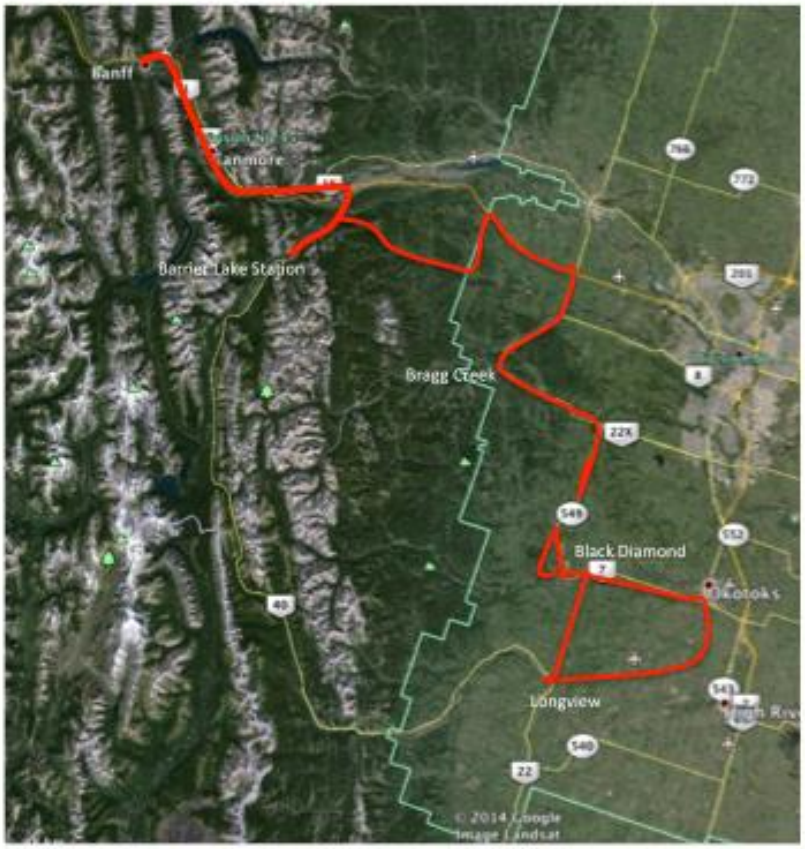
Field Trip Guide

Soils and Landscapes of the Front Ranges, Foothills, and Great Plains



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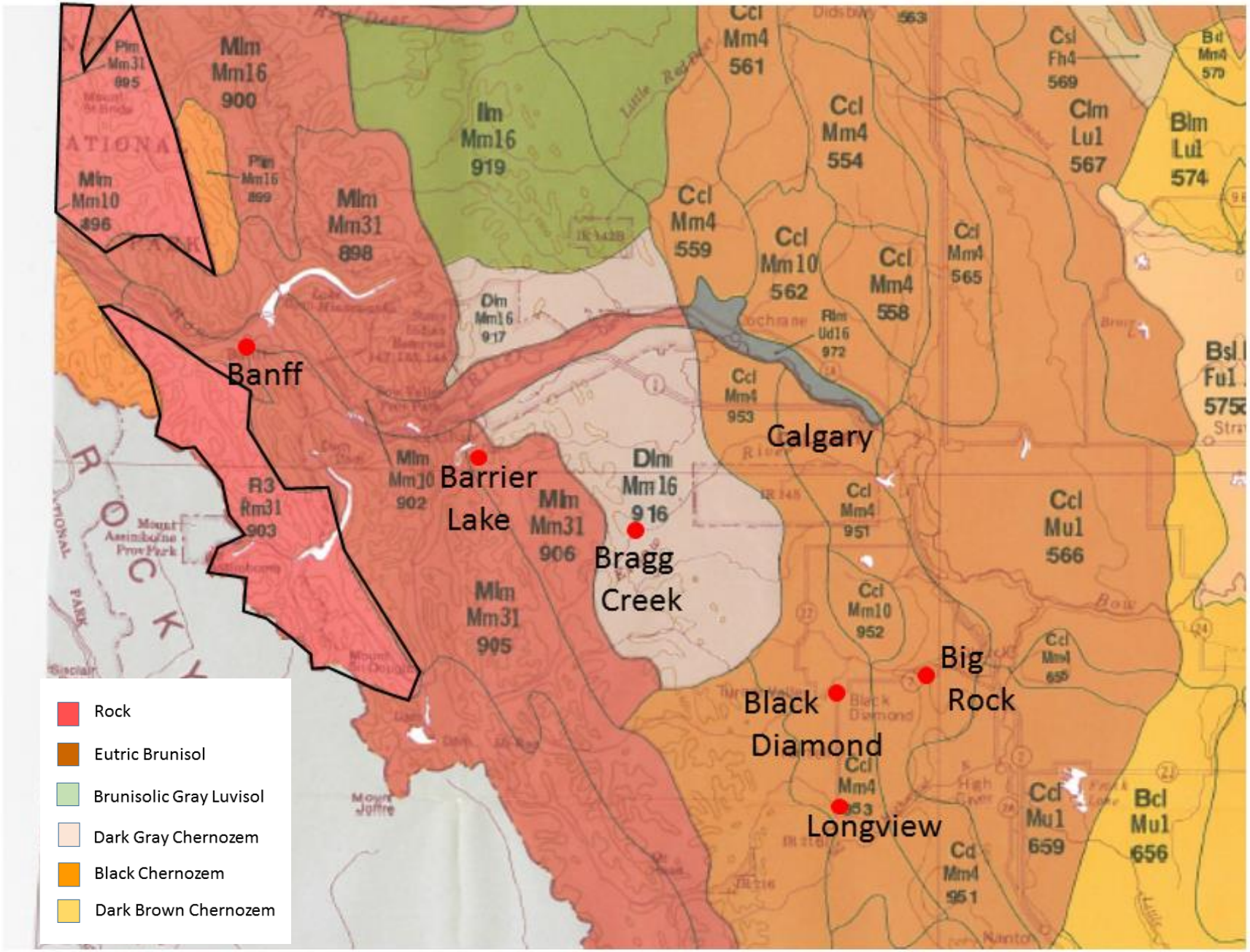

Banff
Barrier Lake
Bragg Creek
Calgary
Black Diamond
Big Rock
Longview
Rock
Eutric Brunisol
Brunisolic Gray Luvisol
Dark Gray Chernozem
Black Chernozem
Dark Brown Chernozem

Banff Park

In the fall of 1883, three Canadian Pacific Railway construction workers stumbled across a cave containing hot springs on the eastern slopes of Alberta's Rocky Mountains. From that humble beginning was born Banff National Park, Canada's first national park and the world's third. Spanning 6,641 square kilometres (2,564 square miles) of valleys, mountains, glaciers, forests, meadows and rivers, Banff National Park is one of the world's premier destination spots.

