

January 22, 2024

## News and notes

Before going on to discuss the geology and geopolitics of [Canada](#), here are some news items I thought were interesting.

## Research

- Bad science: [In the latest twist of the publishing arms race, firms churning out fake papers have taken to bribing journal editors.](#)
- [Titanium-rich basaltic melts on the Moon modulated by reactive flow processes](#); Phys.org summary [here](#).
- From the bottom of the ocean: [Scientists retrieve rare methane hydrate samples for climate and energy study.](#)
- Geophysics: [Unveiling the effect of Ni on the formation and structure of Earth's inner core.](#)

## Oceanography

- [Oceanographic dataset collected during the 2021 scientific expedition of the Canadian Coast Guard Ship Amundsen.](#)
- [Evolution of ocean circulation and water masses in the Guaymas Basin \(Gulf of California\) during the last 31,000 years revealed by radiolarians and silicoflagellates in IODP expedition 385 sediment cores.](#)

## Plate Tectonics

- [Massive tectonic collision causing Himalayas to grow may also be splitting Tibet apart](#); pre-peer-reviewed pre-print [here](#).
- [The shape of the Himalayan "Arc": An Ellipse pinned by syntaxial strike-slip fault tips.](#)
- [Neogene and Pleistocene geodynamics: the paleoseismic evolution of Armorica \(Western France\).](#)

## Sedimentology

- [Large-scale sedimentary shift induced by a mega-dam in deltaic flats.](#)
- [Impact of wave, tides and fluid mud on fluvial discharge across a compound clinoform \(Pliocene Orinoco Delta\).](#)
- [Fossilized autogenic responses of grain-size transition to sediment supply and water discharge: Alluvial fan experiments.](#)
- [Logratio analysis of components separated from grain-size distributions and implications for sedimentary processes: An example of bottom surface sediments in a shallow lake.](#)

- [Tectonically induced travertine deposition in the Middle Miocene Levač intramountain basin \(Central Serbia\).](#)

## Paleontology

- [A giant tyrannosaur from the Campanian–Maastrichtian of southern North America and the evolution of tyrannosaurid gigantism](#); Sci Tech Daily summary [here](#).
- Video: [La Brea Tar Pits Unveil an Ice Age Mystery](#).

## Mining and Energy

- Exploration techniques: [Machine Learning Tools and Ore Deposits: a Perspective from Vulcanogenic Massive Sulfide \(VMS\) Chalcopyrite Trace Element Composition \(Part I\)](#).
- [Manitoba mining industry looks to the future, Access to potential mineral deposits, partnerships with First Nations vital.](#)
- [Uranium Energy Restarts Wyoming Production](#); related: [First Uranium Mines to Dig in the US in Eight Years Begin Operations Near Grand Canyon](#).
- British Columbia: [Partnership paves way for rare earth elements mine north of Prince George](#).
- New uses for Lithium: [New solid state battery charges in minutes, lasts for thousands of cycles](#).
- Metals refining: [Saskatoon's Vital Metals liquidates assets amid bankruptcy](#).
- [Why Oil Markets Aren't Reacting to Supply Disruptions and Geopolitical Risk](#).
- [Africa's Largest Refinery Begins Production in Nigeria](#).
- Nuclear: [Why the U.S. might just set its sights on Canadian-owned Westinghouse Electric](#).
- [Modular nuclear reactors being explored in Alberta](#).

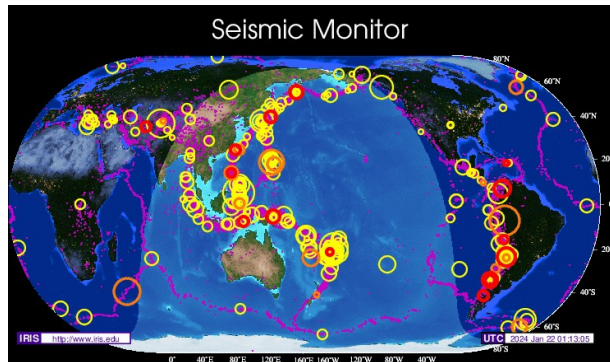
## Glaciers and Climate Change

- Antarctica: [New animation shows track of giant A23a iceberg](#).
- [Ubiquitous acceleration in Greenland Ice Sheet calving from 1985 to 2022](#).
- Glaciers and erosion rates: [Holocene warming of alpine rockwalls decreased rockwall erosion rates](#); Phys.org summary [here](#).
- Ancient climate change: [Global oceanic oxygenation controlled by the Southern Ocean through the last deglaciation](#); Phys.org summary [here](#).

