Top Ten Geological Wonders of Banff, Yoho, and Jasper National Parks

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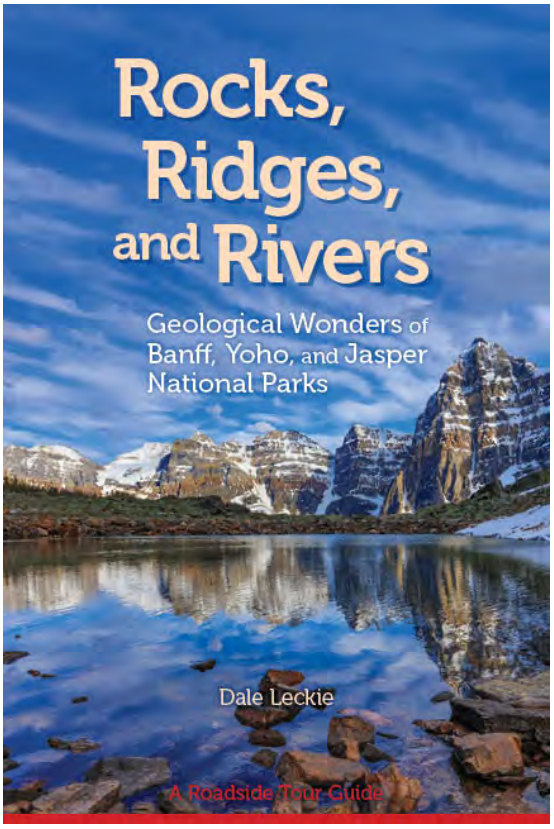

1. Canyons, caves, and lakes of the Maligne River, Jasper National Park

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A spectacular spot in the Jasper area is the canyons, caves, and lakes of the Maligne River system. The Maligne River enters the Athabasca River valley as a 90 metre high hanging valley, flowing over 365 million year old limestones. At Maligne Canyon, multiple waterfalls, potholes, and outlets of underground springs are preserved from what may well be an old and exhumed cave system. The hike along Maligne Canyon, with the waterfalls, deep chasms and gushing springs is breathtaking.

Medicine Lake, Jasper National Park, drains through caves at its base.

Farther upstream, the spectacular and unique cave drainage system at the bottom of Medicine Lake is one of several reasons that the United Nations created the UNESCO Canadian Rocky Mountain Parks World Heritage Site. Medicine Lake rises and falls as much as 19 meters every year due to snowmelt and rainfall raising water levels. At the bottom of the lake, much like a bathtub at home, are two drains that try to empty the lake year round. The river valley that exits Medicine Lake is dry most of the time, because most of the lake drains away through its underground plumbing system.

Springs entering Maligne River, Jasper National Park. Spring water flows through a cave system draining Medicine Lake 16 km away.

The water from Medicine Lake drains through an underground cave system downstream for 16 kilometres to emerge as a series of springs at the lower end of Maligne Canyon just above the Athabasca River valley.

2. The immense scale of mountain building from Mount Norquay Lookout, Banff National Park

My favorite location near Banff townsite is Mount Norquay lookout. There is just so much to see from this easy to access location. The view is a spectacular panorama across the Front Ranges of the Rocky Mountains.

The Mount Norquay viewpoint gives you a feel for the enormous forces involved in mountain building. If you want to feel the tremendous vertical and horizontal scale of the mountain building, you have to go here. You can actually see how the mountains are stacked against one another, like shingles on a roof.

You look down on the Bow River, where it is cutting across several of those enormous thrust sheets. You can see Mount Rundle, Sulphur Mountain and Mount Borgeau, each on separate thrust sheets. Cave and Basin National Historic Site is located at the junction separating two separate thrust sheets. From the viewpoint, you can imagine cold water from the mountain tops across the valley, percolating down to 3.2 kilometres depth, becoming heated by radioactive minerals, and then rising as hot water along Sulphur Mount Thrust to Cave and Basin National Historic Site.

What else can you see? The mountains have been uplifted kilometres. Now they are being eroded! Consider the amount of erosion that has taken place. In front of you, 4.5 to 7.5 kilometers of sediment has been eroded from the tops and the valleys of these mountains over the last 55 to 60 million years. This amount of material that has been eroded away is just astonishing!

View of stacked thrust sheets as seen from Mount Norquay lookout, Banff National Park – Mount Rundle (left), Sulphur Mountain (centre) and the Sundance Range (right).

3. Thermal Springs at Cave and Basin National Historic Site, Banff National Park

Banff National Park owes its existence to railway workers' encountering an open, steaming vent that led down to a cavern with a pool of hot water at its base. Snow melt and rainwater on the peaks of nearby mountains makes its way to a depth of 3.2 kilometres before being heated and recirculated up a major thrust fault to emerge as hot springs. Water temperatures are 27 to 47° C at the

surface, varying seasonally and at the different springs.