In Banff's early years, The Canadian Pacific Railway built the Banff Springs Hotel and Chateau Lake Louise, and attracted tourists through extensive advertising. In the early 20th century, roads were built in Banff, at times by war internees, and through Great Depression-era public works projects. Since the 1960s, park accommodations have been open all year, with annual tourism visits to Banff increasing to over 5 million in the 1990s. Millions more pass through the park on the Trans-Canada Highway. As Banff is one of the world's most visited national parks, the health of its ecosystem has been threatened. In the mid-1990s, Parks Canada responded by initiating a two-year study, which resulted in management recommendations, and new policies that aim to preserve ecological integrity

Source: Parks Canada website, Wikipedia

Banff Townsite

The town of Banff is situated at the junction of the Bow and Spray Rivers, and sits between Sulphur and Tunnel Mountains. To the east is Rundle Mountain, which is also noticeable as you approach Banff on the Trans-Canada highway from the west. Behind the iconic Banff Springs Hotel is Bow Falls: the falls and river are bisecting two very different rock formations, one of which is 70 million years older than the other.

Banff (population 8,244, including 7,251 permanent and 993 temporary residents) is a UNESCO World Heritage Site located entirely inside the national park. Although it was settled in the 1880's, it was not incorporated until 1990, when it became the first municipality in Canada to be incorporated inside a national park (Jasper was incorporated in 2001). The townsite boundaries are fixed by federal law,

One of the most notable figures of early Banff was Norman Luxton, who was known as "Mr. Banff". He published the Crag and Canyon newspaper, built the King Edward Hotel and the Lux Theatre, and founded the Sign of the Goat Curio Shop, which led to the development of the Luxton Museum of Plains Indians, now the Buffalo Nations Museum. He and his family helped organize the Banff Indian Days and the Banff Winter Carnival.
Source: Town of Banff official website; Travel Alberta web site; Wikipedia

Stop 1: Old Banff Dump Site

Our first site was originally the town dump for Banff (dumps are beloved by field trip organizers as they often contain human-made exposures). In a simpler time the dump had bleachers so that park visitors could watch the bears rummage through the garbage. It was decommissioned as a dump and vegetation cover restored, but the exposure that has been visited by many field trips remains for our edification.

The site is described in Nat Rutter's 1972 Geological Survey of Canada Bulletin 206 – Geomorphology and Multiple Glaciation in the Area of Banff, Alberta (see Figure 26 below from Rutter (1972).

Figure 26. Volcanic ash layer in wind-blown sand (A) and above lacustrine sand and silt (B) near the Banff town dump (51°12'00"N, 115°31'40"W). View looking north. *(201497)*

As shown in Figure 26, Rutter suggests that the lowest sediment is a lacustrine silt and sand layer overlain by a layer of volcanic ash deposited in the great ash cloud that was generated by the destruction of Mount Mazama (now Crater Lake Oregon) in 7627±150 cal yr BP (Zdanowicz et al. 1999. Geology 27: 621-624). This ash layer is common in depositional landscape positions throughout southern BC and Alberta. The upper material is an eolian sand deposit very similar to loess. Primary loesses are often somewhat less well sorted than the secondary loess that we would find in the American Mid-West (for example).

The surficial soil at the site is developed in the surficial loess and is quite brightly coloured, which often indicates it has been subjected to high temperatures through fire. The horizon

sequence of the soil is _____,

and it is classified as a _____

Bankhead

The town of Bankhead no longer exists; it was a coal-mining town created in the early 20th century near Banff, in proximity to deposits of high-grade anthracite at the base of Cascade Mountain. The Bankhead mine was operated by a subsidiary of the CPR, which needed the coal to fuel its steam engines. At its height, Bankhead was a town of about 1,000 people, but in the early 1920s the mine was closed because it was unprofitable (and in the wake of a strike by the miners), and many of the town buildings were moved to Banff and Canmore. The Bankhead Railway Station now sits on the grounds of the Banff Hostel on Tunnel Mountain Road.

Source: Wikipedia

Bow Valley: Banff to Kananaskis Turnoff

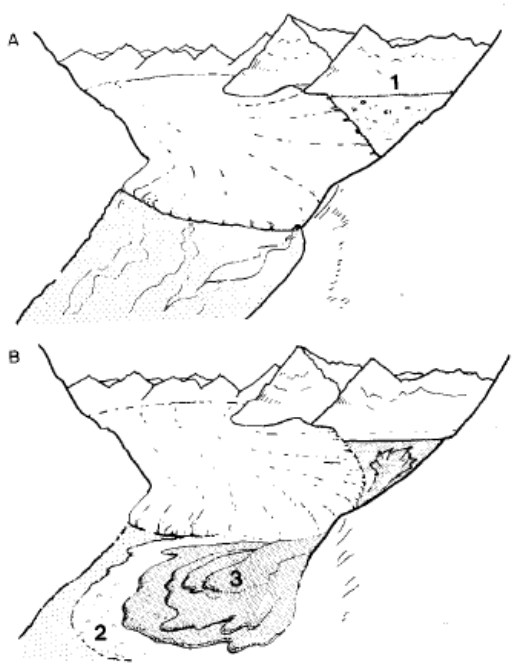


Fig. 11. Inferred late-glacial depositional setting for gravel and diamict sequences exposed near Banff. (A) Deposition of braided river gravels by a retreating Bow Valley glacier and ponding of water and sediment in tributary valleys (1). (B) Deglaciation of tributary valleys, release of floodwaters (2) followed by the mobilization of exposed outwash and lacustrine sediments as debris flows (3). Large volumes of heterogeneous debris were also stored along the valley walls. Bare bedrock slopes above a well-defined upslope limit of valley infill sequences (e.g. Figs 1, 2) record very effective stripping of unconsolidated sediments by late glacial down-slope mass movements.

The Bow Valley contains a number of striking geomorphological features.

In the section from Banff to the park gate the valley is lined with benches with steep, almost vertical faces. The benches have a basal, gravelly outwash sediment up to 30 m thick, which is overlain by a diamict (i.e., a poorly sorted sediment with gravel supported by the matrix of finer sediment (till is the best known diamict)) again up to 30 m thick. Rutter (1972) interpreted the upper diamict as a till, whereas Eyles et al. (1988; Sedimentology 35:465-480) interpret it as a debris-flow sediment, deposited when catastrophic drainage of valley-dammed lakes occurred during de-glaciation (see diagram to the left from Eyles et al. 1988).

