

*December 18, 2023*

## News and notes

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

## Research

- Geophysics of the atmosphere/ocean interface: [Agglomeration Drives the Reversed Fractionation of Aqueous Carbonate and Bicarbonate at the Air–Water Interface](#); Phys.org summary [here](#).
- Mineralogy from out of this world: [‘Head-scratcher’: first look at asteroid dust brought to Earth offers surprises](#).
- Australasian tektites from an [earth shattering](#) kaboom: [Proximal ejecta of the Bolaven extraterrestrial impact, southern Laos](#).
- Geochemistry and sedimentology: [Tectonically induced travertine deposition in the Middle Miocene Levač intramountain basin \(Central Serbia\)](#).

## Bad Science

- Dishonesty: [Dino extinction researcher committed research misconduct—but not fraud, university report finds](#).
- Retractions: [Record year for bad science with 10,000 studies retracted](#).

## Paleontology



Gorgosaurus skeletal mount. On display at the Royal Tyrrell Museum, Alberta  
**Credit:** Etemenanki3, [Creative Commons Attribution-Share Alike 4.0 International](#) license

- What did *Gorgosaurus* eat: [Exceptionally preserved stomach contents of a young tyrannosaurid reveal an ontogenetic dietary shift in an iconic extinct predator](#): ATI summary [here](#).
- [Worldwide Late Pleistocene and Early Holocene population declines in extant megafauna are associated with Homo sapiens expansion rather than climate change](#); Phys.org summary [here](#).
- Rare discovery: [Soft tissues in fossil crab](#); Phys.org summary [here](#).

## Mining and Energy

- Moving people put of the way to make room for a mine, not always a peaceful process: [Barrick says outside actors to blame in new abuse allegations at North Mara in Tanzania](#).
- Gold-copper mineralization: [Seabridge confirms new porphyry discovery at Iskut property in British Columbia](#).
- Markets can be cruel: [Cobalt is in demand, so why did America's only cobalt mine close?](#)
- [Five coal companies sue province of Alberta for \\$8 billion](#).
- [Record-breaking oil production from the US has left OPEC with its lowest crude market share in nearly a decade](#).
- [We won't see peak oil demand in our lifetime, JPMorgan's top energy strategist says](#).
- [OPEC Maintains Oil Demand Outlook Amid Resilient Economic Growth](#).
- [IEA Raises Its 2024 Oil Demand Growth Forecast](#).
- [IEA: Global Oil Inventories Fell in October](#).
- [TotalEnergies Cements Its Position in South Africa's Offshore Oil Boom](#).
- [Harnessing the heat beneath our feet: Geothermal's past and future](#).

## Environmental Geology and Hydrogeology

- Problems with using wastewater for irrigation: [Assessment of heavy metal accumulation and health risk in three essential edible weeds grown on wastewater irrigated soil](#).
- [Groundwater is a hidden global keystone ecosystem](#); related commentary in The Conversation [here](#).
- Free book from the Groundwater Project: [Biotic Transformations of Organic Contaminants](#).

## Glaciers and Climate Change

- [Scientists drilled through 500 metres of Greenland's ice — here's what they found at the bottom](#).
- Glacial lake outburst floods: [Enhanced glacial lake activity threatens numerous communities and infrastructure in the Third Pole](#); Phys.org summary [here](#).
- [Carbon Capture Needs Enough Pipelines to Circle Earth Four Times](#).



December 18, 2023

## Geology and the Fate of Societies – Burundi



Figure 1 – Map of Burundi

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

The Republic of [Burundi](#) is a small landlocked country in [Africa](#). It is bordered on [Tanzania](#) to the east, [Rwanda](#) to the north, the [Democratic Republic of the Congo](#) to the west and Lake [Tanganyika](#) to the southwest. According to the [Central Intelligence Agency \(CIA\) World Factbook on Burundi](#), the country has a total area of 27,830 square kilometres (km<sup>2</sup>) of which 25,680 km<sup>2</sup> is land and 2,150 km<sup>2</sup> is water.

The CIA Factbook also [estimates](#) the current population of Burundi at 13,162,952. The main ethnic groups in the country are [Hutu](#) 85%, [Tutsi](#) 14%, and [Twa](#) 1%, together with small numbers of [Europeans](#), [South Asians](#), and [Phuthi](#). The official languages spoken in Burundi are [Kirundi](#), [French](#) and [English](#); the [Swahili](#) language is also used.

