

OUR DIVERSE PRAIRIE LANDSCAPE: SASKATCHEWAN IS NOT JUST FLAT!

The Ice Age: architect of our landscape

The Ice Age glaciers shaped the landscapes we know today. As the continental ice sheet retreated for the last time between 17,000 and 8,000 years ago, it left behind a carpet of glacial debris, or till, scoured from underlying materials and transported with the moving ice. Melting ice released enormous volumes of water that deposited extensive sands and gravels. Giant glacial rivers carved deep valleys. While depressions trapped waters in large glacial lakes.

12 000 years ago
Maximum ice cover 17 000 years ago

11 500 years ago

10 000 years ago

As the glaciers melted...

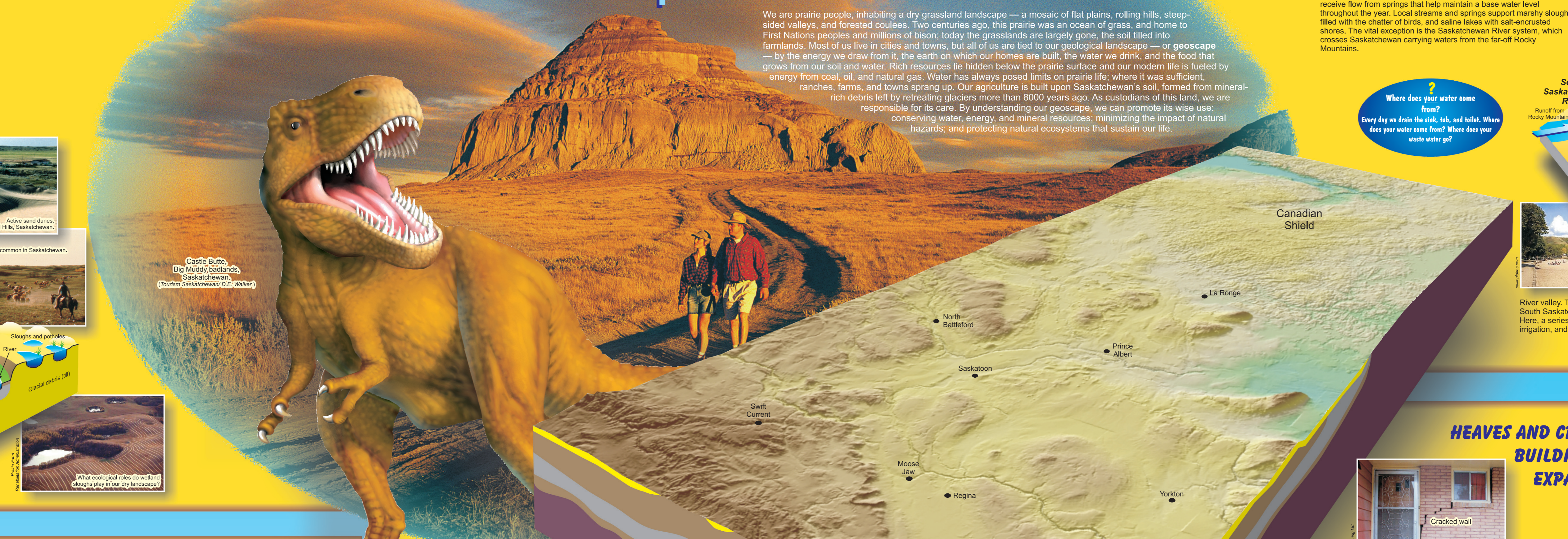
Unleashed by glaciers
A small lot of Saskatchewan is never glaciated. Do you know where this is?

...today's landscape took shape

Different landscapes, different origins
Though many people might describe southern Saskatchewan as flat, it is a patchwork of diverse landscapes of different origins: rolling hills, flat plains, and long winding valleys. Rolling hills are sediments deposited in high-charge basins from melting glaciers. Flat plains are the floors of ancient glacial lakes! The Qu'Appelle River valley and other major valleys were carved by great rivers that carried glacial meltwater towards the sea. Skooghs and potholes fill the depressions created by the melting of buried ice blocks that were left behind by retreating glaciers.