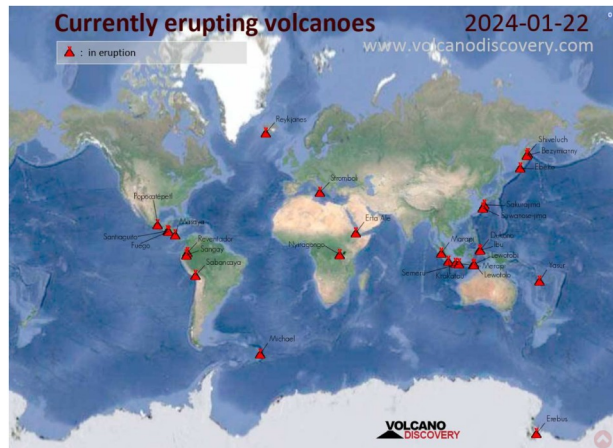
## Environmental Geology and Hydrogeology

- [Study quantifies how aquifer depletion threatens crop yield](#).
- Plastic pollution: [Impacts of pristine, aged and leachate of conventional and biodegradable plastics on plant growth and soil organic carbon](#).

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- United States Geological Survey (USGS) Volcano Watch: [Upgrades below the surface](#).
- USGS Yellowstone Volcano Observatory: [Erupting Bore Holes! The Thrills and Chills of 1967–1968 Yellowstone Research Drilling](#).
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- Ancient volcano: [Giant offshore pumice deposit records a shallow submarine explosive eruption of ancestral Santorini](#); Phys.org summary [here](#).
- Iceland:
  - [Experts Confirm: Icelandic Faultline Has Awakened After 800 Years](#);
  - [Iceland battles a lava flow: Countries have built barriers and tried explosives in the past, but it's hard to stop molten rock](#).
- [The 2023 US 50-State National Seismic Hazard Model: Overview and implications](#); Phys.org summary [here](#).
- [M5.4 earthquake below Lake Baikal](#); USGS summary [here](#).
- [M5.6 earthquake strikes below Colombia](#); USGS summary [here](#).
- [M5.3 earthquake shakes Fairbanks, Alaska](#); report from the Alaska Earthquake Center [here](#); USGS summary [here](#).
- [Surface deformations of the 6 February 2023 earthquake sequence, eastern Türkiye](#); Phys.org summary [here](#).
- [Ionospheric response to the 2020 Samos earthquake and tsunami](#).

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## Geology and the Fate of Societies – Canada