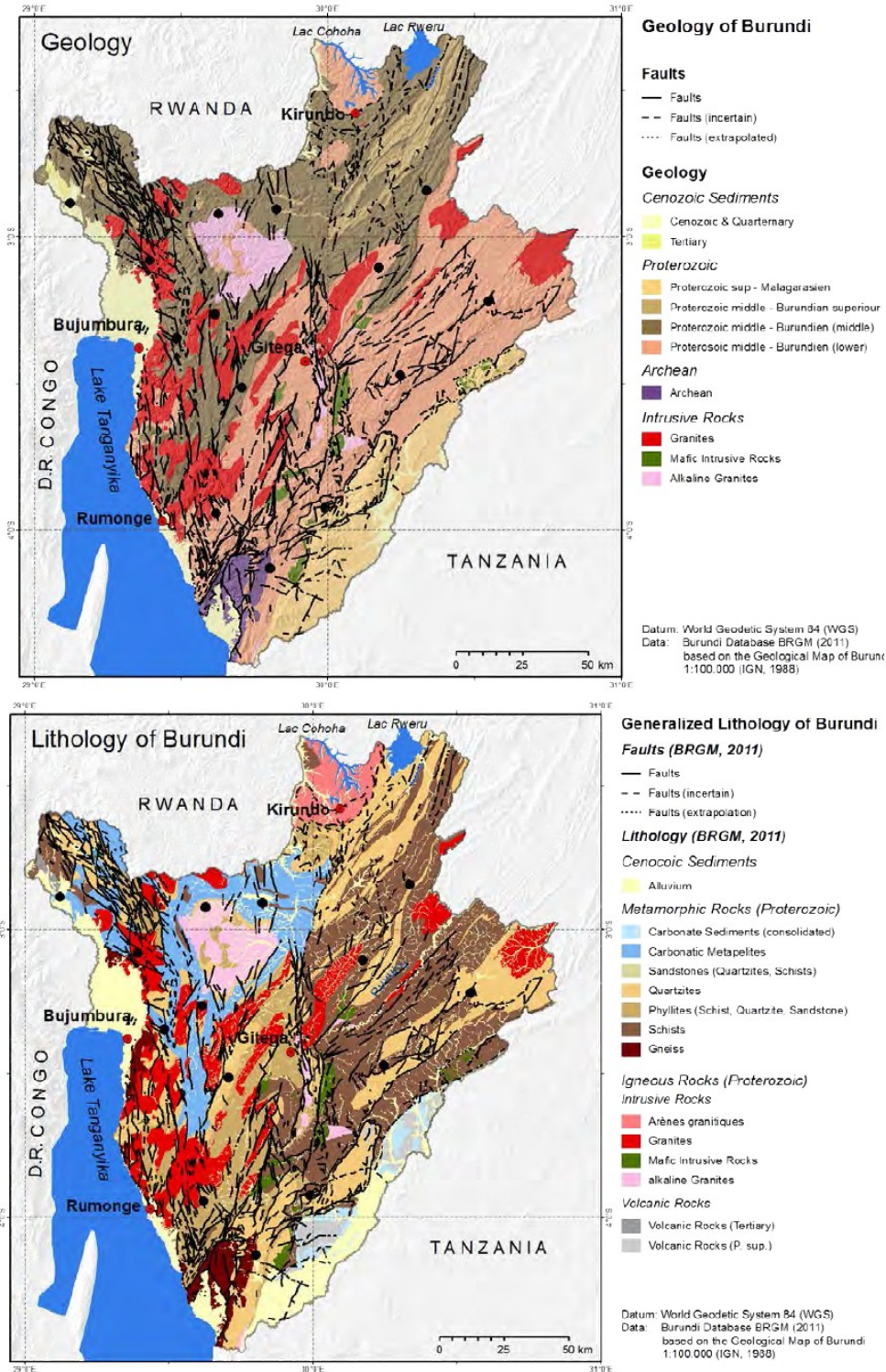
The most common religions in Burundi are varieties of [Christianity](#):

- [Roman Catholics](#) are 58.6% of the population;
- General [Protestants](#) are 32.6%; and
- One particular Protestant sect, the [Seventh Day Adventists](#), are 2.7% of the population.

Among non-Christians, Muslims are 3.4% of the population and 2.6% are either no religion or other.

Burundi is densely populated with approximately 513 people per km<sup>2</sup> of land. The demographic profile shows a young population, as in Figure 2.





