

February 12, 2024

## News and notes

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

## Research

- No longer the [Boring Billion](#): [The Balanced Billion](#); Phys.org summary [here](#).
- [Syn-Drift Plate Tectonics](#); Phys.org summary [here](#).
- [Olivine formation processes and fluid pathways in subducted serpentinites revealed by in-situ oxygen isotope analysis \(Zermatt-Saas, Switzerland\)](#).
- Lanthanides and yttrium (REY) mineralogy: [Effects of phosphate on REY adsorption by goethite: Insights into REY enrichment and release in marine iron oxyhydroxides during early diagenesis](#).
- Plate tectonics: [Duration of Sturtian “Snowball Earth” glaciation linked to exceptionally low mid-ocean ridge outgassing](#); Phys.org summary [here](#). Related story here: [Impact-induced initiation of Snowball Earth: A model study](#); Phys.org summary [here](#).

## Oceanography

- The North Atlantic circulation: [Physics-based early warning signal shows that AMOC is on tipping course](#); Phys.org summary [here](#).
- [Four New Seamounts Discovered in the High Seas](#).

## Sedimentology

- [Unidirectional and combined transitional flow bedforms: Controls on process and distribution in submarine slope settings](#).
- [Organic matter influence on ooid formation: New insights into classic examples \(Great Salt Lake, USA; Triassic Germanic Basin, Germany\)](#).
- [Testing magnetic tracers as indicators of sediment transport in a wave flume experiment](#).

## Paleontology

- [A new pterosaur from the Middle Jurassic of Skye, Scotland and the early diversification of flying reptiles](#); Phys.org summary [here](#).
- [The expansion of land plants during the Late Devonian contributed to the marine mass extinction](#); SciTechDaily summary [here](#).
- [The Cabrières Biota \(France\) provides insights into Ordovician polar ecosystems](#); Eureka Alert summary [here](#).

- [Tusked walrus \(\*Carnivora: Odobenidae\*\) from the Miocene–Pliocene Purisima Formation of Santa Cruz, California \(U.S.A.\): a new species of the toothless walrus \*Valenictus\* and the oldest records of \*Odobeninae\* and \*Odobenini\*; see also \[A 13-year-old found a 5-million-year-old fossil, and now there's a new species of walrus named in his honor\]\(#\).](#)
- Evolution and ecosystems: [Meta-analysis shows that wild large herbivores shape ecosystem properties and promote spatial heterogeneity](#); SciTechDaily summary [here](#).
- Sharks: [A new species of \*Palaeohypotodus\* Glückman, 1964 \(\*Chondrichthyes, Lamniformes\*\) from the lower Paleocene \(Danian\) Porters Creek Formation, Wilcox County, Alabama, USA](#).
- [Detection of intact polyene pigments in Miocene gastropod shells](#); Eureka Alert summary [here](#).
- [Another one bites the dust: A new \*Lithoserix\* species \(\*Hymenoptera, Ichneumonidae, Pimplinae\*\) from the early Oligocene in France, with an evaluation of wing morphometrics](#).
- Trade offs in safety and preserving fossil trackways: [A former mine at a fossil-rich site is causing the BLM headaches](#).
- Vandalism! [Activists spray paint on a replica dinosaur skeleton at Canadian Museum of Nature](#).

## Mining and Energy

- Ore deposit geology: [Tracing Detrital Epidote Derived from Alteration Halos to Porphyry Cu Deposits in Glaciated Terrains: The Search for Covered Mineralization](#).
- It's hard to attract people to a boom & bust industry: [Mining industry dogged by retirements and lack of new recruits](#).
- Northern Ontario: [Australians ramp up resource drilling at mothballed White River mine](#).
- [New Gold unveils three-year plan for 35% production growth](#).
- [New St. Lawrence mine owners promising big things for fluorspar, including a return to the deeps](#).
- [Gates, Bezos-backed KoBold Metals says Zambia copper find largest in a century](#).
- [Pressure groups sue LME for allowing trade of 'polluting' Indonesian metal](#).
- [Canada Announces Over \\$4 million to Support Critical Minerals Value Chain and Create Good Jobs in Ontario](#).
- [Rare earths prices seen rebounding in second half of 2024 – analysts](#).
- [U.S. Thermal Coal Finds New Life Overseas](#).
- [Another Merger Being Explored in the U.S. Shale Space](#).
- [The Geopolitical Risk Premium Is Back in Oil Markets](#).