**Figure 1 – Map of Canada**

**Credit: [CIA World Factbook – Canada](#), public domain**

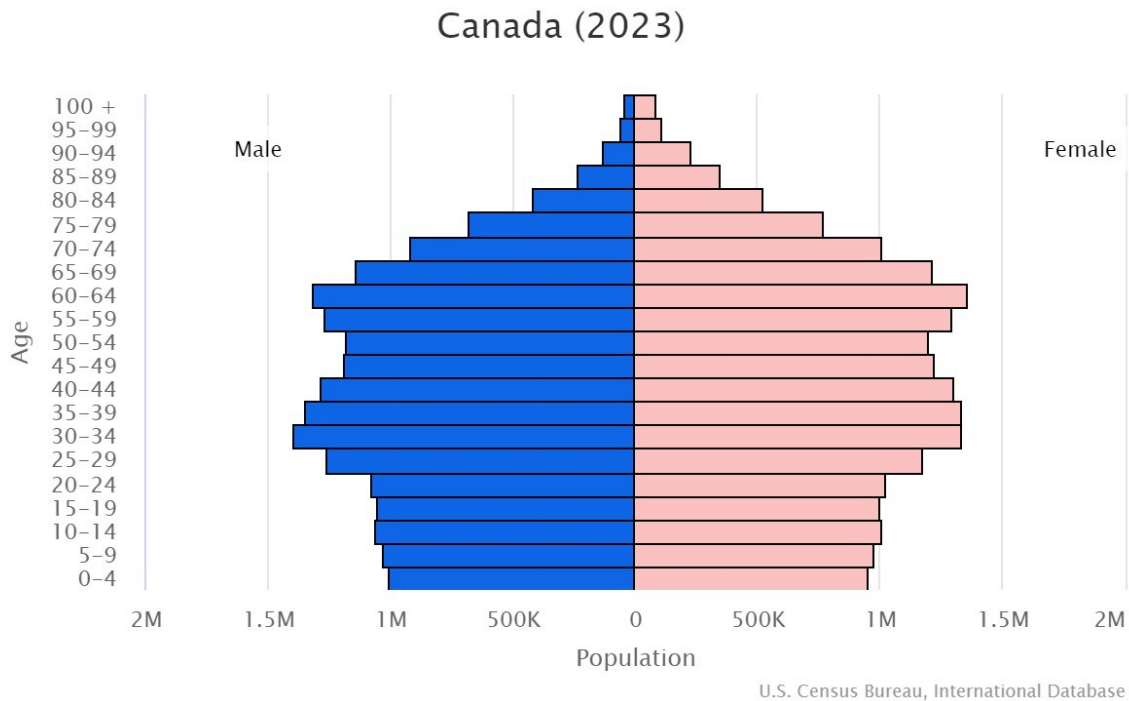
This week's posting will be on my home country of [Canada](#). It is a big subject and I will probably have to revisit it sometime in the future to provide more details. For this week, we'll take a just brief look at the geology and geopolitics of Canada.

According to the American [CIA World Factbook on Canada](#), Canada has a total area of 9,984,670 square kilometres (km<sup>2</sup>), making it the [second largest country](#) in the world in terms of area. Of the total area, 9,093,507 km<sup>2</sup> is land and 891,163 km<sup>2</sup> is water. Canada's main international border is with the [United States](#), some 8,891 km, the [longest international border](#) in the world. Canada also has a maritime border with the [French possessions](#) of [St. Pierre and Miquelon](#), off the coast of Newfoundland. Recently, Canada resolved a [border dispute with Denmark](#) (actually [Greenland](#)) over [Hans Island](#), agreeing to divide the island between them. So, now Canada has a land border with Denmark/Greenland as well.

[Canada's population](#) is now over 40 million. Of that [40 million](#), 15.6% identify themselves as just [Canadian](#) (that includes me), 14.7% as [English](#), 12.1% as [Scots](#), 11% as [French](#), 12.1% as [Irish](#), 8.1% as

[German](#), 4.7% as [Chinese](#), 4.3% as [Italian](#), 1.7% as [First Nations](#), 3.7% as [Indian](#), 3.5% as [Ukrainian](#) and 1.5% as [Metis](#). It adds up to more than 100% since many people identify as more than one ethnicity.

Religions in Canada reflect the ethnic diversity. A fair number, 34.6% have no religion. Of the remainder 53.3% identify as [Christian](#), 4.9% as [Muslim](#); 2.1% as [Sikh](#), 1% as [Buddhist](#), 0.9% as [Jewish](#), 0.2% as [Native American Religion](#), and 0.6% as other. The diversity of [religion in Canada](#) is even more bewildering than the basic statistics suggest, any spiritual practice you can imagine or desire has its adherents in Canada.



**Figure 2 – Demographic Profile of Canada**  
**Credit: U.S. Census Bureau, International Database – Canada, public domain**

The [demographic](#) profile of Canada shows an old country, [the average age in Canada on July 1, 2022 was 41.7 years](#).