After deposition of the debris flow deposits, post-glacial down-cutting by the Bow River created steep erosional faces in the diamict, which has a carbonate content of the < 2 mm fraction of over 50%. The high carbonate content imparts a weak cementation to the diamict and gives it an ability to stand at high slope angles. In places water erosion of the steep face causes pillars of sediment to become detached from the bench, and these features are locally called “hoodoos”.

Canmore

Canmore was officially named by CPR director Donald A. Smith after Malcolm III of Scotland, who was nicknamed Canmore (Celtic for “Big Head”) in 1884. It began as a mining town, then became the site of a North-West Mounted Police Barrack. The 1988 Olympics provided an

economic boost for Canmore with the creation of skiing facilities just south of the town, and it has become a tourist and recreational destination as well as the location for a number of feature films including Brokeback Mountain and Legends of the Fall.

Dead Man's Flats

The hamlet of Dead Man's Flats, just east of Canmore, is of interest mainly for the curiosity of its name (which was officially changed from the more prosaic Pigeon Mountain Service Centre in 1985, though it had been called Dead Man's Flats by locals for decades). There are several explanations given for the name: one associates it with a murder which took place in 1904 at a dairy farm situated on the flats of the Bow River. Francois Marret stood trial in Calgary for killing his brother Jean, whose body he had disposed of in the Bow River, but the jury acquitted him by reason of insanity. Another account states that two or three First Nations people who were illegally trapping beaver noticed a warden approaching in the distance. Knowing that they did not have time to flee without being spotted, they smeared themselves with beaver blood and pretended to be dead. The warden, fooled by their deception, ran for help. Meanwhile the trappers took their beaver pelts and escaped. This account is regarded as dubious; for example, no known description of this incident appears in the official wardens' reports. In 1954, the *Calgary Herald* wrote that it was "named only 10 to 12 years ago after a man was found shot in a cabin in the area". **Source: Wikipedia**

Lac des Arcs is formed by damming of the Bow river caused by alluvial sediments in a well-developed fan from Heart Creek. The alluvial sands and gravels are several meters deep immediately adjacent to the creek and are overlain by a thick (2-3 m) loess deposit created by wind erosion from the exposed lake bed during low water periods. The loess sheet contains multiple fire bands and a distinct Mazama ash layer.

Exshaw

The hamlet of Exshaw was originally within Banff National Park but has been for many years the site of multiple quarries into the mountains north of the hamlet. The major structures are associated with a Lafarge cement plant, and other plants include a Baymag calcined magnesium oxide plant and a Graymont lime and limestone products plant.

Canadian trivia question – A legendary Canadian actor best known for his role as Nick Adonidas in Canada's longest running weekly dramatic TV series grew up in in Exshaw. Who is he?

Beyond Lac des Arcs the valley opens up, and deposition of extensive deposits of outwash gravels and sands occurred during deglaciation of the Bow headwaters. These gravels extend almost to the turn-off we will take into the Kananaskis valley. The volume of outwash in the valley and throughout the Bow valley upstream speaks to the incredible erosional events associated with Cordilleran glaciations.

Nakoda (Stoney) First Nation

The land east of Exshaw is part of the Nakoda (Stoney) First Nation. Prior to the establishment of Banff National Park the Nokoda had hunted throughout the area of Banff park, but they were systematically excluded from the park between 1890 and 1920 (Binnema and Niemi 2006; Environmental History 11: 724-50). The First Nation is now home to a thriving casino and hotel

complex. Throughout western Canada the reserves set aside for aboriginal people were often located on stony or sandy soils that were not suitable for agricultural activity.

Kananaskis Country

Kananaskis Country is an extensive series of parks and recreational sites, including Nakiska, a ski hill developed for the 1988 Winter Olympics. It was established by the Municipal Affairs branch of the Alberta Government for multiple uses including timber harvesting, gas and oil extraction, cattle grazing, recreation and tourism. All activities are planned and facilities are developed with watershed protection as a priority.

Stop 2: Colluvial Soil

Soil formation in mountain slopes (or in steeply sloping land anywhere) does not typically lead to well-organized soils with clear horizonation. The pedogenic processes that lead to horizon formation can be overwhelmed by geomorphic (and bio-geomorphic) processes that physically move material downslope – soil creep, soil transport by water, tree throw, burrowing by animals and subsequent winnowing of fines, and major earth displacements such as slumping or landsliding.

As well, physical weathering processes are very active in mountain environments in Canada, and mountain soils often contain a very high percentage of rock fragments. Some systems of classification recognize these soils as a separate order, but the Canadian System of Soil Classification does not.

The soil at this site is developed in colluvium (i.e., slope deposits). The orientation of the horizons, and of the material within the horizons, is determined by the configuration of the slope.

The horizon sequence at this site is_____

The soil is classified as a _____

Stop 3: Barrier Lake Field Station

This site was originally developed as a relief camp for unemployed young men from the Prairies during the depression. With the start of World War II, it was used to house conscientious objectors and then merchant seaman captured at sea. It then became a major prisoner-of-war camp, housing up to 650 German officers at its peak. The Guard Tower visible at the site was originally used at the POW camp and was re-purposed as a fire tower before being brought back to this site. The Colonel's Cabin was used by the various commanders of the facility and houses an exhibit (now closed!) about the site. Some remnants of the POW structures are evident on the southern edge of the site.

After the war the site was developed as a Forestry Research Station and was ultimately donated by the Government of Alberta to the University of Calgary. It is now houses the Biogeoscience Institute of that University, and provides a base for a diverse range of scientists working in this region including the Center of Hydrology of the University of Saskatchewan.

Canadian trivia question: How many German POWs successfully escaped from Canada during WWII?

High Calcium Carbonate Soil

The soil in the (always handy!) dump at the field station is an example of a soil with high amounts of calcium carbonate (lime to non-pedologists) in all horizons. The glacial sediments the soil has formed in are glacio-lacustrine and glacio-fluvial sediments derived from the limestone rocks of the Front Ranges and hence are inherently high in calcium carbonate – the fine earth fraction of these sediments is typically over 50% carbonate minerals. This can be readily assessed in the field using dilute hydrochloric acid, which, when sprayed on the soil, causes the calcium carbonate ($CaCO_3$) to dissolve and carbon dioxide to be released. The approximate carbonate content can be assessed by the degree of effervescence.

A number of important pedogenetic processes cannot begin to operate in soils until calcium carbonate has been removed from the fine earth fraction through the processes of decalcification. For example, Ca^{2+} causes clay to flocculate (i.e, join together to form micro-aggregates) and hence the clay is not available for physical translocation in the process of lessivage. As well, the presence of calcium carbonate maintains the soil pH at or above 8, and few if any chemical weathering processes occur at these high pH levels. As well, calcium bonding to organic matter occurs, which can limit the decomposition of organic materials and the production of organic acids important in chemical weathering and the transport of ions (e.g. in podzolization). The result is that soils that are inherently high in calcium carbonate have limited expression of many key pedogenetic processes and hence have quite simple horizonation.