GEOSCAPE SOUTHERN SASKATCHEWAN

Geoscience for prairie communities



We are prairie people, inhabiting a dry grassland landscape — a mosaic of flat plains, rolling hills, steep-sided valleys, and forested coulees. Two centuries ago, this prairie was an ocean of grass, and home to First Nations peoples and millions of bison; today the grasslands are largely gone, the soil filled into farmlands. Most of us live in cities and towns, but all of us are tied to our geological landscape — or geoscape — by the energy we draw from it, the earth on which our homes are built, the water we drink, and the food that grows from our soil and water. Rich resources lie hidden below the prairie surface and our modern life is fueled by energy from coal, oil, and natural gas. Water has always posed limits on prairie life, where it was sufficient, ranches, farms, and towns sprang up. Our agriculture is built upon Saskatchewan's soil, formed from mineral-rich debris left by retreating glaciers more than 8,000 years ago. As custodians of this land, we are responsible for its care. By understanding our geoscape, we can promote its wise use — conserving water, energy, and mineral resources; minimizing the impact of natural hazards; and protecting natural ecosystems that sustain our life.

WATER: A PRECIOUS RESOURCE IN A THIRSTY LAND

Watering a dry land
Water has always been the limiting resource for prairie life — where there was sufficient water, ranches, farms, and towns sprang up. Because rainfall in southern Saskatchewan is meagre, most streams are small and originate from spring snowmelt. Many streams also receive flow from springs that help maintain a base water level throughout the year. Local streams and springs support many sloughs filled with the chatter of birds, and saline lakes with salt-encrusted shores. The vital exception in the Saskatchewan River system, which crosses Saskatchewan carrying waters from the far-off Rocky Mountains.

Where does your water come from?
Every day we drink the milk, oil, and wheat. Where does your water come from? Where does your waste water go?

The Qu'Appelle River: borrowed water
At the end of the last ice age, the South Saskatchewan River flowed down the Qu'Appelle River valley. Today, 11,500 years later, about one per cent of the South Saskatchewan River is diverted into the Qu'Appelle River. Here, it serves of reservoirs and lakes used for recreation, irrigation, and industrial and municipal use.

A continental divide in southern Saskatchewan
The wall between continental divide in the Rockies separates waters that flow to the Gulf of Mexico from those that flow to Hudson Bay. Where is this divide?

The many ways we depend on the Saskatchewan River system
The Saskatchewan River system is the most reliable source of good-quality water in southern Saskatchewan. Over 30 communities, including Saskatoon, Regina, Prince Albert, the Battlefords, and Moose Jaw, draw their water from the river system. River water is increasingly used to irrigate farmland and generate hydroelectric power.

Where streams don't flow to the sea
Most rivers run to the sea. However, there are large areas of southern Saskatchewan where the drainage is internal and water does not escape to the sea. Such areas are called endorheic basins. Runoff within these internal drainage basins can produce saline lakes surrounded by white salt crusts. Dissolved salts are transported in surface and ground waters to the lakes. As the lakes have no outlet stream, the salts are trapped, and concentrated by ongoing evaporation of the lake waters.

OUR BIG VALLEYS: VITAL MULTI-USE CORRIDORS

Large valleys, such as the Qu'Appelle and Souris river valleys, are major landscape features of vital importance to southern Saskatchewan. These valleys provide for diverse uses — water storage, farmland, wetland habitat, woodlands, gravel pits, and even ski areas. Try to imagine Saskatchewan without its valleys!

A puzzle:
Many large valleys such as the Qu'Appelle, Souris, and Frenchman river valleys that are too small to have named them. How did these valleys form?

Making badlands — what's the recipe?
Badlands form where the natural ingredients on a central plateau produce sparse vegetation, steep slopes, warmer thunderstorms that produce flash floods, and underlying soft rocks. Why do these conditions favour badlands?

For dinosaur detectives: why badlands are a good place to look
Badlands are ideal places for paleontologists to look for fossils. There is little vegetation to cover the rock that contains the fossils. The rock is being continually eroded, exposing new material every year. To find dinosaur bones, rocks of the right age — that is, rocks that formed during the Age of dinosaurs — must be exposed. Younger and older rocks can contain fossils, but not of dinosaurs.