At Cave and Basin National Historic Site, enter through the main building to see hot springs pool with glacial till overlain by a layer of travertine flowstone that is more than 1-metre-thick, and which has precipitated over and draped the till. The thermal spring waters flow at the contact between the travertine and the till. The till has been eroded by the stream flow, whereas acidic hydrogen sulphide coming out of solution from the spring water corrodes the travertine. The two caves and the outside collapsed cave formed as a result of stream erosion of glacial till and the travertine dissolution by acid gases. Gypsum crusts coat the travertine, slowing the rate of acid corrosion. Eventually, the travertine will be corroded and another cave roof may collapse.

Steaming hot spring water in the cave at Cave and Basin National Historic Site, Banff National Park

The combination of temperature range and chemistry at the thermal springs have created a unique habitat for the endangered Banff Springs snail. This half-centimetre-long snail lives nowhere else on Earth, thriving on the 30-to-36° C spring-water temperatures. Blue-green coloured cyanobacteria grow in undisturbed thermal pools as does white, filamentous bacteria.

4. **Fossils of the Burgess Shale and the edge of a continent, Yoho National Park?**

The Burgess Shale fossils provide a view into life that existed 505 to 510 million years ago, after a period called the Cambrian Explosion. What is so exciting and unique about these soft-bodied fossils is the preservation of features such as eyes with retinal and brain tissues, livers, hearts, neural tissues, stomachs, and even eggs containing embryos! Many of these fossils are predecessors to many of the species that exist today, including humans. The Burgess Shale was deposited into deeper water in front of an extensive, shallow-water carbonate platform. Animals having jointed limbs allowing them to move had evolved. Animals could now crawl and swim to eat algae, scavenge dead organisms, and prey on living ones. Several organisms were predators, indicated by shells in gut contents, bite marks, and evolution of hard, defensive spines on prey species. The organisms lived on the sea floor or swam just above it. At that time on land, there was still no animal life, not even plants!

View to Wapta Mountain from the hiking trail to Walcott Quarry on Walcott Mountain.

What is now the village of Field in Yoho National Park was near the western edge of North America half a billion years ago! To the east, towards Lake Louise, was a shallow-water carbonate platform only a few metres deep. At Field, there was a steep cliff about 200 m high, which directly in front of lived and died the small organisms that were to become the fossils of the Burgess shale. The whole area was located close to and south of the equator at the time.

5. The natural hazard of debris flows at Spiral Tunnels, Yoho National Park

Descending down from Kicking Horse Pass, heading westward from the Continental Divide, there are large earthen and concrete works constructed to contain debris flows that affect the railway and highway. These civil-engineering efforts prevent debris flows from burying or washing out the highway or the CPR main line. Debris flows – consisting of liquefied, water-saturated sediment resembling a concrete slurry – can be extremely destructive natural hazards.

Cathedral Mountain and Mount Stephen, on the south side of the highway, rise high above the floor of the Kicking Horse River where the valley is less than a

Debris flow chute draining Mount Stephen, Yoho National Park. The chute drains down to cross the Canadian Pacific Railway and Trans-Canada Highway.

kilometre wide. The debris flows coming down Cathedral Gulch are triggered by meltwater that is stored in the glacial lakes and meltwater channels on and within Cathedral Glacier. Glacial lake water accumulates behind a ridge of ice at the front of the glacier during warm periods. Water flows to the base of the ice through the numerous subglacial meltwater channels and fissures. Water level in the lake continues to rise,

increasing the hydrostatic pressure below the glacier front until the ice lifts and catastrophically gives way. The lake drains as an outburst flood triggering gravity-driven debris flows on the steep slopes. Periods of heavy and steady rains on the upwind, westward side of the mountains also trigger debris flows and related floods.

6. The Icefields Parkway along the spine of the Rocky Mountains, Banff and Jasper National Park

The Icefields Parkway is one of the most spectacular and scenic highways in North America, if not the world, especially on a clear, blue-sky day.

