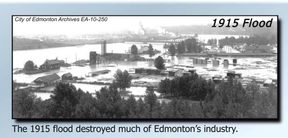
Geoscape Edmonton

Our river valley, once a transportation corridor and source of mineral riches, is now spectacular parkland. The valley also is a window into Edmonton's geological landscape or geoscape. In our geoscape, we see geological forces carving the valley and creating resources and hazards, geological layers opened like the pages of a book for reading and a long and remarkable history. Geology helps us see and study this past and learn to control our future.

Geohazards

FLOODING: all washed up

The North Saskatchewan River can flood and also fall to a very low water level; both events restrict our use of the river for recreation or transportation and damage our drinking water supply. Floodwaters undercut riverbanks, increasing the danger of landslides, and can destroy property and industry. In 1915 and 1986, floods damaged lumberyards, brickyards, coal mines and homes. The Bighorn and Brazeau dams help maintain a steady water level in the river and provide a measure of safety from flooding, but the potential for a major flood at Edmonton remains a possibility.



The 1915 flood destroyed much of Edmonton's industry.

Compare the river in this 1905 photo with the 1915 flood photo.

LANDSLIDES: slip sliding away

Landslide cracks and toppled houses, along the top of Grierson Hill, 1901.

Landslides are common along the valley. Slides often occur on the outside of river bends, where fast currents have undercut the banks and created steep valley sides. Other factors contributing to landsliding include the presence of slippery clay (bentonite) or human activity on the hillside. We can reduce the danger of landslides by draining water from the hillside, protecting the hillside from erosion with boulders and anchoring the area into the bedrock behind the slope.

Site of the 1999 Whitemud Road landslide.

Geological Time

ROCKING THE RECORD: time & time again

The geological history of the rocks below Edmonton extends a mind-boggling 2,000 million years into the past. The youngest rocks are exposed in the North Saskatchewan River valley. Holes drilled to find oil cut through a succession of older and older rocks. These rocks tell a fascinating story of Edmonton geology: glaciers sculpting the land surface, ancient river systems carrying gold, mountain building and warm oceans teeming with life. Geological time is divided into four eras; from youngest to oldest they are the Cenozoic, Mesozoic, Paleozoic and Precambrian.

ALL ABOARD: going down

Modern sediments

1 ***River gravel & floodplain clay*** - eroded from rocks, carried by the North Saskatchewan River and deposited as gravel bars or clay beds; sources of placer gold or brick-making clay.

Volcanic ash – a thin white layer of volcanic ash blown here from Oregon.

Ice age sediments

2 ***Glacial Lake Edmonton clay, silt & sand*** – dark clay and silt layers covered the bottom of Glacial Lake Edmonton; sand dunes formed from wind blowing across the dried lake bed.

3 ***Glacial debris*** – clay, sand and angular rock fragments melted out of the glacier and blanketed the Edmonton area.

Preglacial sediments

4 ***Gravel deposits*** – sand and gravel beds, now buried under glacial sediments, formed in rivers that flowed before the great ice age; a source of gravel for road and building construction.

Bedrock

5 ***Sandstone & shale*** – light grey sandstone and dark grey shale beds are exposed along the valley; buried sandstones can contain gas resources.

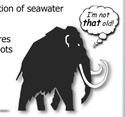
Coal – evidence of abundant plant growth in swamps; coal resources are used to produce electrical power in the region.

6 ***Limestone*** – porous and permeable carbonate rocks formed in shallow tropical seas; a storehouse for oil and gas resources.

Shale – shale formed from mud; mud with plant and animal remains that were the source of the oil that accumulated later in the limestone reefs.

Rock salt – thick beds of salt formed from the evaporation of seawater in an inland sea; a source of chemicals and table salt.

7 ***Granite & gneiss*** – last stop the basement: 2,000 metres beneath Edmonton are crystalline rocks formed in the roots of an ancient mountain chain.