The Brunisolic order in Canada recognizes the importance of pH at the great group level (i.e., the second highest level). Soils of the Eutric great group have pH levels (measured in 0.01 M $CaCl_2$) of ≥ 5.5, whereas soils of the Dystric great group have a pH less than 5.5.

The horizon sequence at this site is_____

The soil is classified as a _____

Stop 4: Jumping Pound Demonstration Forest

The Eastern Slopes of the Rocky Mountains in Alberta experience a range of competing land use activities, including forestry, and balancing these activities poses a major and ongoing land use management issue. The displays at the kiosk highlight the range of activities in this region.

Soil developed in till

The soil at this site has developed on a relatively level summit in glacial till. It has more pronounced horizonation than the other sites visited so far as the horizonation-suppressing effects of slope processes are not present.

After decalcification of the upper soil has occurred, soils developed in till often experience the physical transfer of clay from the upper eluvial horizon (the Ae) to the underlying B horizon (the Bt). This creates a texture-contrast soil, and the vertical contrast in texture is very important for water flow and root growth in these soils. Soils with the horizon sequence classified into the Luvisolic order in Canada. In western Canada the contact between the overlying leaf litter and uppermost mineral horizon tends to be quite sharp due to the absence of earthworms and other soil animals that mix the upper soil horizons. Western Canadian soils are almost always classified into the Gray great group of the Luvisolic order.

The horizon sequence at this site is_____

The soil is classified as a _____

Sibbald Lake Road to Black Diamond

The field trip route now takes us from the foothills of the Rocky Mountains to the start of the Great Plains. As you can see on the soil map on page 2 we pass from the Brunisolic-dominated foothills through the Dark Gray Chernozemic soils and onto the beautiful Black Chernozemic soils of the Canadian Prairies.

Bragg Creek, Alberta

The hamlet of Bragg Creek (population about 450) began as a ranching town nestled between the Sarcee Indian Reserve and a provincial park in the early 20th century. By the 1920s it had begun to transform itself into a recreational centre, and is now a popular day trip for Calgarians for hiking, cycling, cross-country skiing, and picnicking. It is also a popular backdrop for feature films and television shoots; the CBC series North of 60 was mainly filmed here. Bragg Creek experienced severe flooding in 2005 and again in 2013.

Source: Wikipedia

Bragg Creek, Black Diamond, and the Great Alberta Flood of 2013

Throughout the field trip we will see repair and reclamation work resulting from the devastating flood of June 2014. The floodplains of almost every stream we cross were greatly scoured by the floods, and many bridges and crossings are under repair at great expense. The Government of Alberta has estimated the total cost of the flood at over 5 billion dollars.

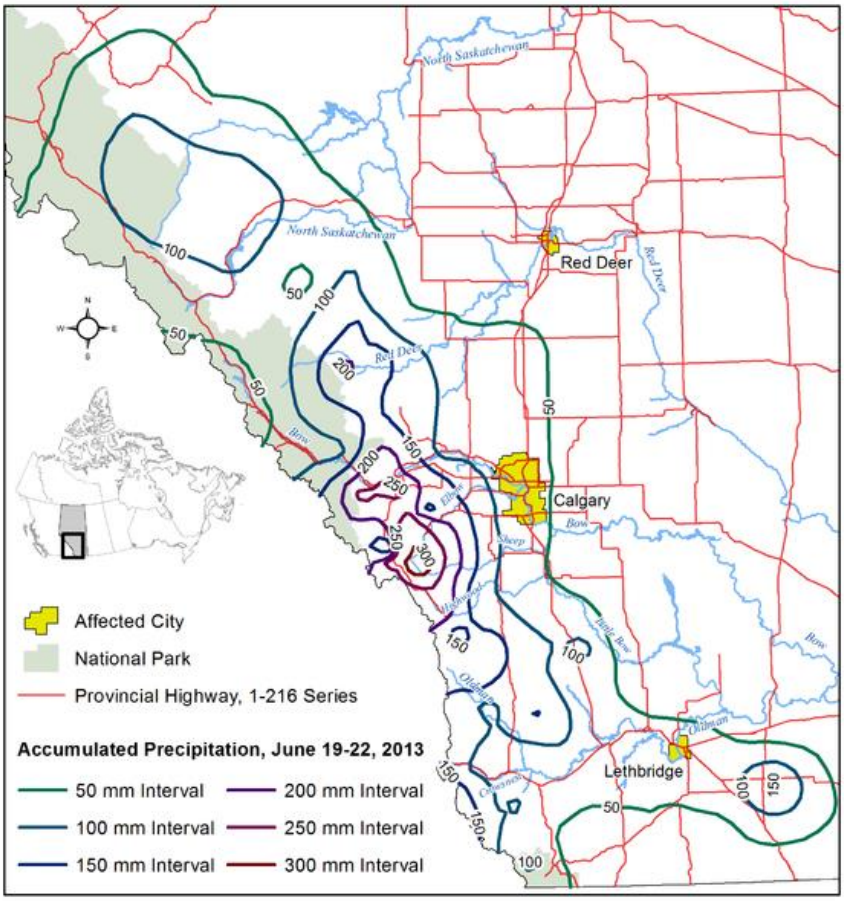
We will pass through the community of Bragg Creek, which was severely affected by the flood, and stop at the floodplain in the community of Black Diamond.

The following is adapted from: http://ec.gc.ca/meteo-weather/default.asp?lang=En&n=5BA5EAFC-1&offset=2&toc=show

The 2013 super flood, which extended from Canmore to Calgary and beyond, was exacerbated by several antecedent hydrometeorological events in the headwaters of the Bow River watershed. To begin with, it began snowing in southern Alberta before Thanksgiving 2012 and didn't stop until a month after Easter. The mountain snowpack in May was over one metre in places. Further, the spring was wet leaving the ground saturated and streams and rivers bloated. Calgary and some foothill weather stations had greater rainfall amounts between May 23 and 24 than those experienced during the flood a month later. At Livingstone, 96 mm of rain fell on May 25. And a brief warm-up that month started melting the nearly one-metre deep snowpack at the treeline. Weeks before, satellite imagery had revealed basin groundwater to be higher than average leaving the land with little extra capacity to take up additional water from rain and melting snow.