Canada is a [parliamentary democracy](#) with a [federal organization](#). It is also a constitutional monarchy, the Head of State is [King Charles III](#); the King's representative in Canada is Governor-General [Mary Simon](#). The Head of Government in Canada is Prime Minister [Justin Trudeau](#). The national parliament includes a [Senate](#) and a [House of Commons](#). The [federal structure includes](#):

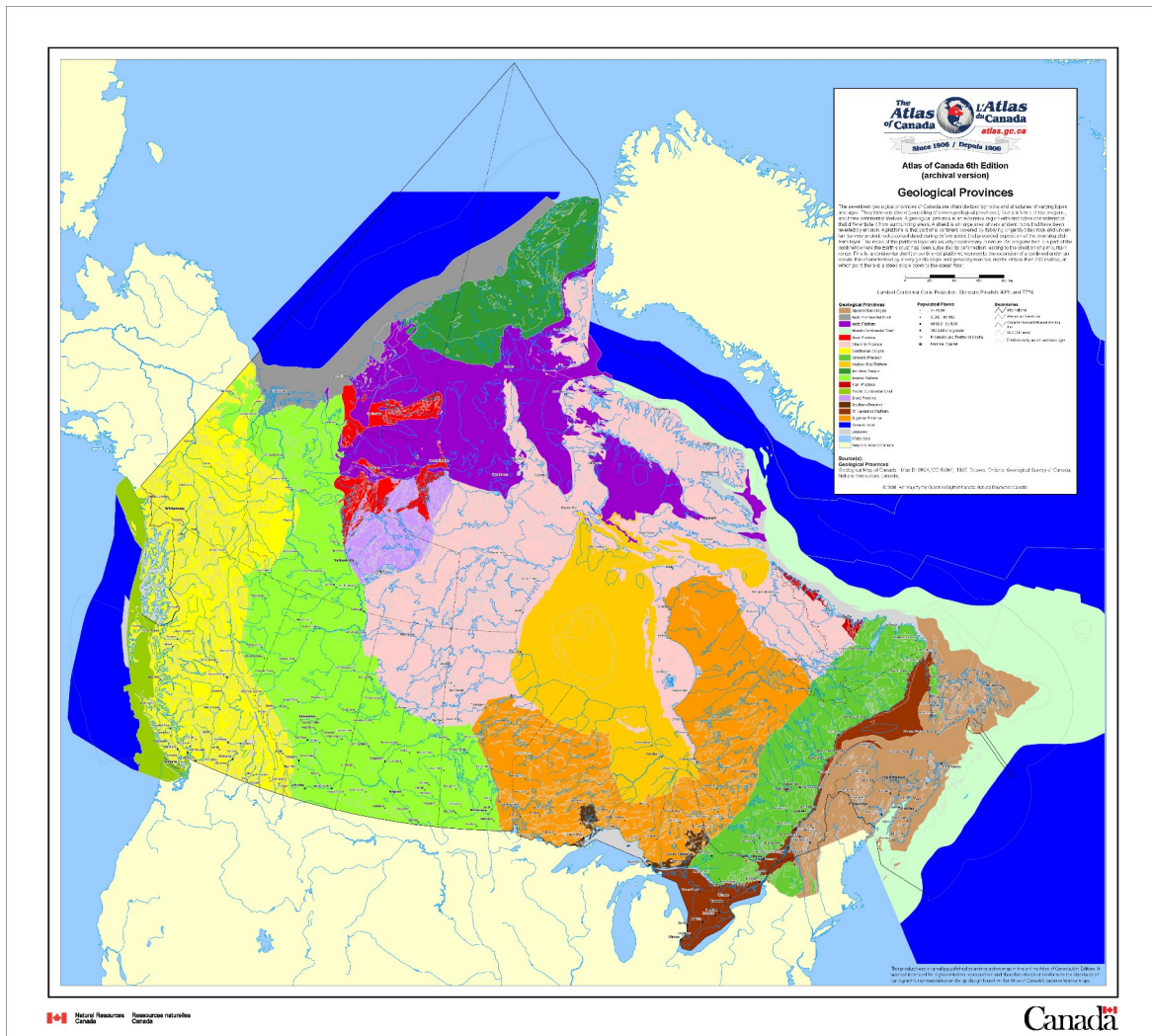
- Ten provinces ([Ontario](#), [Quebec](#), [Nova Scotia](#), [New Brunswick](#), [Manitoba](#), [British Columbia](#), [Prince Edward Island](#), [Saskatchewan](#), [Alberta](#), and [Newfoundland and Labrador](#)); and
- Three territories ([Northwest Territories](#), [Yukon Territory](#), and [Nunavut](#)).