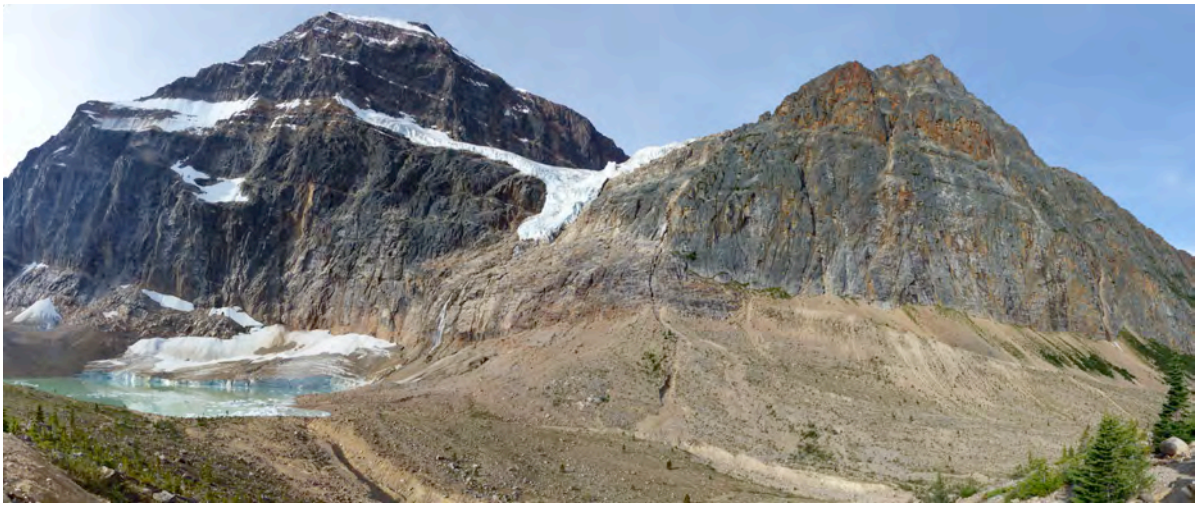
The Icefields Parkway follows the ridge or backbone of the Rocky Mountains. The parkway follows the mountain peaks of the Main Ranges northward from Lake Louise to Jasper, along the Continental Divide, passing by as many as a hundred glaciers, many of which are visible from the highway. The road passes beside wide and narrow braided-river floodplains, narrow entrenched canyons, alluvial fans,

and lakes that have been dammed by moraines or alluvial fans. There are rock glaciers, hanging valleys and large rock slides.

7. Recently glaciated splendour at Mount Edith Cavell, Jasper National Park

Mount Edith Cavell is a harsh, rugged and beautiful mountain environment that was just recently occupied by glaciers. This area is so dynamic and is changing all the time. For example:

a) The two main glaciers are Cavell and Angel, which were much more extensive only three hundred years ago. During the 1700s, Cavell Glacier extended down to the parking lot. The lateral and end moraines from the last advance of the Cavell Glacier in the 1700s are close to the parking lot.



Recently glaciated landscape at Mount Edith Cavell, Jasper National Park.

b) In front of the lower Cavell Glacier, there is small glacial lake that formed in 1960. The lake now fills and drains seasonally. In the summer, blocks of ice from the steep front of the glacier calve off into the lake.
c) Ghost Glacier is the highest of the glaciers on the north face of Mount Edith Cavell. In 2012, a 20-metre thick ice block detached from the glacier into the small lake, creating a large surge wave of water. Blocks of ice up to 4.5 metres across and quartzite boulders up to 1 metre across were hurled downstream and a new channel was cut through glacial moraine that dams the lake. Portions of the highway and parking lot were badly damaged.

8. Waterfalls are everywhere in Banff, Yoho, and Jasper National Park

The mountain parks are fully of water falls! Takakkaw Falls, Natural Bridge, Athabasca Falls, Sunwapta Falls, Maligne Canyon, and Mistaya Canyon are just a few of these cascading flows.

Takakkaw Falls in Yoho National Park.

This is all to do with past glaciations. Mistaya Canyon and Sunwapta Falls were created where rivers flowed over a hanging valley that entered into a larger valley. For example, the Sunwapta River flows into the Athabasca River creating Sunwapta Falls, which has since eroded a deep gorge into the limestone and dolostone of the Middle Cambrian Cathedral Formation. The Sunwapta River drops about 18 metres over the upper and lower falls, making several 90° bends due to jointing of the sediment. There are impressive potholes up to 1 metre deep occur on the upper bedrock surface at the lower falls.

Athabasca Falls plummets over the 25-metre deep gorge that is only 18 metres wide. The powerful torrents create a backdrop of roaring water and fine mist. During the last glaciation, blocks of quartzite from the highly resistant Cambrian Gog Group were plucked at the base of the ice to form a ridge with a vertical cliff. After deglaciation, the narrow gorge was carved through the quartzite by the river.

9. Permanantly frozen ground along Cavell Meadows Trail, Jasper National Park

Cavell Meadows trail is perhaps one of my most favourite geological hikes in the Rocky Mountains. It takes you above tree line to the alpine meadows, providing outstanding views of Mount Edith Cavell and its glaciers. There are the periglacial features of patterned ground; stone polygons, stone stripes, and sorted and non-sorted circles can be seen.