The storm that started on June 19 featured an intense and slow-moving moist upper low that parked itself over southern Alberta, delivering three days of torrential rains. What was not

typical was that it stalled and sat over the mountains for days due to a massive high-pressure ridge to the north that blocked it from moving east and pinched it up against the Rocky Mountains. The stationary, wide-ranging low drew in warm air and moisture from the Pacific Ocean, the Gulf of Mexico and beyond before drenching the Rockies watershed in southeastern British Columbia and southern Alberta. Interestingly, the same high-pressure system had earlier contributed to the devastating forest fires in Colorado and record-high temperatures in Yukon and Alaska. Beginning late on June 19, the skies opened and poured for 15 to 18 hours – a fire hose aimed directly at southwestern Alberta (see figure below). The trapped low studded with thunderstorms just kept drenching the mountains, melting the snowpack but not thawing the partially frozen ground. The already saturated soil on thinly covered steep slopes couldn't take any more water.

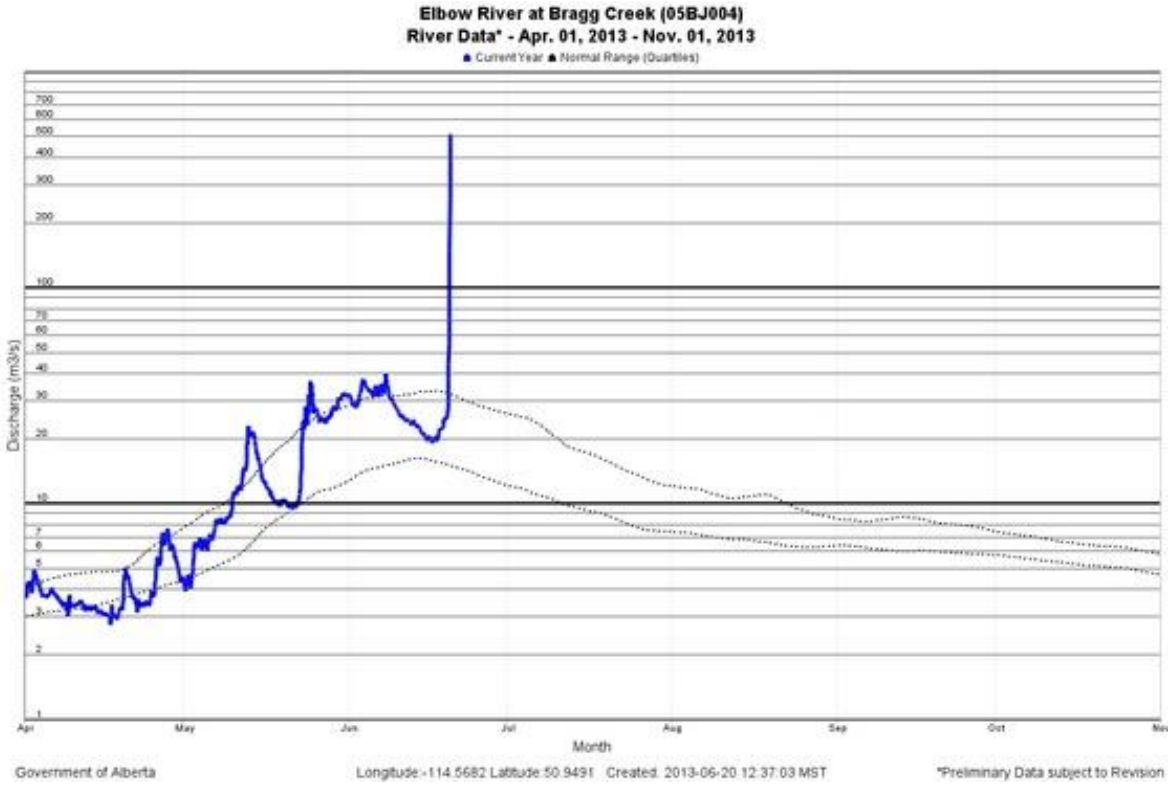


Precipitation map for June 19-22 2013 (Prepared by Alberta Environment and Sustainable Resource Development; available at http://en.wikipedia.org/wiki/File:2013_Alberta_floods_rainfall.png)

Calgary received 68 mm over 48 hours, but the rainfall west of the city in the elevated headwaters of the Bow and Elbow rivers was exceptionally heavy and torrential – more typical of a tropical storm in quantity and intensity. Rainfall rates of 3 to 5 mm/h are considered high; rates from this storm were 10 to 20 mm/h in the higher elevations, with several stations reporting 50 to 70 per cent of their storm rainfall in the first 12 hours. Totals averaged 75 to 150 mm over two and a half days, with Burns Creek (west of High

River at 1,800 m elevation) recording a phenomenal 345 mm. At Canmore, over 200 mm of rain fell – ten times that of a typical summer rainfall. Also contributing to the flood, the warm air and rain melted up to 60 cm of snowpack, which was about 25 per cent above normal for that time of year, instantly engorging streams and rivulets.

Rampaging floods and mudslides forced the closure of the Trans-Canada Highway, isolating Banff and Canmore at the epicentre of the mountain flooding. Raging creeks ate away at riverbanks and backyards, leaving behind crumbling decks and twisted fences. Trees were literally skinned of their bark 10 metres above the ground by gravel and boulders barrelling along in rushing waters. In Canmore, the swirling Cougar Creek left entire homes teetering along its widening banks and sent residents in waist-deep water scrambling to safety. Emergency crews used helicopters, boats, combines, front-end loaders and manure spreaders to rescue stranded residents. More than two dozen towns declared states of emergency. Entire communities, including High River and Bragg Creek, were under mandatory evacuation orders. The rate at which the river sped through High River, a town of nearly 13,000, was faster than that over Niagara Falls, submerging over half the town. Several First Nations communities were particularly hard hit by the floods, with many residents still not back in their homes.



Hydrograph for the Elbow River at Bragg Creek Alberta

In Calgary's downtown, 4,000 businesses were impacted and 3,000 buildings were flooded. The debris flood of the Bow and Elbow rivers washed away roads, rail lines and transit systems as well as several pedestrian bridges, and inundated dozens of city parks and more than 100 km of riverside pathways with water, mud, downed trees and other debris. The tragedy associated with the flooding went beyond the cost of replaceable property and belongings. Four people

died after being swept away in the fast-moving waters, and the lives of thousands of Albertans and their families were changed. The sheer volume and force of raging waters caused visible and permanent changes to the landscape and beauty of southern Alberta forever, including natural carving of the landscape and river channels that would normally take centuries to evolve being destroyed in less than two days.

Stop: Floodplain of the Sheep River at Black Diamond

Black Diamond is named after the coal that was mined here at the time of its settlement in the early 1900's. There is a very fine Black Diamond icon in front of the municipal office.

Extensive restoration work is underway on the floodplain of the sheep river at Black Diamond. We will walk over the floodplain to the recently scoured channel.