- [U.S. Crude Oil Production To See Zero Growth This Year: EIA](#); US EIA article [here](#).
- Only if we change the government in Ottawa: [Opportunity knocks for Canada to become key LNG supplier as U.S. pauses projects](#).
- [Germany To Replace Nuclear With Natural Gas Plants for \\$16B](#).
- Hydrogen research: [A deep reservoir for hydrogen drives intense degassing in the Bulqizë ophiolite](#); Phys.org summary [here](#).
- [First 'private' nuclear reactor to power 2m British homes](#).
- [Nuclear fusion reaction releases almost twice the energy put in](#).

### Environmental Geology and Hydrogeology

- Per- and PolyFluoroAlkyl Substances: [Biden-Harris Administration Announces New Steps to Protect Communities from PFAS and Other Emerging Chemicals of Concern](#).
- [Soil microplastic analysis: a harmonized methodology](#); Phys.org summary [here](#).
- Remediation research: [Enhanced washing of polycyclic aromatic hydrocarbons from contaminated soils by the empowered surfactant properties of de novo O-alkylated humic matter](#).
- [Ghana: Kumasi city's unplanned boom is destroying two rivers – sewage, heavy metals and chemical pollution detected](#).
- [Whiskey's for drinking, water's for fighting: Nevada Supreme Court Rules Surface Water And Groundwater Are One And The Same](#).
- FREE groundwater books from the Groundwater Project: [Cross-Border Impacts Related to Transboundary Aquifers: Characterizing Legal Responsibility and Liability](#) and [Groundwater-Surface Water Exchange](#).

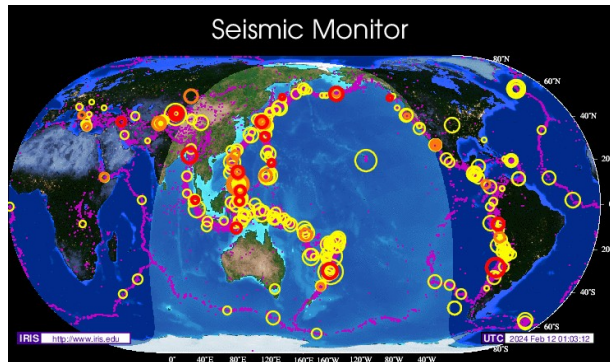
### Glaciers and Climate Change

- Not so stable: [Heterogeneous Basal Thermal Conditions Underpinning the Adélie-George V Coast, East Antarctica](#); Phys.org summary [here](#).
- More on Antarctica: [Abrupt Holocene ice loss due to thinning and ungrounding in the Weddell Sea Embayment](#); Eureka Alert summary [here](#).
- [Ice ages were not as dry as we thought, according to surprising new Australian cave study](#).

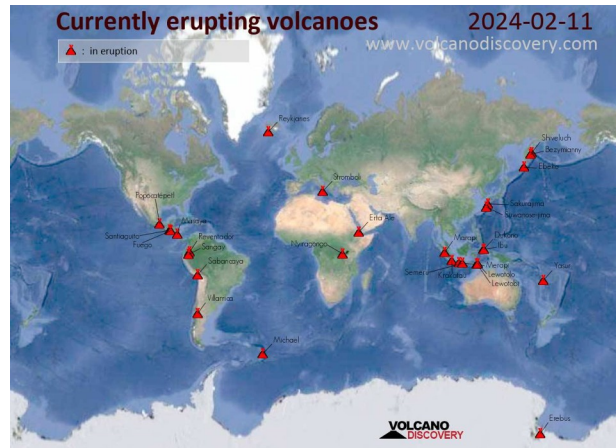
### From Out of This World

- Lunar mineralogy: [High-pressure minerals and new lunar mineral changesite-\(Y\) in Chang'e-5 regolith](#); Phys.org summary [here](#).
- [Asteroid Impact Near Berlin Reveals Rare Aubrite Treasures](#).

