases produced from use of oil and natural gas are dramatically changing the composition of our atmosphere, and producing very worrying global climate change.

Northern BC has warmed significantly in the last 100 years, and direct evidence of this is the widespread and rapid retreat of glaciers in the Coast Mountains around Terrace.

One of the most dramatic impacts of climate change in northern BC is the spread of the Mountain Pine Beetle infestation. Forests throughout central BC are infected, and the infestation is also developing in Alberta. Very cold winters was one factor that used to hold the beetles in check, but warming winter temperatures now help the beetle thrive much farther north and east. Another factor leading to Pine Beetle infestation is the lack of forest fires due to forest management practices during the later part of the 20th century. The rapid death of extensive forest is a huge challenge for the forestry industry and the communities throughout BC dependent on the forest industry. Indeed, this is a very high cost, likely worth billions of dollars.

Get informed. What are the likely impacts of climate change to British Columbia and the rest of Canada? Visit the Natural Resources Canada website **www.adaptation.nrcan.gc.ca/posters** that describes the science behind climate change, and likely impacts. Visit student and teacher resources at **www.gvrd.bc.ca/climate/teacher**

Calculate your own green house gas emissions. Do you know how many green house gas emissions you produce each year? Use this Government of Canada calculator to find out and learn how to reduce them. Visit **www.climatechange.gc.ca/calculator/english**/

What can we do? Lots! Need some ideas? Visit **www.davidsuzuki.org/Climate_Change/What_You_Can_Do/**

Want to know more?

Written for a public audience

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http://www.em.gov.bc.ca/Mining/Geolsurv/Publications/OpenFiles/OF2006-03/toc.htm

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