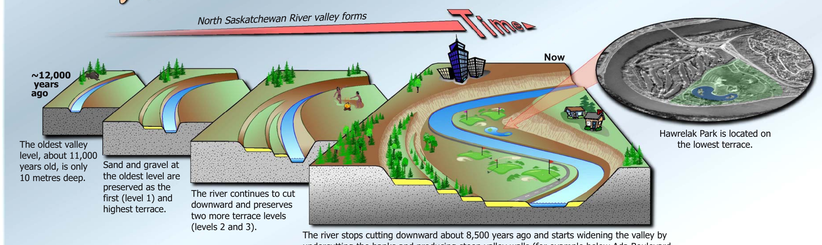


Where can you find lions, sabre-toothed cats and woolly mammoths? Edmonton of course! Go back 25,000 years, before the great ice sheet covered Edmonton, and see them. Or find the bones, teeth and tusks of these great beasts right now in preglacial gravels; sit down with a geologist and imagine our past.

River Valley

VALLEY FORMATION: first deeper, then wider

The North Saskatchewan River began to carve a valley into the underlying sediments and rock around 12,000 years ago, after the glaciers melted and Glacial Lake Edmonton drained away. Sometimes the river stopped cutting downwards and deposited sand and gravel. Some of the original beds and bars are preserved as terraces along the side of the valley. Over the last 8,500 years, the river remained at the same elevation but actively eroded into the valley sides. Slope failure on the steep valley walls can be a serious problem. This erosion is balanced by deposition on the inside of river bends, for example at Hawrelak Park where the river has built a broad floodplain. Such level ground is ideal for parks, trails, golf courses or houses, but is prone to flooding.



The oldest valley level, about 11,000 years old, is only 10 metres deep.

Sand and gravel at the oldest level are preserved as the first (level 1) and highest terrace.

The river continues to cut downward and preserves two more terrace levels (levels 2 and 3).

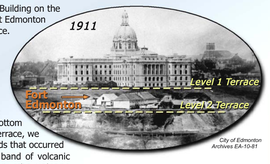
The river stops cutting downward about 8,500 years ago and starts widening the valley by undercutting the banks and producing steep valley walls (for example below Ada Boulevard and Whitemud Road). The floodplain is the lowest and youngest (level 4) terrace.

Hawrelak Park is located on the lowest terrace.

RIVER TERRACES: the valley record

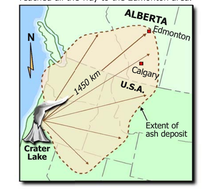
Each terrace is a stack of sediment layers, like a book on its side, with the start of the story (oldest part) at the bottom of the terrace. When we 'read' a low terrace, we see clay layers that are records of floods that occurred thousands of years ago and a white band of volcanic ash from Mount Mazama in Oregon. The volcano exploded about 8,000 years ago, leaving a deep crater now occupied by Crater Lake, and spewed ash into the air that was blown north-eastwards into Alberta.

The Alberta Legislative Building on the highest terrace and Fort Edmonton on the next lower terrace.



The terrace below the south end of the LRT Bridge contains a thin, white layer of volcanic ash that records a spectacular volcanic eruption.

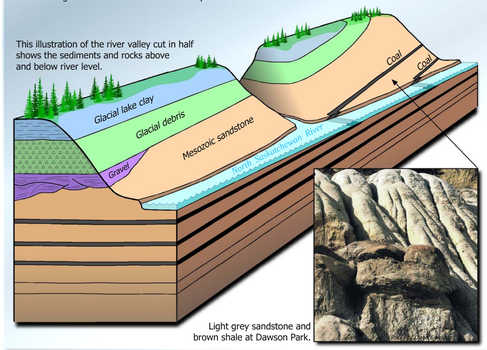
The plume of ash from Mount Mazama reached all the way to the Edmonton area.



River Valley Geology

LET'S ROCK

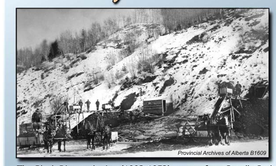
The North Saskatchewan River valley is a trench that cuts into sediments and bedrock older than the valley itself. The upper materials are ice age and preglacial sediments and the older, lower group, is bedrock. At Dawson Park, badlands-type weathering exposes sandstone, shale and coal bedrock. The sandstone and shale formed from river sediments and contain the remains of a rich flora and fauna including dinosaurs. Coal is visible along the walking trail just east of Emily Murphy Park and in the slope west of Rundle Park. Coal formed from swamp plants that turned to organic material and later were compressed into coal.