The soils of the more elevated portions of the floodplain show evidence of recent deposition of sediment associated with the flood of 2013. The deposition of fresh sediment in floods leads to a soil with buried, weakly developed A horizons separated by layers of alluvial sediment. These soils are classified as Cumulic Regosols in the Canadian System of Soil Classification.

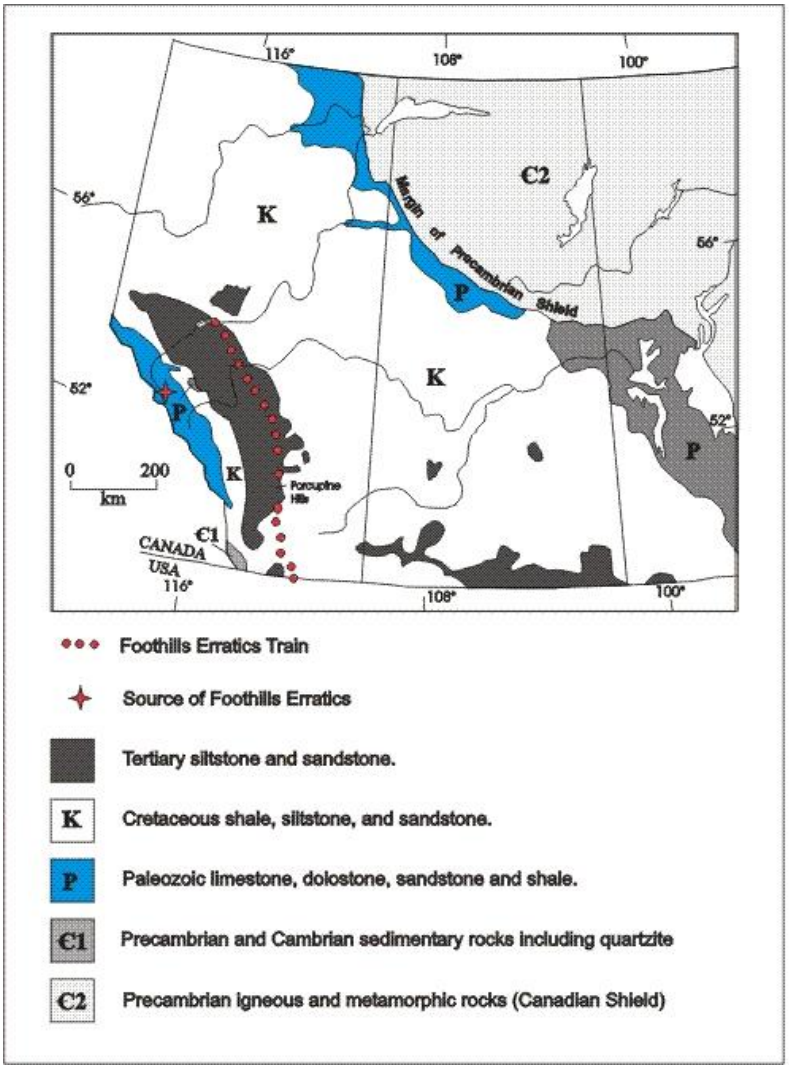
Stop: The Big Rock at Okotoks

"The Big Rock" is an enormous glacial erratic – a rock transported far from its place of origin by glacial ice. The Okotoks Erratic is the largest known rock in the Foothills Erratics Train, a group of rocks that were carried by ice along the mountain front and let down as the glacier melted more than 10,000 years ago. The erratics lie in a narrow band extending from Jasper National Park to northern Montana. The Okotoks Erratic weighs an estimated 16,500 tonnes. It measures about 9 metres high, 41 metres long and 18 metres wide. The rock has broken into pieces, but is still a large landmark on the flat prairie. (from http://www.history.alberta.ca/historicsites/default.aspx)

The geological history of the Foothills Erratic Train was published in a classic work of geology by Archie Stalker - Stalker, A. M., 1956, The Erratics train, Foothills of Alberta: Geological Survey of Canada Bulletin 37. Subsequent cosmogenic dating by Dr. Lionel Jackson Jr. of the GCS revealed dtaes ranging from 12000±600 yrs BP to 53300±1500 yrs BP, with most dates clustering around 25000 to 12000 yrs BP. This indicates that deposition of the Erratics Train Till occurred at the end of the last glaciation to affect this area.

The following is from Search for the Source of the Foothills Erratics Train (from http://www3.telus.net/lejgeology/etrain/htmls/source%20of%20erratics.htm)

As he [Dr. Stalker] systematically mapped the extent of the Foothills Erratics Train during the early 1950s, Dr. Stalker pondered the source of these rocks. He knew from existing geologic maps that similar quartzite existed in the Rocky Mountain Trench near Windermere, B.C., the Waterton Lakes area, the Rocky Mountain Main Ranges in Banff and Jasper National parks, and in the Lake Athabasca area along the edge of the Canadian Shield some 800 to 1300 km to the northeast.

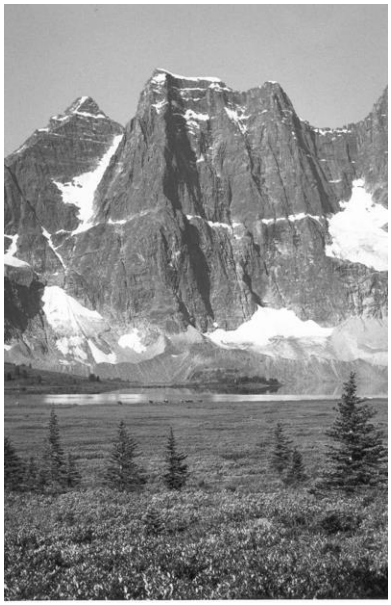


He eliminated sources southwest of the erratics train because his mapping of ice-formed directional features indicated that the ice-age glaciers that had transported the erratics train, had flowed generally north to south, and not south to north. He eliminated the Canadian Shield as a source because the erratics would had to have been plucked from bedrock along the base of several kilometres of glacial ice and transported more than a thousand kilometres beneath the sliding, grinding ice sheet.

Boulders transported along the base of glaciers are typically covered with scratches, called striations, or are polished and rounded and streamline in shape. The Foothill erratics almost entirely lack striations. They are also cut by cracks called joints. It was inconceivable to Dr. Stalker that these very large (many exceed 4 m in length) highly jointed, blocks could have remained intact and angular for any distance if they had been carried along the along the base of a glacier.