- The [Arctic Platform](#),
- The [Hudson Bay Platform](#), and
- The [St-Lawrence / Great Lake Platform](#).

On the rim of the continent are the [orogenic belts](#):

- The [Appalachian Belt](#),
- [Innuitian Mountains](#), and
- The [Cordilleran Orogenic Belt](#).



**Figure 4 – Geological Provinces of Canada**  
**Credit: [Natural Resources Canada](#), [Open Government Licence – Canada](#)**

This is just a beginning. You can spend your whole life studying the geology of Canada and only scratch the surface.

## Resources

### *Agriculture*



**Figure 5 – Wheat Field in Saskatchewan**

**Credit: BriYYZ, [Creative Commons Attribution-Share Alike 2.0 Generic](#) license**

Canada is a major world food producer and exporter (production statistics [here](#)). This is all the more amazing when you consider that only 6.2% of [Canada's land area](#), some 62.2 million hectares, is used for food production and employing only 573,100 people (out of a total of 40 million).

Canada is rich on food and while hunger is not unknown, [obesity is a major health concern](#). As for hunger, where it exists in Canada it is not because of a lack of food on the market but because some people are simply too poor to buy sufficient food. This situation has been exacerbated in the recent couple of years as [price inflation](#) has hurt the poorest people the most. Food banks and soup kitchens help, but I think the Canadians can do better.

### *Forestry*



**Figure 6 – Rounding Up Logs in Gold River, British Columbia**

**Credit: [Tim Gage](#), [Creative Commons Attribution-Share Alike 2.0 Generic](#) license**

[Forestry in Canada](#) is a major industry, and has been since the first European settlement. About 39% of [Canada's land area](#) is covered by forest, representing about 9% of the world's total forest area (more statistics here). The [forest industry](#) includes:

- Wood manufacturing,
- Pulp and paper manufacture, and
- Forest harvesting and management.

Canada is the world's largest exporter of wood products, [exporting](#) \$44,896,428,730 worth of product in 2021.

### *Mineral Resources*



**Figure 7 – Diavik Diamond Mine**  
**Credit: Planet Labs, Inc., [Creative Commons Attribution-Share Alike 4.0 International](#) license**



**Figure 8 – Oil Well Pump in Longview Alberta**  
**Credit: Kevstan, [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**

For geologists, Canada is a land of great opportunity. The [mineral industry in Canada](#) is huge (statistics on solid minerals [here](#), oil and gas production statistics are [here](#)).