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- United States Geological Survey (USGS) Volcano Watch: [Another intrusion southwest of Kīlauea's summit](#).
- More on Kilauea: [Stress-driven recurrence and precursory moment-rate surge in caldera collapse earthquakes](#); Phys.org summary [here](#).
- USGS Yellowstone Volcano Observatory: [How much CO2 does Yellowstone emit?](#)
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- [Euro-Mediterranean Seismological Centre](#).
- Iceland:
  - [Declare the eruption completed](#);
  - [First footage of the eruption](#).
  - [Fracturing and tectonic stress drives ultrarapid magma flow into dikes](#); behind a paywall, Phys.org summary [here](#).
- Central America: [Fiery Eruption Lights Up Costa Rica's Poás Volcano](#).
- From Judith A Hubbard and Kyle Bradley: [One year after the February 6 Türkiye-Syria earthquakes](#).
- [M5.7 earthquake shakes Hawaii](#); USGS summary [here](#).
- Earthquake research: [Reconstruction of the deformation history of an active fault: implications from the Atera Fault, Central Japan](#).

February 12, 2024

## Geology and the Fate of Societies – Central African Republic



**Figure 1 – Central African Republic**

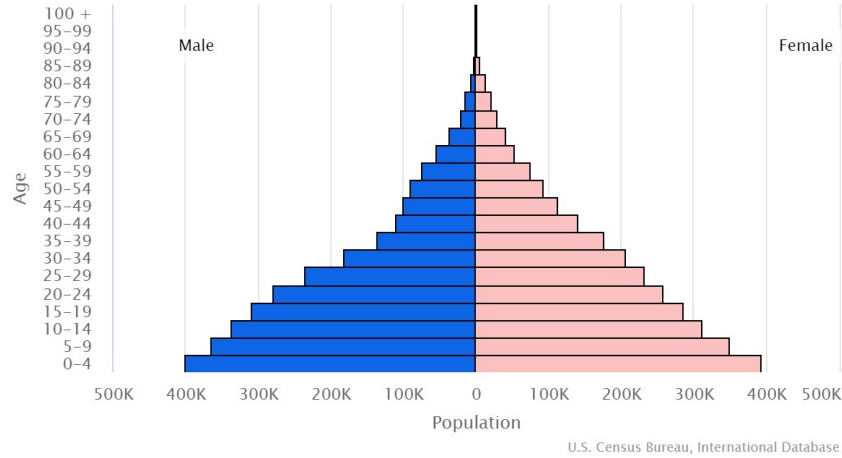
**Credit: [CIA World Factbook – Central African Republic](#), public domain**

The [Central African Republic](#) (CAR) is a former [French colony](#) in [equatorial Africa](#). Currently, the country is suffering from a [civil war](#).

According to the U.S. Central Intelligence Agency (CIA) World [World Factbook on the Central African Republic](#), the CAR has a total area of 622,984 square kilometres (km<sup>2</sup>) with no significant water bodies. The surrounding countries are: [Cameroon](#), [Chad](#), [Democratic Republic of the Congo](#), [Republic of the Congo](#), [South Sudan](#), and [Sudan](#).

The CIA estimates the current population of the CAR at 5,552,228. The approximately 5.6 million in the CAR are ethnically mixed with 28.8% in the [Baya tribe](#); 22.9% [Banda](#), 9.9% [Mandjia](#), 7.9% [Sara](#), 7.9% [M'Baka-Bantu](#), 6% [Arab-Fulani](#) (Peuhl), 6% [Mbum](#), 5.5% [Ngbanki](#), 3% [Zande-Nzakara](#), and 3% other. The demographic profile of the CAR (see Figure 2, below) shows a young country with a median age of 20.2 years. With a young population there is also a fairly high fertility rate where there are 3.99 births per woman. It's just as well, life expectancy is relatively short, at 56 years.

### Central African Republic (2023)



**Figure 2 – Demographic Profile, Central African Republic**

**Credit:** [United States Census Bureau, International Database, Central African Republic, public domain](#)

The official languages of the CAR are [French](#), the language of their former colonial masters; and [Sangho](#), a [lingua franca](#) or [creole language](#) that arose to facilitate communication between the many ethnic groups in the CAR. The majority religion is [Christianity](#), followed by 89% of the population; of the remaining, 9% are [Muslim](#), 1% follow [folk religions](#), and 1% are unaffiliated.