Badlands: not just in Alberta!
The Drumheller and Dinosaur Provincial Park areas in southern Alberta may be Canada's best-known badlands, but southern Saskatchewan can lay claim to its own, in the Big Muddy, Frenchman River valley, Grasslands National Park, and Avonlea regions.

HEAVES AND CRACKS: BUILDING ON EXPANSIVE CLAYS

Regina's woes
Many Regina homeowners know these problems: cracks appear in walls, sidewalks, and driveways; the basement floor heaves and cracks, and doors and windows won't open or close. What's going on? These problems are caused by glacial-lake sediments below Regina that expand and shrink with changes in moisture content so that house foundations, sidewalks, and roads shift. These sediments contain clays that swell when they become wet, and shrink when they dry.

Source of the problem: glacial-lake clay
Many communities in southern Saskatchewan experience foundation problems. All these communities share one thing in common: they are built on clay sediments deposited in ancient glacial lakes.

Looking for solutions
Sealing and shrinking are limited to the uppermost part of the ground, which gains and loses moisture through the year due to changes in precipitation and vegetation growth. Below this active zone, the ground is stable. One engineering solution is to build foundations on piles that extend through the active zone to stable ground below.

THE BADLANDS: DINOSAUR COUNTRY!

What's so bad about badlands?
Badlands are a complex terrain of largely unvegetated gullies and hills formed by differential erosion of soft shale and harder sandstone. Buttery slick when wet, and without shade in the hot sun, these lands were referred to by French explorers as "bad lands" to travel through — giving rise to the term "badlands". However, to many they are beautiful and fascinating.

Riches from the earth: energy, fertilizer, diamonds, and hot water
The production and sale of Earth resources are vital to Saskatchewan's economy. Crude oil is the largest revenue-generating, followed by potash, uranium, and natural gas. Uranium mining occurs in the Canadian Shield of northern Saskatchewan.

Earth resources: a billion-dollar bonanza
The production and sale of Earth resources are vital to Saskatchewan's economy. Crude oil is the largest revenue-generating, followed by potash, uranium, and natural gas. Uranium mining occurs in the Canadian Shield of northern Saskatchewan.

Value of Saskatchewan exports (billions of dollars, 1999-2000)

Crude oil	\$19.1 billion
Potash	\$1.2 billion
Uranium	\$1.1 billion
Natural gas	\$0.8 billion
Other	\$0.7 billion
Total	\$23.9 billion

What powers Saskatchewan?
Seventy per cent of Saskatchewan's electrical power comes from coal and natural gas. Coal-fired power plants are located in Estevan and Cononach, near the coal mines that feed them. Natural-gas-fired power plants near Saskatoon, Swift Current, Landis, and Meadow Lake are used during periods of peak demand, especially in winter. Hydroelectric generating stations on the Saskatchewan River system provide most of the remaining 30% of the province's power. Wind turbines such as those near Gull Lake also contribute to Saskatchewan's energy supply.

Moose Jaw spa taps deep hot water
Engineers who design deep mines and drill deep wells worldwide know that the further we go into the Earth, the hotter it gets. Heated or geothermal waters circulate throughout the Earth's upper crust to depths of 10 km or more. Such hot waters underlie much of southern Saskatchewan, and the Moose Jaw spa exploits some of these. Limestone beneath Moose Jaw contains abundant water-filled fractures, making it an excellent geothermal reservoir from which large volumes of hot water are extracted. Could other towns in Saskatchewan tap into this hot-water resource?

GROUNDWATER: VITAL BUT VULNERABLE

Where Saskatchewan communities get their water
Groundwater meets the needs of about 75% of all communities and most of the farms and ranches in southern Saskatchewan. Much of this groundwater comes from aquifers composed of sand and gravel deposits that lie tens to hundreds of metres below the surface. The freshest (lowest salinity) groundwater tends to be at shallow depths. Deeper groundwater is generally more saline and therefore less useful, although some towns, such as Melville, Rosetown, and Weyburn, deplete groundwater to make it potable. If not properly managed, the amount of available water stored underground can be reduced by withdrawal of groundwater at rates that exceed the rate of natural recharge. Such depletion lowers the water table, increases the pumping cost, and ultimately can exhaust water supplies.