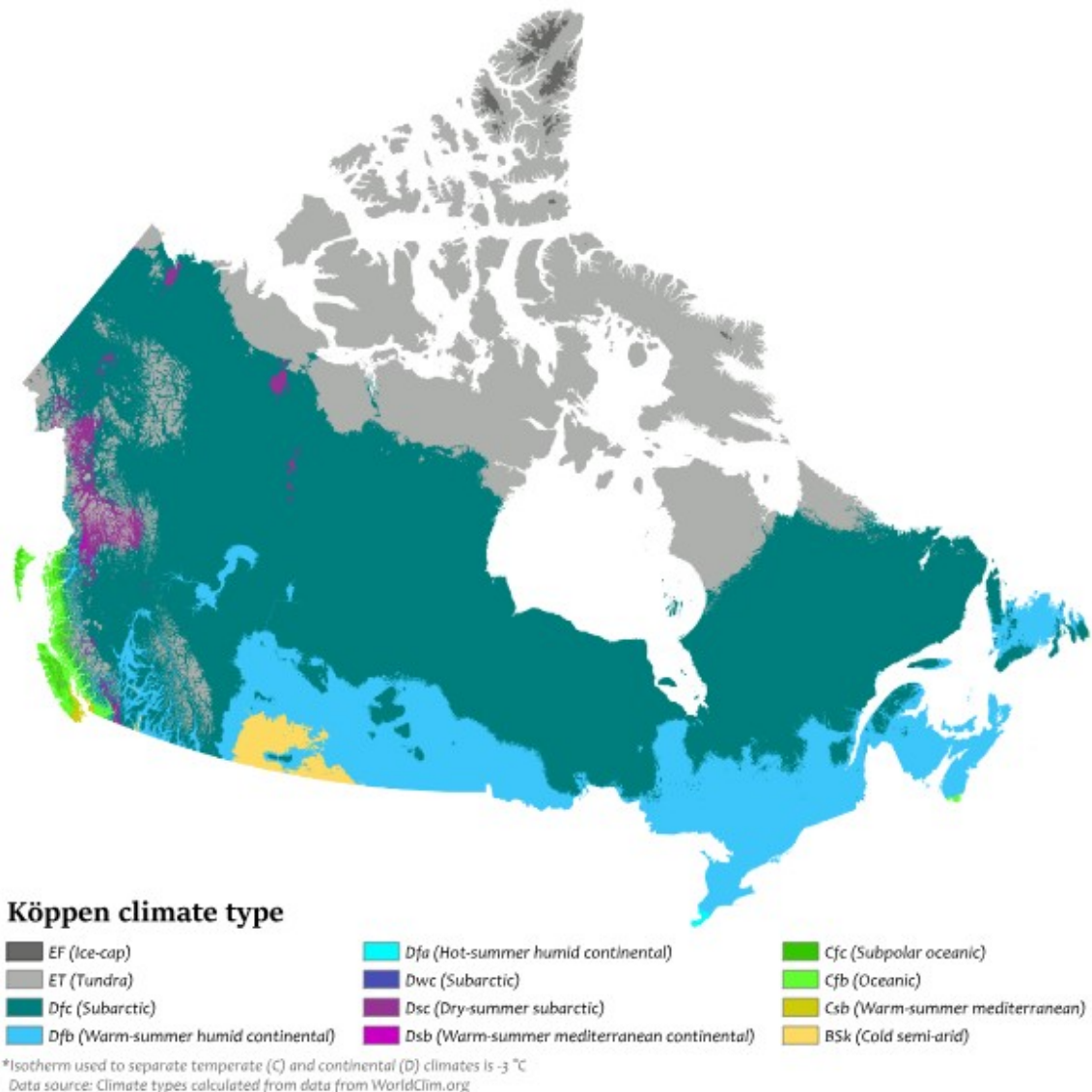
Mineral production of all sorts is found throughout Canada and in every region. For solid minerals, the Canadian Shield is a big producer, but the solid mineral production from the Cordillera and Appalachian orogenic belts are not insignificant. For oil and gas production, the Western Canada Sedimentary Basin is the largest, but there is also production in the St-Lawrence / Great Lake Platform and off-shore of the Appalachian belt in the continental shelf.

While many environmentalists decry the production of minerals, the fact is that modern industrial society is dependent on them. You may not like it that much of the new production for petroleum product is from the [Athabasca oil sands](#), but still you use petroleum products which come from there or from similar deposits. Who is to blame for the environmental damage that comes from [the extraction](#) and [use of petroleum product](#), the producer or the consumer? As for natural gas, the most important use is for the production of ammonium nitrate fertilizer through the [Haber-Bosch process](#). Prior to the introduction of

the Haber-Bosch process, the world could only support about 1 billion people, now we can support 8 billion. No natural gas, no fertilizer, delete the livelihoods of 7 billion people.

## Climate

# Köppen climate types of Canada



**Figure 9 – Köppen Climate Map of Canada**

**Credit:** [Adam Peterson](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

Canada's climate varies from arctic in the far north, subarctic in the central regions, and continental climate in most of the inhabited area. Vancouver and Southern Vancouver Island have the most pleasant climate, and the highest property values. You can find an explanation of the Köppen climate classifications shown in Figure 9, [here](#). If you want to travel to Canada, you might want to check out this [site](#), this [site](#) and this [site](#).