**Figure 4 – Geology and Lithology of Burundi**

**Credit: Figure 5 in Heckmann et al, 2016**

The [rift valleys](#) formed by the tectonic breakup of Africa have been, and are currently being filled in, with [Cenozoic](#) aged deposits, mostly [alluvium](#). Cenozoic deposits also include [Neogene](#) and [Paleogene](#) (a.k.a. Tertiary) aged [volcanic deposits](#).

A major [unconformity](#) exists between the Cenozoic deposits and the underlying [Precambrian](#) rocks. Most of the Precambrian rocks in Burundi are [Proterozoic](#) aged [metamorphic rocks](#) such as [carbonates](#), [quartzites](#), [phyllites](#), and [schists](#). There are also Proterozoic [intrusive deposits](#) such as [granites](#), [alkaline granites](#), and [mafic](#) intrusive rocks such as [diabase](#) and [gabbro](#). Finally, there are also Proterozoic aged [volcanic rocks](#). The oldest rocks in Burundi are [Archean](#) aged [gneisses](#) in the south of the country.

## Resources

### *Agriculture*



**Figure 4 – Rice Farm in Burundi**

**Credit: [IRRI Images](#); [Creative Commons Attribution 2.0 Generic](#) license**

Agriculture in Burundi is a major part of country's life, employing 90% of the population. 90% of the agriculture in the country is [subsistence agriculture](#), where the produce is grown to directly feed the producers. [Food insecurity](#) is a major problem.

According to the [United Nations Food and Agriculture Organization](#) (FAO), in 2018, Burundi produced approximately:

- 2.3 million tons of cassava;
- 1.6 million tons of banana;
- 583 thousand tons of sweet potato;
- 556 thousand tons of vegetable;

- 393 thousand tons of beans;
- 302 thousand tons of potato;
- 290 thousand tons of maize;
- 178 thousand tons of sugar cane;
- 85 thousand tons of palm oil;
- 56 thousand tons of taro;
- 55 thousand tons of rice;
- 53 thousand tons of tea;
- 28 thousand tons of sorghum; and
- 14 thousand tons of coffee.

[Livestock production](#) is also very important in Burundi; the main animals raised include: goats, poultry, cattle, pigs, rabbits, and sheep. Statistics for production can be found [here](#).