This illustration of the river valley cut in half shows the sediments and rocks above and below river level.

Light grey sandstone and brown shale at Dawson Park.

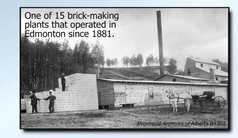
Valley Resources



The Black Diamond mine (1903-1952), across from Rundle Park, produced 25% of the coal mined at Edmonton.

COAL MINING: gone but not forgotten

Since the blacksmith at Fort Edmonton dug his own coal, over 109 coal mines have operated at Edmonton. More than 13 million tonnes of coal were produced from three major coal seams. These seams are not quite flat but slope into the earth at a small angle toward the west.



BRICK: old time baking

The North Saskatchewan River floodplain was a primary source of clay for manufacturing brick. The seventh fairway of the Victoria Golf Course and the south end of the High Level Bridge are locations of former clay quarries. Valley bricks now 100 years old were used to construct some University of Alberta buildings.

GRAVEL AND SAND: the foundation of our society

Mining preglacial gravel in a pit near Villeneuve.

The Edmonton region produces the world's three most valuable mineral resources: oil, gas and mineral aggregate. Edmonton's mineral aggregate is made from sand and gravel and is used in concrete or asphalt to make roads, building foundations, railways and airport runways. The High Level Bridge (1915) and Edmonton's Convention Centre (1981) required huge amounts of concrete. Gravel originally was mined from valley terraces right in the city and former pits include Hawrelak Park, Valley Zoo-Laurier Park, Rundle Park and Hermitage Park. Gravel supplies now come from the region around Edmonton.

PLACER GOLD: flour, flakes and fever

Gold flakes are found in gravel bars in the North Saskatchewan River. Gold is 19 times heavier than water and naturally concentrates in the bars along with other heavy minerals, such as platinum, magnetite and garnet. Preglacial rivers from the Rocky Mountains carried the gold here. Gold is recovered from gravel pits near Villeneuve and Heatherdown.

Modern, recreational gold panning.

A prospector (1890) washing gold through a sluice and grizzly.

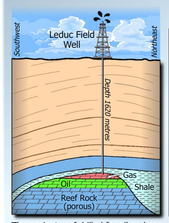
Regional Resources

ENERGY & MINERALS: the Edmonton region has it all

Edmonton is the centre of mineral and energy riches in northern Alberta: oil and gas pools, oil sands deposits, salt formations and gravel beds. Diamonds have been discovered and have potential for future mining.

OIL AND GAS: energy from fossils

In 1947, an ancient reef was drilled that became part of the Leduc oilfield. The Leduc discovery gave birth to the Alberta energy industry, including Edmonton's refineries and oil pipelines stretching east to Toronto and west to Vancouver. Geologists went on to identify a buried chain of fossil reefs with petroleum and aptly called it the 'Golden Trend.' The reefs formed in a warm, shallow sea 375 million years ago. Soft, organic ooze from the remains of marine plants and animals was transformed by heat and pressure into oil and gas. The petroleum moved into the very porous reef rocks and was sealed in the reefs by an impermeable shale barrier formed from ancient mud.



The ancient reef drilled for oil and gas.

Oil-filled reefs of the deeply buried Golden Trend.

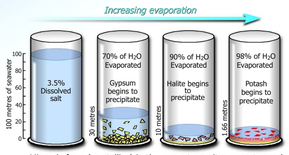
COAL: swamp power

Sixty-five million years ago plants in extensive swamps died and became buried by mud. Over time the plant remains turned into coal layers or seams. Coal seams near Lake Wabamun stretch many kilometres in all directions and are near enough to the surface to be mined in open pits. Plains coal is burned to generate 80% of Alberta's electricity.

Coal mined near Wabamun.

SALT: pass the salt, please!