## History and Geopolitics

### History



**Figure 10 – Kuchin Winter Lodges, ca. 1847**  
**Credit: A. H. Murray in Richardson, 1851, public domain**

Rather than give a detailed description of that history, I suggest that you first read a few good summaries of Canadian history: [here](#), [here](#), [here](#) and [here](#). For history buffs, there is an online history magazine that deals with Canadian history, [here](#). My brief summary of Canadian history follows.

The history of humans in Canada began with their arrival during the [Pleistocene Epoch](#). Archaeologists and oral histories record that these people developed [many different cultures](#) to make a living. With the arrival of Europeans, [starting with the Vikings](#) around 1000 AD and continuing with [British and French exploration](#) in the [15<sup>th</sup>](#) and [16<sup>th</sup>](#) Centuries, the peoples of North America were drawn into the wider world.

Claiming North America for their respective governments, the [British](#) and [French](#) fought both the [native peoples](#) and one another for supremacy in the 17<sup>th</sup> and 18<sup>th</sup> Centuries in 1763, during the [Seven Years War](#), the British decisively defeated the French and acquired the lands previously claimed by France. The financial and political dislocations from the Seven Years War led most of the British colonies in North America to break away from their [British masters and form the United States](#), leaving the Canadian colonies as part of [British North America](#). Note that throughout these conflicts between European powers, and their American offshoot, the native tribes of North America usually ended up losing, regardless of the side they took in the conflicts.

Following the [War of 1812](#), the status of Canada as a British possession was settled and the colony, called [Upper](#) and [Lower Canada](#), later [Canada West](#) and [Canada East](#), continued to develop with a steady influx

of immigrants from Britain and Western Europe as well as by natural increase. In 1867, the two Canadas, together with the colonies of [Nova Scotia](#) and [New Brunswick](#) united into [the Canadian Confederation](#) with Canada West now [Ontario](#) and Canada East now [Quebec](#). [Rupert's Land](#) was acquired in 1869 and following a dispute with the Metis inhabitants of the [Red River Settlement](#), the [Province of Manitoba](#) was formed. In 1871, the British colonies on the west coast joined Canada as [British Columbia](#). In 1873, [Prince Edward Island](#) joined confederation and the final province to join was [Newfoundland & Labrador](#) in 1949.

Canada's independence from Britain was gradual. Under the [British North America Act](#) of 1867, Canada became self-governing except for foreign affairs, which were a British responsibility. Under the [Statute of Westminster](#) of 1931, Canada became fully self governing, retaining its link to Britain through the [monarchy](#) and the [Commonwealth of Nations](#). In 1982, the passage of the [Constitution Act](#) gave Canada complete independence. Canada still has a monarchy under the current [Constitution](#), a [point of pride](#) to some and [derision to others](#).



**Figure 11 – Canadian Soldiers in Afghanistan, 2002**

**Credit: [S. Sgt. Robert Hyatt](#), [public domain](#)**

Canada's history also includes internal rebellions and participation in external wars, these include:

- The [Rebellions of 1837 to 1838](#);
- [The Red River Rebellion of 1869 to 1870](#);
- [The Fenian Raids 1870 to 1871](#);
- [The Boer War 1899 to 1902](#);
- [World War One 1914 to 1918](#);

- [World War Two 1939 to 1945](#);
- [The Korean War 1950 to 1953](#); and
- [The Afghan War 2001 to 2021](#).

### *Geopolitics of Canada*



Figure 12 – South Junction Border Crossing, Roseau, Manitoba

Credit: [Lorie Shaull, Creative Commons Attribution-Share Alike 4.0 International license](#)

### *Internal Issues*

As a mature democracy with an [industrial](#) or even a [post-industrial economy](#), Canada's internal problems are often characterized as “[first world problems](#)”, especially when compared to the problems of some of the countries we have seen so far in our look at their geopolitics. However, to people suffering from economic dislocation, cultural disruption and fear of the future, these problems are real enough. Laying aside the regular churn of a democratic society, including [endemic condemnation](#) of political leaders, I see the following as the significant current and future problems for Canada:

- Cultural change arising from internal change of attitudes and the effect of new arrivals in the country;
- Political challenges arising from these cultural changes;
- Economic challenges coming from internal and external market forces.