### *Forestry*

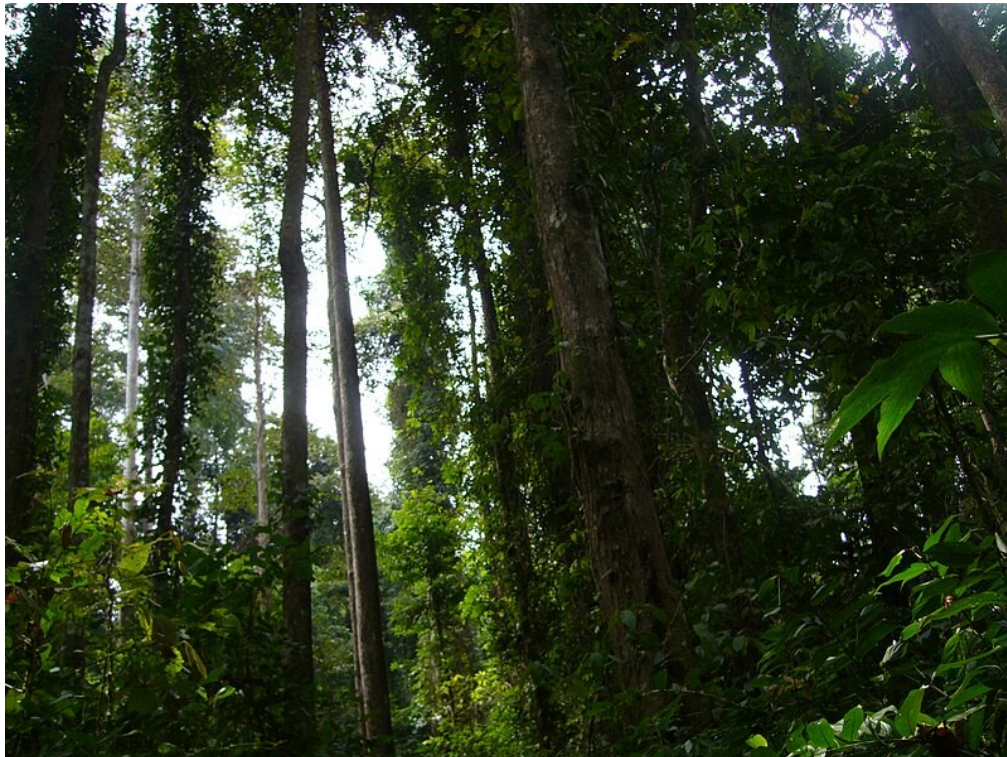


Figure 5 – *Terminalia* trees in Kigwena Forest Reserve

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

[During the civil wars in Burundi during the 1990's](#), up to 30% of the natural forest was cut down for various uses. Currently, about 11% of the country is covered in forest, [according to the FAO](#). The major use of the forest is for fuel wood and charcoal production. [In 2019](#), about 4.19 million tonnes of wood products were produced.

## Mineral Resources



Source: GAO. | GAO-15-561

**Figure 6 – Artisanal Miners at a Gold Mine in Burundi**  
**Credit: U.S. Government Accountability Office, public domain**

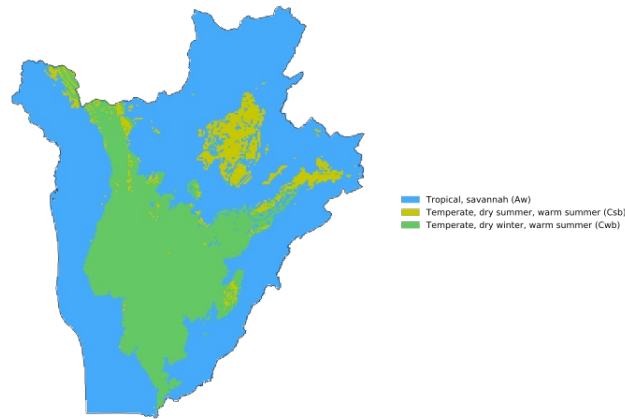
[Mines in Burundi produce](#) tantalum, aggregates, clay, gold, limestone, niobium (columbium), peat, rare earths, tin, and tungsten. According to the [USGS 2019 Minerals Yearbook](#) Burundi produced the following commodities that year:

- 567 kilograms (kg) Gold;
- Niobium, mineral concentrate, columbite-tantalite: 193,174 kg Gross weight, 38,000 kg Nb content;
- Rare-earth, mineral concentrate: 338 tonnes Gross weight, 200 tonnes Rare-earth oxide equivalent;
- Tantalum, mineral concentrate, columbite-tantalite: 193,174 kg Gross weight, 38,000 kg Ta content;
- Tin, mine, cassiterite: 382 tonnes Gross weight, 240 tonnes Sn content;
- Tungsten, mine, wolframite: 265 tonnes Gross weight, 130 tonnes W content;
- Industrial minerals: 75,000 tonnes of cement, 1,500,000 tonnes sand and gravel;
- 18,300 tonnes of peat, fuel.

Groundwater resources are also significant since most rural communities rely on groundwater for domestic supply. The [British Geological Survey](#) report on the [Hydrogeology of Burundi is here](#).

## Climate

Köppen-Geiger climate classification map for Burundi (1980-2016)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, *Scientific Data* 5:180214, doi:10.1038/sdata.2018.214 (2018)

**Figure 7- Köppen-Geiger Climate Classification Map for Burundi**  
**Credit: from Figure 1 in [Beck et al, 2020](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license**

[The climate of Burundi](#) reflects its position the equatorial region. Climate is largely controlled by elevation with the lower elevations having tropical savannah ([Aw](#)) climate and the higher elevations having temperate climates ([Csb](#) and [Cwb](#)).

At this time of the year, for those of us in the Northern Hemisphere, a visit to a hot tropical country might be very tempting. However, before you take the next plane to Bujumbura check out [this site](#) for a summary of the climate and [this site](#) for a summary of the dangers of such a visit.

## History and Geopolitics



**Figure 8 – Countryside Close to Gitega, Burundi**  
**Credit: [SuSanA Secretariat](#), [Creative Commons Attribution 2.0 Generic](#) license**

### ***A History of Many Deaths***

While humans have lived in the [Great Lakes Region of Africa](#) since the [Paleolithic](#), there is little written history of the region prior to relatively modern times. The earliest inhabitants in historic times were the ancestors of the Twa people (formerly called Pygmies). During the [Bantu expansion](#), the ancestors of the Hutu and Tutsi arrived in the country over the last 3000 years.