Salt is used to make chemicals, for ice control on slippery roads and in our food. Salt, buried hundreds of metres below Fort Saskatchewan, is mined by dissolving it and pumping the salty solution to the surface for recovery by evaporation. The salt formed in a shallow ocean 375 million years ago. As seawater evaporated, the mineral halite (salt) formed on the ocean floor. Salt beds built-up several hundred metres thick.



Minerals form (crystallize) in the seawater as it evaporates and settle to the bottom. Halite, gypsum and potash can form very thick beds.

OIL SANDS: our huge resource

The Athabasca oil sands near Ft. McMurray are a vast resource that will fuel Alberta's economy in the 21st century. Some of the oil sands are near enough to the surface to be mined in an open pit. It takes a lot of work to separate the sand from the tar (bitumen) and refine the bitumen. About 2 tonnes of oil sand are needed for one barrel (159 litres) of refined oil. Where the oil sands are too deep to be mined, steam is pumped down wells to heat the bitumen. The hot bitumen is pumped to the surface and flows through a pipeline to the refinery.

DIAMONDS: the new frontier

Diamonds are formed at depths of over 150 kilometres in the earth and can be brought to the surface by a special type of molten rock (kimberlite magma). Kimberlite rock is found in about 50 places in Alberta and diamonds are found in the rock at half of these locations.

Glacial Geology

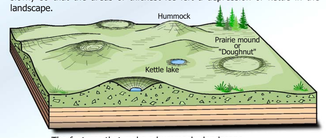
GLACIATION: even colder than now

Over the last 2 million years, a series of cold episodes caused great ice sheets to form and cover most of Canada. The last glacier entered the Edmonton region 25,000 years ago. It deposited a thick layer of glacial debris (pebbles, sand and clay) that geologists call 'till.' The glacier melted 12,000 years ago with the onset of the present warm period. Most of the surface sediments and features in the Edmonton region were formed by the continental ice sheet or by the huge lake (Glacial Lake Edmonton) that formed as the ice sheet melted.

Map of glacial and glacial lake sediments in the Edmonton region.

HUMMOCKY LANDSCAPE: doughnuts anyone?

The glacier formed the Cooking Lake moraine east of Edmonton, a highland with a distinctive hilly or hummocky appearance. The doughnut-shaped mounds found in this landscape are a unique product of the glacier: huge ice blocks became covered by a layer of glacial debris, the blocks melted slowly so that the areas of thickest ice left a depression or kettle in the landscape.



The features that make a hummocky landscape.

GLACIOTECTONISM: ice scrunching

The glacier that covered Edmonton was over 1000 metres thick and, as it moved, it folded (bent) and faulted (cracked and moved) the sediments and bedrock beneath it. It is important to recognize deformation such as this as it can weaken the bedrock and affect overlying construction.

Glacially deformed bedrock near Lake Wabamun.

TILL: who dumped that here?

Glacial debris (till).

Groundwater

SET THE TABLE: with water

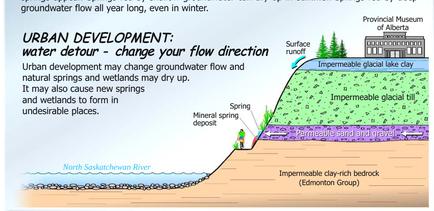
The ground under our feet contains water in the underground pore spaces and cracks. This is called groundwater. The upper surface of the groundwater is called the water table. If the water table is at the ground surface it appears as a slough or marsh. Sudden rain causes shallow water tables to rise quickly and can lead to flooded basements.

SPRING IN THE VALLEY: all year long

Rainfall and snowmelt soak into the ground to replenish the groundwater. Groundwater moves by gravity from highlands to lowlands. When the groundwater flow comes together in lowland areas it moves upwards to the surface and releases water to streams, lakes and wetlands. If the moving groundwater encounters geological features, like gravel seams, that come to the surface, springs appear. Springs fed by shallow groundwater can dry up in summer. Springs fed by deep groundwater flow all year long, even in winter.

URBAN DEVELOPMENT: water detour - change your flow direction

Urban development may change groundwater flow and natural springs and wetlands may dry up. It may also cause new springs and wetlands to form in undesirable places.



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