The CAR is a [presidential republic](#); the current President is [Faustin-Archange Touadéra](#) and the Prime Minister is [Félix Moloua](#). There is a single house legislature, the [National Assembly](#), the President of which is [Simplice Sarandji](#). [Bangui](#) is (pop. 812,407) the country's capital and largest city.

### Geology

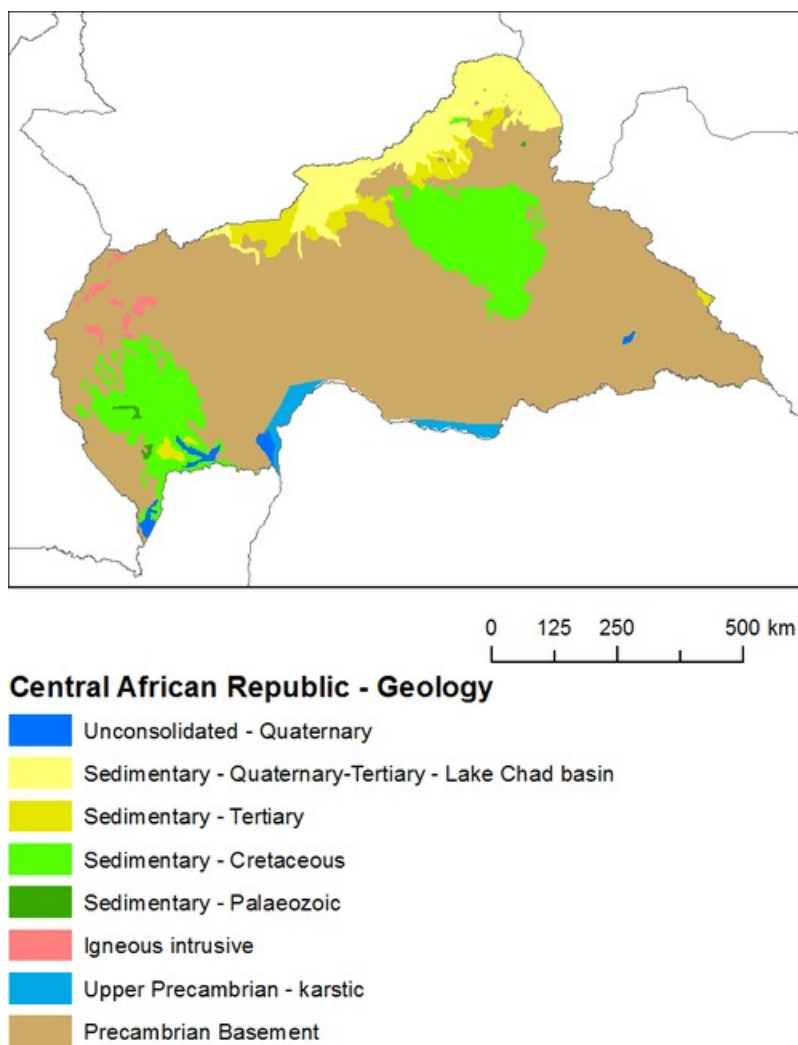


**Figure 3 – Ancient Pannotia Supercontinent**

**Credit:** [Aymatth2, public domain](#)

The underlying [basement rock](#), and most of the near-surface bedrock of the CAR is of [Precambrian](#) age. These Precambrian rocks are from two main [cratons](#): the [Sahara Metacraton](#), to the north and the [Congo Craton](#), to the south. Both of cratons were once part of the [Pannotia Supercontinent](#) that formed during the [Pan-African orogeny](#) that occurred during the [Neoproterozoic](#). The Precambrian rocks of CAR include:

- An [Archean](#) aged basement of [quartzite](#), [schist](#), [gneiss](#), [amphibolite](#), [granulite](#), [migmatite](#) and [granite](#);
- [Proterozoic](#) aged subdivided into three units: an upper unit with a series of [schist](#), [quartzite](#), [limestone](#) and [sandstone](#); a middle unit consisting mainly of [carbonate](#) formations with a [glacial conglomerate](#) at the base; and a lower unit represented by quartzite alternating with schist; and
- Proterozoic to [Cambrian](#) igneous [intrusions](#) consisting of discontinuous granite [batholiths](#) and [dolerite](#) veins.