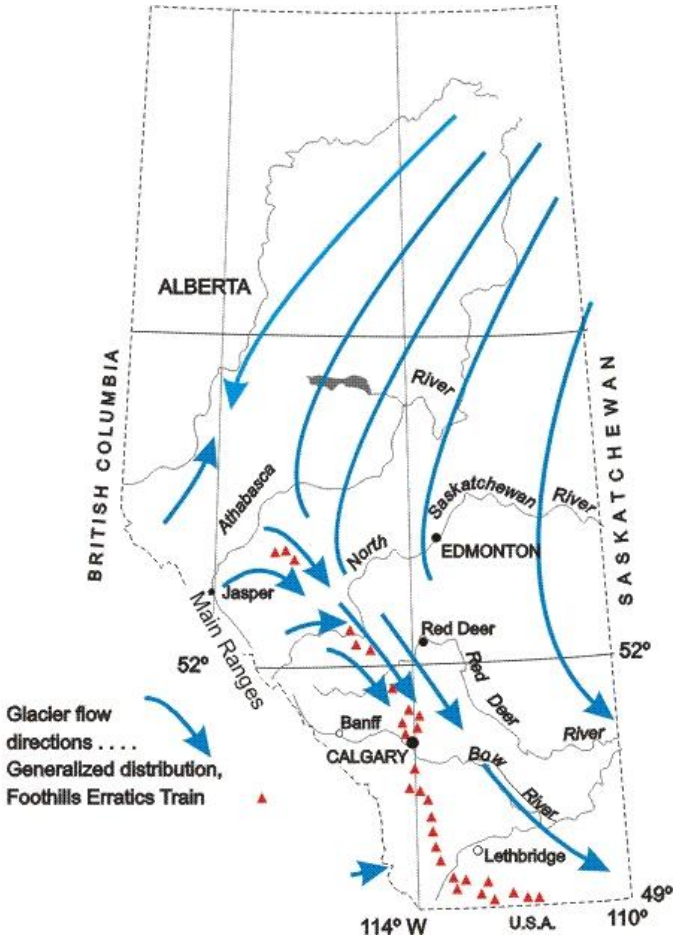
He concluded that they had to have been transported on or near the surface of glacier ice. Only the lower Cambrian quarztite formations to the west and northwest of the erratics train in the Rocky Mountains remained as possible sources, but where? Similar erratics could not be found west of the erratics train in the Bow and North Saskatchewan valleys, and so these were eliminated. Stalker did not have the answer in his 1956 paper, but he was able to describe the physical characteristics of the source area, based upon his conclusions of superglacial transport of the erratics and their characteristics of the layered structure of them refered to as bedding:

"*It must have been near a large pass in the mountains to the west that, during one of the glacial stages, contained a valley glacier with a large volume of fairly rapidly flowing ice. A bed of the characteristic pebbly quartzite must have been present high enough on the main or tributary valley walls for the glacier to undermine and quarry it in large blocks and to carry them on its surface. This pebbly conglomerate bed must have been not less than 30 feet thick, the thickness of the Big Rock...*"



This is a vivid description of the environment of the lower Cambrian quartzite beds in the mountain faces of the Mt. Edith Cavell-Tonquin Valley area (shown left) in the headwaters of the Athabasca River, Jasper National Park.

This area was shown to be the source of the Foothills erratics in paper written by Dr. Murray Roed and others in 1967. Although Stalker concluded that the Foothills erratics had been transported by glacial ice originating in the Rocky Mountains, he also concluded that transport by mountain glaciers alone could not explain the great length, narrowness, and changes in elevations which characterize it. He reasoned, on the basis of his regional mapping, that the Laurentide ice sheet must have been present immediately to the east of the Foothills. It prevented the erratics from being deposited in a lobe shape at the mouth of their (then) unknown source valley.



The east flowing mountain glacier transporting the erratics joined the south flowing Laurentide ice thus confining it between the western edge of the Laurentide ice sheet and the Foothills. The glacier carrying the erratics remained a comparatively narrow ribbon of ice as it traversed the eastern edge of the Foothills. This explained the narrowness of the erratics train and the small differences between the highest and lowest erratics at any latitude. In Stalker's words: *"The erratics from the west would be carried southward near the surface of this combined ice-sheet, and strung-out for a long distance near its margin..."*. This picture of glaciers flowing out of the Rocky Mountains and joining the south-flowing Laurentide ice sheet has been supported by subsequent mapping along the Foothills by Jackson and others.

This site is of great spiritual significance to the Blackfoot people, and the name of the erratic was derived from the Blackfoot word for rock, "okatok."

Longview

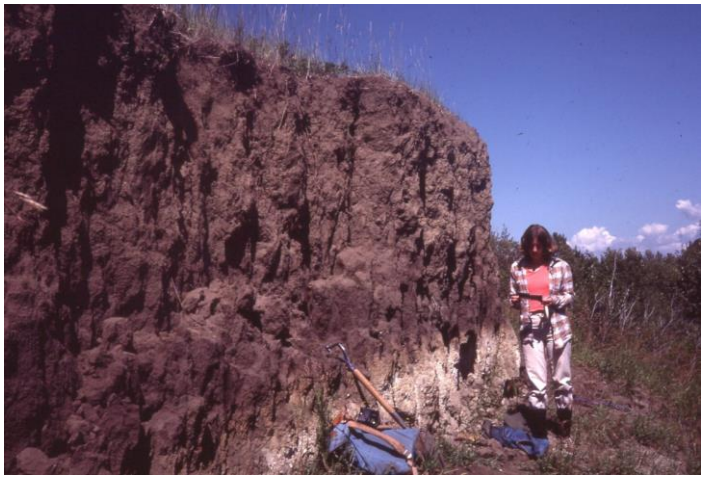
The Long brothers', Thomas and Oliver, homesteaded at Big Hill, not far from where the village is now. Their last name combined with the view from the then post office, which was opened in 1908, is how the village was named. When the oilfields at Turner Valley were revived in 1936, Longview became known as Little New York. Little New York, had a sister town uphill to the north called Little Chicago. No one seems to know how Little Chicago and Little New York got their names and both towns actually grew up over night. In 1936 there was nothing there but an empty prairie field. Then, in 1937, oil was discovered at the 6,828-foot (2,081 m) level and people, most of them long out of work because of the great depression, came flocking and Little Chicago and Little New York were born. Buildings appeared like mushrooms. For the first time in years, men who without so much as a coat on their backs or a nickel in their pockets had the first money they had earned since the depression began. Today Little Chicago is gone and little remains to show it ever existed. Little New York was more fortunate, as it is now the village of Longview. In 1991, Clint Eastwood's Academy Award-winning film *Unforgiven* was filmed in and around Longview. (*from Wikipedia)*.

Canadian trivia question: Longview's best-known resident followed the advice from his own Canadian classic song "Think I'll go out to Alberta, weather's good there in the fall". Who is he?