The written [history of Burundi](#) began with the earliest recorded polity in the region, the [Kingdom of Burundi](#). The Kingdom officially lasted from 1680 to 1966 but in fact the Burundian kingdom lost its independence when it became part of [German East Africa](#) in 1899. In 1916, [Belgian](#) troops conquered the territory and the Belgians [administered the territory](#) through the local King, until they returned independence to the [Burundian King](#) in 1962.

The history of Burundi since independence has not been happy:

- A military coup d'état [overthrew the monarch in 1966](#);
- Civil unrest continued and escalated into widespread [genocidal conflict in 1972](#);
- Another military coup d'état took control of the [country in 1976](#) and a civilian government was established in 1981;
- In 1987, the government was overthrown in [another coup d'état](#), and a civilian government was [established in 1993](#);
- Civil unrest continued leading to [genocide](#) and [civil war](#) that lasted until 2005.
- The civil war wound down and there were elections leading to new administrations in [2005](#) and [2010](#).
- Civil unrest [escalated in 2015](#) and the Burundi Army stage [another coup d'état](#) that year;
- Following the 2015 coup, a [new government](#) was elected, however human right violations, such as arbitrary arrests and detentions, acts of torture and cruel, inhuman or degrading treatment, extrajudicial executions, enforced disappearances, rape and other forms of sexual violence continued.
- In 2018, a [new constitution](#) was approved in a referendum;
- On May 20, 2020, the current president, [Évariste Ndayishimiye](#), was elected.

### ***Geopolitics of a Very Poor Country***

Burundi has many problems. As the result of past disorders, [Burundi is the poorest country in the world](#) by [GDP per capita](#). On top of the poverty, [serious human rights violations by government officials continue](#). As if criminal activity by government officials wasn't enough, private crime is endemic – the [statistics are grim](#). The overall story is one of endemic violence.

Ethnic conflict is a prominent part of the current and past affairs in Burundi. The two main groups, the Hutu and Tutsi, [have been at odds](#) throughout the past 100 years in both Burundi and neighbouring Rwanda. While the two ethnic groups speak a common language, they have different lifestyles and one

of the groups, the Tutsi, tends to be wealthier than the Hutu. This economic disparity underlies some of the revolts by poor people. As well, in general, Tutsi politicians and military officers have often been the national leaders, so revolts by the poor against the rich will tend to be Hutu against Tutsi.

As if endemic violence wasn't enough, [deadly infectious diseases](#) are a major problem in Burundi. These killers include [malaria](#), [HIV/AIDS](#), [tuberculosis](#), [diarrhoeal diseases](#), and [acute respiratory infections](#). This past year, [a new horror](#), resembling [Ebola](#), showed up.

Internal problems are not the only one facing the people of Burundi. Unrest in the nearby [Democratic Republic of the Congo](#) (DRC) has spilled over into Burundi in the [form of some 18,000 refugees](#). Tanzania appears to be [currently stable](#) and the government there faces [many challenges](#), including [accusations of civil unrest](#). Rwanda, to the north, has a [similar history to Burundi](#), both countries are home to ethnic Hutu and Tutsi with similar sad histories of mass murder. In the past, [Rwanda and Burundi](#) have had strained relations. Also, while Rwanda is [currently stable](#), there is no guarantee that this will always be the case.

Casting further afield, [China](#) has taken an interest in [neighbouring Tanzania and the DRC](#); that interest could presumably extend to Burundi in the future. Similarly, [Russia](#) and its mercenary outfit, the [Wagner Group](#), have been [active in Africa](#) and it could also become active in Burundi if there is money to be made.

Burundi's freedom from foreign colonialism could be brief should an ambitious power decide that its mineral wealth is worth exploiting. An ironic deterrent to any outside power seeking to control Burundi is the disorder and poverty of the country, who wants to own that situation? Even if you really don't care about the lives of the people in the country, the endemic disorder in Burundi does not bode well for the security of any investment you might make there. The prize might not be worth the cost.

So there you have my brief look at Burundi. It's hard to be optimistic but the country could have a better future if, and that's a big if, an orderly society can be created. Investments in their own people, like education and health care, would pay off, especially in reducing the incentives for revolt by raising overall standards of living. Burundi faces big challenges, only time will show if they are up to them.

### **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.