Culturally, Canada is changing and not necessarily for the better. Canadians are losing their social cohesion. Some of this comes from the effect of integrating immigrants from many parts of the world, all with different cultures. Some comes from disillusionment with the society as a whole: many feel left out and that their own government is more of a hindrance than a help. The recent [Covid-19 pandemic](#), and the response to it, left many people feeling like Canada was no longer their country. Also, in what has become a multicultural society, no end of grievance and resentment can be found to justify an “us versus them” attitude. You can lay the blame where you want, the rise of a malevolent [Managerial Class](#) or cyclical changes like the [Fourth Turning](#), but these changes have occurred and the social drama is continuing to play out.



Figure 13 – Freedom Convoy 2022, Ottawa, Canada (February 12, 2022)

Credit: [Maksim Sokolov \(Maxergon\)](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

Politics follow from culture and the cultural changes have exacerbated many existing disputes:

- Always a distinct society, [Quebec](#) is gradually pulling away from the rest of Canada and is going its own way;
- In Western Canada, resource rich provinces such as [Alberta](#) and [Saskatchewan](#) are openly defying national leadership on energy and environmental policy;
- Nationally, the government seeks even more immigration to add to the multicultural mix of the country, [regardless of the ability of local communities to actually house those people](#); and

- The [politics of grievance](#) is used by the leaders of many groups; for example First Nations are seeking to carve out a place for themselves in opposition to the general society and especially those they deride as “settlers” i.e. Canadians of European ancestry.

All these political changes, and many more, are potentially toxic and could lead to further unrest.

The [economic changes](#) that have occurred [have not lead to universally better conditions](#). Increased immigration, a function of the Canadian national government’s commitment to [globalization](#), has occurred at a rate that exceeds the ability of Canadians to build new housing. The consequence has been a steady increase in the cost of housing and increase in the number of people without a place to live – a serious problem when normal winter temperatures are below freezing. Many worry that the open door immigration policy has [dire economic consequences](#).

Another consequence of globalization has been the loss of employment in manufacturing industries. While many have benefited from access to less expensive goods, many have also lost a good livelihood. Also, [one of the lessons of the Covid-19](#) episode is that you can’t always depend on other countries to meet your needs for critical supplies.

None of these internal issues need be fatal to the Canadian confederation, the problems are not technical but social. Some call for action as soon as possible to [save the country](#), but will the people respond or have the [managerial elite lost the confidence of the Canadian public](#)?

### External Issues

The elephant in the room for Canadian geopolitics is the United States. Whether they like it or not, Canada’s fate is intimately tied up with that of its next door neighbour. Canada maintains a close relationship with the U.S.A. through [NATO](#), [NORAD](#) and [free trade agreements](#) between Canada, the U.S.A. and Mexico. These arrangements have had a mixed reception in Canada, but the fact is that the agreements have allowed Canadians to share in American prosperity and to benefit from American military protection.

The downside of Canada’s close relationship with the U.S.A. comes if and when the Americans get involved with a great power conflict. Right now, [Canada is woefully unprepared](#) for the next big conflict and Canada’s defence spending is laughably small. They have good people in the Canadian Armed Forces, just not enough of them and with the necessary equipment. This situation has been noticed by at least one [American think tank](#). If Canadians don’t take their defence seriously, the Americans will. Canadians might find their national sovereignty taken away if their American neighbours need to do so in their own defence.

Another potential danger is that the Americans aren’t the only ones looking at Canada’s relative weakness. Both [China](#) and [Russia](#) have their eyes on the Canadian Arctic and Canada is in no way prepared for meeting the challenge.

So that kind of wraps up this look at Canada. I am guardedly optimistic about Canada’s future, Canadians have the ability to make the necessary changes to meet the challenges they face, the question of course, is will they?

## Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.