Waste storage: trouble underground?
Groundwater can be contaminated by industrial, agricultural, and household activities. Rainwater naturally infiltrates porous sand and gravel and can carry contaminants with it. Thick clayey natural barriers to contamination flow and are the best materials above which to site waste-storage areas. The risk of contamination is much greater where aquifers extend to the surface and have no natural protection. Once contaminated, it can take years to clean up an aquifer.

Tapping subterranean water
Groundwater meets the needs of about 75% of all communities and most of the farms and ranches in southern Saskatchewan. Much of this groundwater comes from aquifers composed of sand and gravel deposits that lie tens to hundreds of metres below the surface. The freshest (lowest salinity) groundwater tends to be at shallow depths. Deeper groundwater is generally more saline and therefore less useful, although some towns, such as Melville, Rosetown, and Weyburn, deplete groundwater to make it potable. If not properly managed, the amount of available water stored underground can be reduced by withdrawal of groundwater at rates that exceed the rate of natural recharge. Such depletion lowers the water table, increases the pumping cost, and ultimately can exhaust water supplies.

THE TROUBLE WITH VALLEY SLOPES: LANDSLIDES

Valley slopes throughout southern Saskatchewan are prone to landslides. Most of the landslides move slowly, millimetres or centimetres per day, but even slow movement is very damaging to roads, houses, and other structures. Landslides are particularly common in the South Saskatchewan River valley where, over time, the river has eroded its banks, forming steep valley slopes.

A history of failure
The east bank of the South Saskatchewan River 13 km south of Saskatoon has experienced over 40 landslides. Over the years, landslides have threatened residential homes, roads, streets, and grave sites. This hazard has led the municipal government to establish a control zone along the riverbanks, where building is not permitted.

Collapsing riverbanks
The Beaver Creek landslide, which is located on the South Saskatchewan River 13 km south of Saskatoon, has expanded eastward 40 m since 1944. Movement is greatest during spring snowmelt and early summer rainstorms, when high groundwater levels lubricate the slide.

Engineering a solution
In 1999, workers on the Meewasin Trail noticed cracks in the road beside the Broadway Bridge over the South Saskatchewan River in Saskatoon. Within a week, the land had moved several metres. The cause of the landslide was a plugged and leaking underground water drain that elevated water pressure in the slope materials. To stabilize the landslide, the underground drain was repaired, and a berm of coarse rock was placed along the river edge to hold the slope in place and prevent bank erosion.

Recipe for trouble!
What conditions favour a landslide? Back to the recipe — start with the natural pull of gravity, add some rainwater to saturate the slope to make it steeper, mix in the slope materials (soil, sand, silt, and gravel), and voila! — a landslide!

FOOD FROM THE LAND: DIFFERENT LANDSCAPES, DIFFERENT HARVESTS

How landscape controls agriculture
Any farmer will tell you that different landscapes are suited to different types of agriculture. For example, flat plains (floors of ancient glacial lakes) with rich soils are ideal for growing wheat and corn. Rolling hills of glacial deposits are suitable for pasture or grain farming depending on the proportions of clay, silt, sand, pebbles, and boulders and on the amount of local precipitation. The floors of major rivers have rich stream deposits of silt and clay and provide important sites for market-garden farming where irrigation water is available.

Seeing patterns in the complexity: modern management of the land
Because landscapes are complex, land management is also complex. Computer-based geographic information systems (GIS) can store complex information in layers that can be combined to produce a map useful for land management. Which areas are best for cultivation? For pasture? For conservation? The map shown here combines topographic data (shape of the land) with earth-material and satellite data in order to illustrate slope, earth materials, and land cover, each of which affects the potential use of the land.

Start with the shape of the land
How to build a 3-D map of the land

Picking roots
Many people who grow up in farms have memories, nearly gone, of how they used to pick roots from fields. We can use some facts of soil roots to address either base or soil at all.

WHAT IF WE JUST KEPT DIGGING?

A big shortcut?
It's a bit of a shortcut, but we can look to the Canadian Shield north of La Ronge, home of the oldest rocks in Saskatchewan. But will this shortcut help us find ancient roots in southern Saskatchewan? How can this be?