**Figure 4 – Geology of the Central African Republic**

**Credit:** [British Geological Survey](#), [Hydrogeology of Central African Republic](#), [public domain](#)

Overlying the Precambrian rocks are the following [Phanerozoic](#) deposits:

- The [Palaeozoic](#) aged [Mambéré](#) and [Kombélé](#) formations, both of which consist of glacial conglomerate and sandstone;
- The [Cretaceous](#) aged [Carnot](#) and [Mouka Ouadda Sandstone](#) formations;
- [Paleogene \(Eocene\)](#) aged [Bambio Sandstone](#) (in the south); [Continental Terminal](#) formations (north); and
- [Quaternary](#) aged [ferricrete](#), [lacustrine](#) deposits, [alluvial](#) deposits, and [laterite](#) soils.

An interesting feature of the Carnot, Mouka Ouadda and Bambio formations is that they often contain diamonds that were deposited in [fluvial sedimentary environments](#). Many of the diamonds found in the CAR are [carbonado](#), or black diamonds. Carbonado is a form of diamond generally associated with fluvial sedimentary deposits and not with [kimberlite](#) – the usual source of diamonds.

## Resources

### *Agriculture*



Figure 5 – Preparing the Ground for Seeding in the Central African Republic  
**Credit:** Selengomadavid; [Creative Commons Attribution-Share Alike 4.0 International](#) license

About 8.1% of the [land in the CAR](#) is agricultural (2.9% arable land, 0.1% permanent crops, and 5.1% permanent pasture). Agriculture contributes 43.2% to the overall economy. Much of the agriculture is for [subsistence](#). Major agricultural products are: [cassava](#), [yams](#), [groundnuts](#) (peanuts), [taro](#), [bananas](#) and [plantains](#), [sugar cane](#), [maize](#), [beef and milk](#). Statistics on food production from the United Nations Food and Agriculture Organization (FAO) are [here](#).

A poor country in the midst of a civil war, the CAR has a significant problem with food insecurity. According to the [FAO](#), up to 48.7% (!!!) of the population was undernourished in the years 2020-2022.

### *Forestry*



**Figure 6 – Timber Transport in the Central African Republic**  
**Credit: [WRI Staff](#), [Creative Commons Attribution 2.0 Generic](#) license**

About [45% of the land](#) in the CAR is forest of which 36% is considered dense forest. Commercial forestry sector contributes 40% to 50 % to the national economy and is the major non-farm employer. The CAR government is responsible for [forest management](#). With the on-going civil war, this is probably difficult. [Endemic corruption](#) in government activities also contributes to the problems with forest management.

Logging activities include commercial harvesting, timber harvesting for local needs and charcoal production. Statistics from the FAO on forest production can be found [here](#). Data on deforestation can be found [here](#).

### *Mineral Resources and Deposits*

The main [mineral resources exploited](#) in the CAR are diamonds and gold. The USGS Minerals Yearbook report on the mineral industry in the CAR is [here](#). The most recent statistics for diamond production in

the CAR was for 2018 when 13,572 carats of diamonds were produced. Much of the diamond production is from [artisanal or small scale mining](#) that employs approximately [80,000-100,000 workers](#), generally at subsistence wages. Statistics on diamond production in the CAR are hard to come by since there is a civil war going on in the country.



**Figure 7 – [Ndassima Gold Mine](#), Central African Republic**

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

The mining of gold in the CAR follows a similar pattern to diamonds with much of the production from artisanal mining. There is one large scale gold mine, however, the [Ndassima Gold Mine](#). Originally an artisanal mine, in 2010 [AXMIN Inc.](#) began large scale mining operations. These operations were interrupted by the civil war, when [UPC](#) rebels occupied the mine site. In 2017 the [Wagner Group](#) of mercenaries took over the mine, delegating operations to their subsidiary, [Midas Resources](#). Among the actions taken to secure control of the mine, the [Wagner Group massacred villagers](#) in the nearby village of [Boyo](#) in 2021.