When you get above tree line, look for circular patterns of boulders that are several metres across. The stone stripes are elongate alignments of boulders that extend for up to 10 metres. These features form because of freeze–thaw action that causes frost heaving and creation of seasonal ice within the ground in the cold environment adjacent to the glacier. Watch for solifluction lobes on sloping surfaces along the trail. Solifluction lobes are steep-fronted, vegetation-covered, large, bulbous tongues of sand and silt that make their way downslope by creep and shallow shearing. Individual lobes are about 1 metre high and 2 to 5 metres long.

Stone stripe in permanently frozen ground along the Cavell Meadows Trail, Jasper National Park.

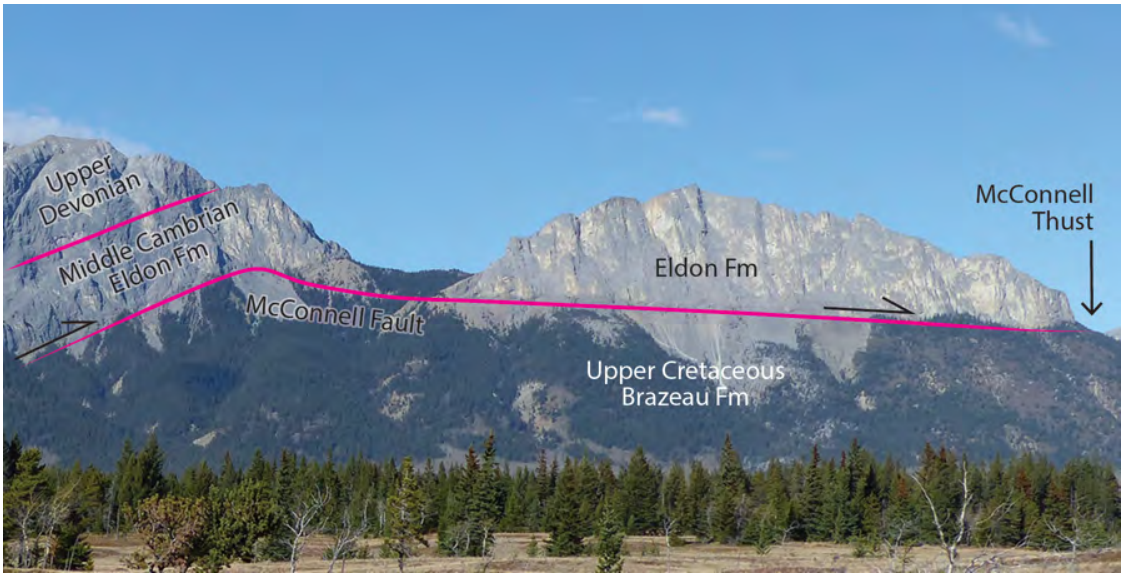
10. Edge of the mountains at Mount Yamnuska, Bow Valley Provincial Park

Located east of Banff National Park, Mount Yamnuska provides a spectacular panoramic overview of the abrupt boundary between the Rocky Mountain Foothills and the Front Ranges. Grey limestone cliffs of the Cambrian Eldon Formation were transported 32 kilometres northeastward by fault movement to be placed above the fluvial sediments of the Upper Cretaceous Brazeau Formation. The rocks above the fault are 400 million years older than the rocks below.

The abrupt vertical escarpment is the result of thrusting on the McConnell Fault followed by differential erosion of the resistant Cambrian carbonate sediments and easily eroded Mesozoic sandstones and mudstones to the east. The McConnell Thrust Sheet extends 480 kilometres along the mountain front, making it one of the largest thrust faults in the Canadian Rocky Mountains.

The McConnell Thrust itself is clearly visible at the base of the vertical cliff of Cambrian limestone, overlying the gentle slopes of the more easily erodible Cretaceous deposits. The fault contact between the two formations is knife sharp and near horizontal.

Several small springs upwell to create a series of ponds along the southward extension of the McConnell Thrust from Mount Yamnuska into Bow Valley Provincial Park. Along the Many Springs trail in the park, water comes to the surface at a year-round temperature of between 11 and 13° C and does not freeze in winter. This water originates from precipitation in areas above the McConnell Fault and makes its way down to a depth of approximately 600 metres. Geothermal heat warms the water before it is circulated upward through a highly porous and permeable zone along the fault plane.



Mount Yamnuska at the eastern leading edge of the Rocky Mountain Main Ranges. The McConnell Fault has placed carbonates of the Eldon Formation above sandstones of the Brazeau Formation. The Eldon rocks are 400 million years older than the underlying Brazeau Formation.