The deeper we go, the older it gets!
The landscape of southern Saskatchewan rests on a thick series of sedimentary rock layers that underlie central Canada from the Rocky Mountains to the Canadian Shield. These layers — sandstone, shale, limestone, dolomite, potash, salt, and coal — formed during the last half-billion years of Earth's history. The youngest layer is at the top, deeper layers are progressively older. This record of geological time is only partly complete. Numerous layers are missing due to periods of erosion in the geological past — somewhat like a book with many of its pages missing. The layers of sedimentary rock that remain are tilted to the south. They overlie ancient metamorphic and igneous rocks of Precambrian age that are exposed at the surface in the Canadian Shield of northern Saskatchewan.

Mining underground treasure
The sedimentary rocks that underlie southern Saskatchewan contain many valuable resources. Layers of coal, formed by the accumulation of organic matter in ancient swamps, are mined where the coal lies near the surface. Potash, a potassium-rich salt used as fertilizer, also forms layers, and is extracted in underground mines.

Pumping black gold
Both oil and gas flow by the decay of deeply buried organic matter. These fluids migrate through layers of rock until trapped and stored in spaces (pores) between the grains or crystals in sandstone and carbonate reservoir rocks. Vertical and horizontal wells drilled into the reservoirs extract the oil and gas.

OUR BIG VALLEYS: VITAL MULTI-USE CORRIDORS

Large valleys, such as the Qu'Appelle and Souris river valleys, are major landscape features of vital importance to southern Saskatchewan. These valleys provide for diverse uses — water storage, farmland, wetland habitat, woodlands, gravel pits, and even ski areas. Try to imagine Saskatchewan without its valleys!

A puzzle:
Many large valleys such as the Qu'Appelle, Souris, and Frenchman river valleys that are too small to have named them. How did these valleys form?

Making badlands — what's the recipe?
Badlands form where the natural ingredients on a central plateau produce sparse vegetation, steep slopes, warmer thunderstorms that produce flash floods, and underlying soft rocks. Why do these conditions favour badlands?

For dinosaur detectives: why badlands are a good place to look
Badlands are ideal places for paleontologists to look for fossils. There is little vegetation to cover the rock that contains the fossils. The rock is being continually eroded, exposing new material every year. To find dinosaur bones, rocks of the right age — that is, rocks that formed during the Age of dinosaurs — must be exposed. Younger and older rocks can contain fossils, but not of dinosaurs.

Badlands: not just in Alberta!
The Drumheller and Dinosaur Provincial Park areas in southern Alberta may be Canada's best-known badlands, but southern Saskatchewan can lay claim to its own, in the Big Muddy, Frenchman River valley, Grasslands National Park, and Avonlea regions.

OUR BIG VALLEYS: VITAL MULTI-USE CORRIDORS

Large valleys, such as the Qu'Appelle and Souris river valleys, are major landscape features of vital importance to southern Saskatchewan. These valleys provide for diverse uses — water storage, farmland, wetland habitat, woodlands, gravel pits, and even ski areas. Try to imagine Saskatchewan without its valleys!

A puzzle:
Many large valleys such as the Qu'Appelle, Souris, and Frenchman river valleys that are too small to have named them. How did these valleys form?

Making badlands — what's the recipe?
Badlands form where the natural ingredients on a central plateau produce sparse vegetation, steep slopes, warmer thunderstorms that produce flash floods, and underlying soft rocks. Why do these conditions favour badlands?

For dinosaur detectives: why badlands are a good place to look
Badlands are ideal places for paleontologists to look for fossils. There is little vegetation to cover the rock that contains the fossils. The rock is being continually eroded, exposing new material every year. To find dinosaur bones, rocks of the right age — that is, rocks that formed during the Age of dinosaurs — must be exposed. Younger and older rocks can contain fossils, but not of dinosaurs.

Badlands: not just in Alberta!
The Drumheller and Dinosaur Provincial Park areas in southern Alberta may be Canada's best-known badlands, but southern Saskatchewan can lay claim to its own, in the Big Muddy, Frenchman River valley, Grasslands National Park, and Avonlea regions.