Besides the developed resources of diamonds and gold there are undeveloped deposits of [copper](#), [graphite](#), [ilmenite](#), [iron ore](#), [kaolin](#), [kyanite](#), [lignite](#), [limestone](#), [manganese](#), [monazite](#), [quartz](#), [rutile](#), [salt](#), [tin](#), and [uranium](#). Given the chaotic conditions in the CAR, it may be a while before these deposits can even be assessed for development as resources.

## Climate

Central African Republic map of Köppen climate classification

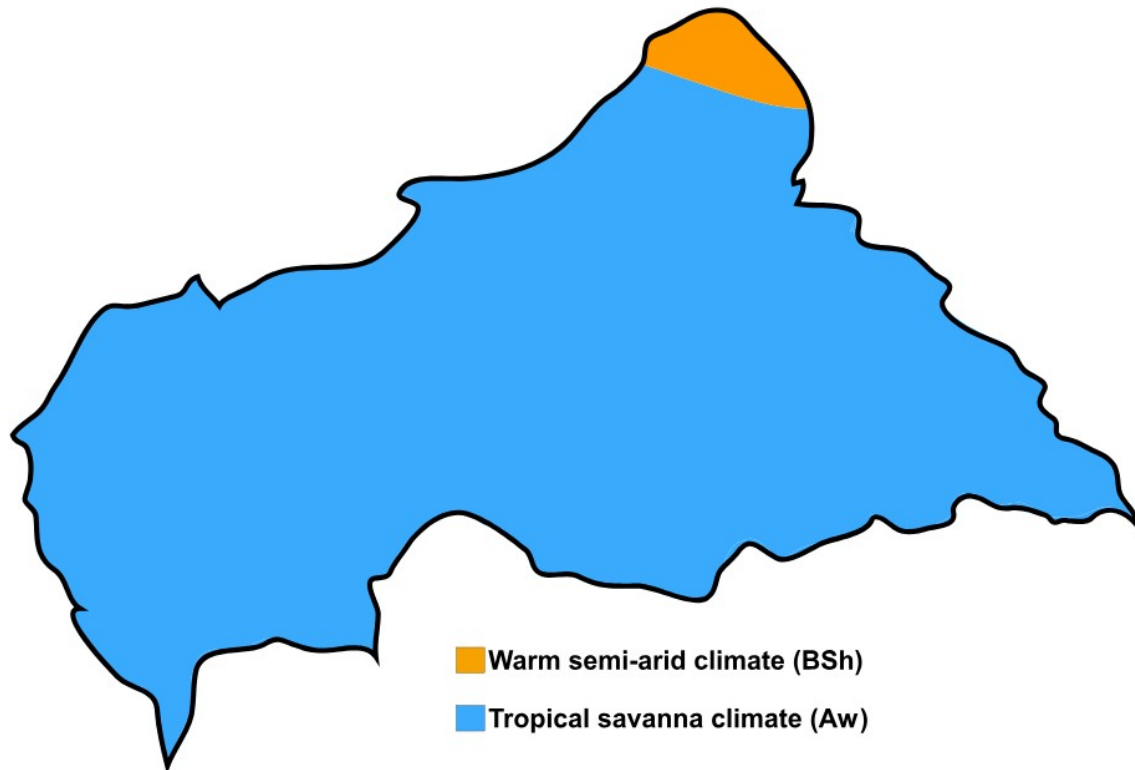


Figure 8 – Köppen Climate Map for Central African Republic

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

The CAR has a predominately a tropical savanna climate ([Aw](#)) in most of the country with a smaller area of warm semi-arid climate ([BSh](#)) in the northeast. Briefly, the climate is tropical, hot all year round. The dry season is from December to February and a rainy season, which lasts for most of the year in the south, The rainiest period is from July to September in the centre-north and from May to October in the south.

If you plan to visit the CAR, you want to visit this [website](#) to check out the climate and [this site](#) for travel advice. You might also want to visit this site for [travel warnings](#). (Spoiler the lead paragraph states: **Central African Republic – AVOID ALL TRAVEL**).

## History and Geopolitics

### *History, Independence to Colony and Back Again*

Briefly, the history of the CAR can be divided into three basic periods:

- The precolonial period,
- French occupation; and

- Postcolonial period.