Longview and the area surrounding it is the heart of cowboy culture, and the Twin Cities Hotel (i.e., Little New York and Little Chicago) has brands from the surrounding ranches displayed on its walls.

Stop: Longview Glacio-Lacustrine Bluff and Paleosol

This site is at the top of a bluff created by side-cutting by the Highwood River. Extensive river terraces along the Highwood River are visible from the cliff top. The terraces were cut by incision by the Highwood River into its floodplain during the post-glacial period. The flood of 2013 removed the lowest terrace from much of the floodplain.

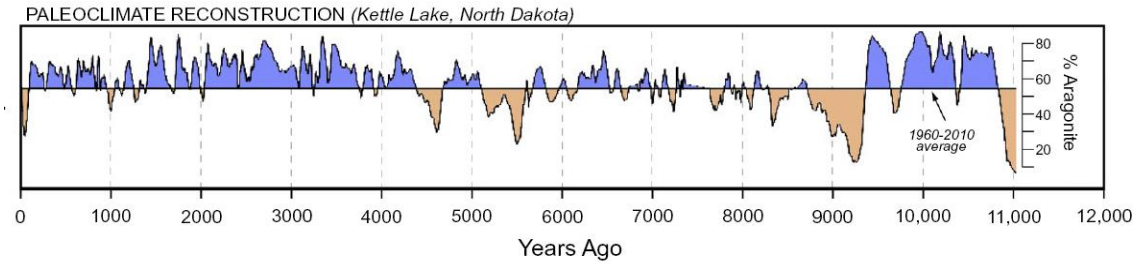


The top of the bluff is a thick (> 10 m) glacio-lacustrine sediment deposited in one of the many proglacial (i.e., in front of the glacier) lakes that formed during the retreat of glaciers on the Canadian Prairies – much of the city of Calgary, for example, is on a proglacial lake plain.

The glacio-lacustrine sediment is capped by a thick paleosol with a Chernozemic profile. The lowermost paleosol is the best-developed in the sequence, and is an example of the pre-

Mazama paleosol that occurs throughout western Canada (see left for a picture of my spouse Lea acting as a human scale at this exposure in 1982). Mazama ash provides an easy stratigraphic marker throughout this region.

The pre-Mazama paleosols are typically better developed than the surface soil at the sites they are found. This is probably due to the wetter conditions that existed in the early Holocene (well shown in the most authoritative paleo-climate record from the region, Kettle Lake in North Dakota (see below) (Grimm et al. 2011: Quaternary Science Reviews 30: 2626-2650)). This wetter, cooler period abruptly ended at 9.25 ka (thousand years ago) when a severe and prolonged drought was initiated. The mid-Holocene experienced fluctuating wet-dry periods, followed by a dominantly wetter- cooler period since about 4.4 ka.



Stop: Turner Valley Gas Plant

History of Turner Valley Gas Plant and the Turner Valley Oil Fields (from http://www.history.alberta.ca/turnervalley/about/history/history.aspx)

1914 - 1923

The Dingman No. 1 and Dingman No. 2 wells - pictured to the right - were both productive and led to the development of Western Canada's first commercial oilfield. They produced a gasoline-like liquid - unrefined condensate - and natural gas.

The Turner Valley Gas Plant National and Provincial Historic Site is the most significant surviving resource associated with the development of the Turner Valley oilfield. From the social history by David Finch: "In early 1911, [Herron] collected a gas sample from the banks of the Sheep Creek and sent it off for analysis. Based on his findings Herron bought Michael Stoos' farm on the banks of the creek where the Turner Valley Gas Plant sits today. Herron set out to attract investors and in January 1913, Calgary Petroleum Products began drilling its first well."

In 1914, the public knew the discovery well as Dingman No. 1. A. W. "Archie" Dingman was the General Manager for Calgary Petroleum Products, so it was easier to call it the Dingman well. Drilling commenced at the Dingman No. 1 well site in January 1913. The well struck a petroleum production zone on May 14, 1914, changing the industrial face of Canada and the Canadian West forever.

The earliest form of the Turner Valley Gas Plant was the first petroleum processing facility west of Ontario. Through three separate stages of development, between World War I and the late 40s, the processing plant at Turner Valley served as the largest natural gas processing plant in Canada's largest oilfield.

Early production used a simple knock out system to remove water from the naphtha. Later, Calgary Petroleum Products brought in a small compressor and built an absorption plant that burned to the ground in 1920.

In the fall of 1921, Royalite Oil Company built a new compressor station and a gasoline absorption plant and by year-end a pipeline to Okotoks had linked Turner Valley gas to Calgary supply systems.

1924 - 1947

New discoveries and new demands changed the Turner Valley Gas Plant through the 1920s until the end of World War II.

Royalite No. 4, one of the Turner Valley field's largest producers, blew in on October 14, 1924.
The new well dramatically altered the nature of the gas plant. High flows from the well led to the installation of new separators to recover gasoline both before and after the absorption stage, and new scrubbers to remove hydrogen sulfide.

The nature of production in the Turner Valley field changed dramatically in 1936, when Turner Valley Royalties No. 1 well hit deep zone crude oil just north of Longview.

The third discovery triggered a drilling boom at the south end of the oilfield. At its peak in 1942, the Turner Valley oilfield produced almost 10 million barrels of oil per year. Then, as its production began to decline rapidly, drillers discovered the Leduc oilfield southwest of Edmonton in 1947.

1947 - Today

Although it was aging, the Turner Valley Gas Plant operated until 1985-nearly 70 years after it was first built. While it was overshadowed by the arrival of Leduc No. 1 in 1947, the Turner Valley field continued to produce oil and gas. The Turner Valley Gas Plant also continued to operate, processing its specialty products until 1985.

In 1952 the plant began to produce propane and a sulphur extraction unit was added. These were last major changes to occur at the site. Throughout the 1950s and into the 1960s the plant continued to scrub gas and produce gasoline, propane and sulphur.

British American Oil acquired controlling interest of the site in 1962 and in 1977 the plant was sold by Gulf, British American's successor, to Western Decalta Petroleum Limited. Western Decalta closed the plant in 1985. In 1985, Alberta Culture asked Western Decalta to assess the historical significance of the plant facilities. The Historical Resources Impact Assessment concluded that the plant, equipment and processes were of provincial, national and international significance to the history of industrial technology. In 1988, Alberta Culture acquired the Turner Valley Gas Plant, and in 1989 it was designated a Provincial Historic Resource. In 1995 it was also named a National Historic Site.

The Turner Valley oilfield produces more oil and natural gas today than it did 50 years ago, in 1964. The story of oil is not dead in Alberta's first commercial oilfield.

We hope you have enjoyed the field trip. You may want to contemplate buying the organizers one of the fine products named after the Okotoks Big Rock on our return to Banff!