The **precolonial period** is the longest, but also the least well documented. Prior to the Holocene, the human occupants of the CAR were various tribes of [hunter-gathers](#), as was the rest of the world.



**French Equatorial Africa, ca. 1930**

**Credit:** [Bibliothèque nationale de France](#)

Beginning around 10,000 years ago, [Neolithic farmers](#) began settling down in the river valleys of Central Africa. Among their accomplishments were the [Bouar Megaliths](#). State level organizations during the precolonial period include: the [Kanem Empire](#) c. 700–1380; the [Sultanate of Bagirmi](#) 1522–1897; and the [Wadai Empire](#) 1635–1909. Also part of the precolonial period was the [Trans-Saharan slave trade](#) c. 1500–1600.

The [French occupation](#) of the lands that are now the CAR began in 1909 and lasted until 1960. It was not an entirely peaceful time with rebellions such as the [Kongo-Wara](#) rebellion from 1928–1931. The French began to divesting themselves from their colonies in French Equatorial Africa beginning with the 1944 [Brazzaville Conference](#) and through negotiations with the [African Democratic Rally](#) from 1946–1958. By 1960, the French were willing to leave and grant there former colonies independence.

The postcolonial period has not been peaceful either and can be summarized by the following events:

- [Bokassa period](#) 1966–1979 beginning with a [coup d'etat in 1966](#), and Bokassa's declaration of the [Central African Empire](#) lasting from 1976–1979, and his [coronation](#) as Bokassa I, [Emperor of Central Africa](#) in 1977;
- The removal of Bokassa in [Operation Caban](#) in 1979, and consolidation of the new regime in [Operation Barracuda](#) from 1979 to 1981;
- The [Kolingba coup d'etat](#) in 1981;
- The [Patassé coup attempt](#) in 1982;
- The [general election of 1993](#);
- A period of [heightened tensions](#) from 1993–1998;
- Negotiation of the [Bangui Peace Accords](#) in 1997;
- The [United Nations Mission](#) in 1998;
- The [Bush War](#) from 2004–2007 including the [Kolingba coup attempt](#) in 2001 and the [Bozizé coup d'etat](#) in 2003;
- The current [Civil War](#) that began in 2012 including such events as the [Conflict under Djotodia](#) 2013–2014 and the [Fall of Bangui](#) in 2013.

Overall, a pretty sad history.

### *Geopolitics of a Failed State*



**Figure 10 – Rebels in northern Central African Republic**

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

The chaotic conditions in the CAR are enough to make people there wonder if they are living through the [prophesied end times](#) with wars and rumours of wars. Their neighbours must be concerned that the chaos could overflow into their countries. Already there is a [severe refugee crisis](#) with more than a [million people displaced from their homes](#). The word tragedy hardly encompasses the situation.

Besides their immediate neighbours, there are other powers with an interest in the CAR such as the former colonial power, [France](#). Over time, relations between the CAR and France have gone from [poor to bad to worse](#). France has [intervened militarily in the CAR](#), often with little to show for it. In 2021, they gave up entirely and withdrew all [French forces and aid from the CAR](#).

In recent years, [Russia](#), through its [mercenary](#) organization, the [Wagner Group](#), has taken an [interest in the affairs of the CAR](#). In addition to appropriating the Ndassima Gold Mine, the Wagner Group has provided mercenaries to help the official government of the CAR in the ongoing civil war. As well, they have engaged in various business activities including the production of beer and vodka (a Russian necessity). Not wanting their activities too well known, the Wagner Group [assassinated](#) journalists Kirill Radchenko, Alexander Rastorguyev and Orkhan Dzhema in 2018.

The [United States](#) has attempted to [intervene](#) in the CAR, offering to provide military training to CAR armed forces and humanitarian aid. The USA are interested in removing the malign influence of the Wagner Group as well as extending American influence in Africa. However, so far, the CAR government have not accepted their help.

It is hard not to view the CAR as a [failed state](#). With the civil war, rampant poverty, and widespread malnutrition it is hard to be optimistic about the country. Still, if an honest government can establish order and work on developing the resources, infrastructure, and especially the people of the country, then they may have a brighter future.

## **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.