

*December 11, 2023*

## News and notes

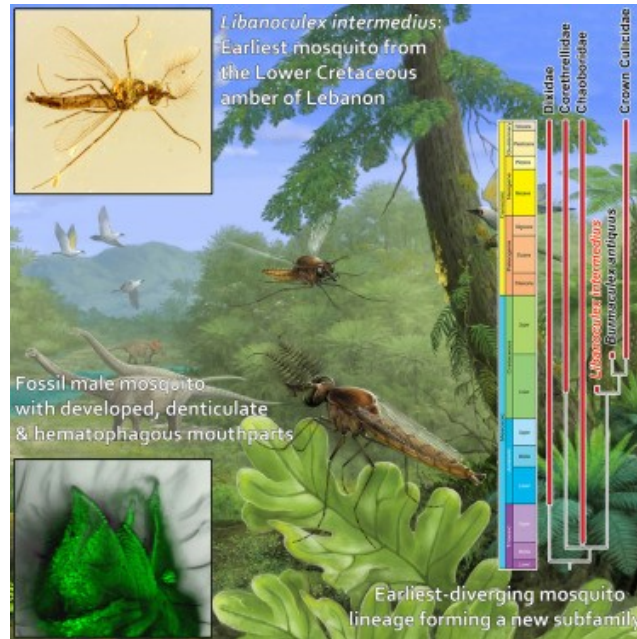
Before going on to discuss the geology and geopolitics of [Burma \(Myanmar\)](#), here are some news items I thought were interesting.

## Research

- From the New Mexico Bureau of Geology & Mineral Resources, a new issue of Lite Geology is available for free [download](#).
- Sedimentology and geochemistry: [Role of bottom water chemistry in the formation of fibrous magnesium calcite at methane seeps in the Black Sea](#).
- Ancient volcanic eruptions in the sedimentary record: [Cryptotephra preserved in Lake Suigetsu \(SG14 core\) reveals the eruption timing and distribution of ash fall from Japanese volcanoes during the late-glacial to early Holocene](#).
- Mineralogy and geochemistry: [Authigenic minerals reflect microbial control on pore waters in a ferruginous analogue](#).
- More mineralogy: [Lithium Pegmatites: Rapid and in-situ Li \(%\) estimation using XRF portable equipment](#).
- REE geochemistry: [Processes controlling rare earth element distribution in sedimentary apatite: Insights from spectroscopy, in situ geochemistry and O and Sr isotope composition](#).
- More REE geology: [Composition of Rare Earth Elements in Fluvial Sediments of the Lesser Zab River Basin, Northeastern Iraq: Implications for Tectonic Setting and Provenance](#).
- High-temperature superconductors: [Superconducting ternary hydrides: Progress and challenges](#).
- Plate tectonics: [The missing ridge Enigma: A new model for the Tuamotu Plateau conjugate and Peruvian flat slab](#).
- Geophysics: [Integrated geologic and geophysical modeling across the Bartlett Springs fault zone, northern California \(USA\): Implications for fault creep and regional structure](#).
- More geophysics: [New constraints on the shear-wave velocity structure of the Ivrea geophysical body from seismic ambient noise tomography \(Ivrea-Verbano Zone, Alps\)](#).
- Ancient plate tectonics: [Considerable heating during clockwise decompression of a long-lived Paleoproterozoic hot orogen: Evidence from the Xuanhua Complex, North China Craton](#).
- More ancient plate tectonics: [Changes in orogenic style and surface environment recorded in Paleoproterozoic foreland successions](#).
- Ancient rocks: [A multi-disciplinary geophysical approach reveals a Paleoproterozoic cryptic suture in the Amazon Craton – Implications for Proterozoic Supercontinent reconstructions](#).

- More ancient rocks: [Metamorphosed Plagiogranite Veins In Salma Eclogites, Belomorian Eclogite Province](#).

## Paleontology



### **Libanoculex intermedius – Lower Cretaceous**

**Credit:** Graphical Abstract in [Azar et al, 2023](#)

- Fossils in amber: [The earliest fossil mosquito](#); Sci News summary [here](#).
- [Decoupling speciation and extinction reveals both abiotic and biotic drivers shaped 250 million years of diversity in crocodile-line archosaurs](#); Phys.org summary [here](#).
- [The expansion of land plants during the Late Devonian contributed to the marine mass extinction](#); Phys.org summary [here](#).
- [Longer mandible or nose? Co-evolution of feeding organs in early elephantiforms](#); Live Science summary [here](#).
- It's a turtle: [An Early Cretaceous \*Sphenophyllum\* or a hatchling turtle?](#) Live Science summary [here](#).
- [Contrasting terrestrial and marine ecospace dynamics after the end-Triassic mass extinction event](#); Phys.org summary [here](#).
- Dinosaur mobility: [Restudy of shoulder motion in the theropod dinosaur \*Mononykus olecranus\* \(Alvarezsauridae\)](#).
- [Tracking 'transitional' diadectomorphs in the earliest Permian of equatorial Pangea](#).

## Mining and Energy

- Ore geology: [3D Geophysical Modeling Based on Multi-Scale Edge Detection, Magnetic Susceptibility Inversion, and Magnetization Vector Inversion in Panjshir, Afghanistan to Detect Probabilistic Fe-Polymetallic Bearing Zone.](#)
- More ore geology: [Geology of the Nautanen North Cu-Au-Ag-\(Mo\) Deposit, Norrbotten, Sweden.](#)
- Use more child slave labour: [China's Plan for Flooding the Market with Cobalt.](#)
- [Do you know where your critical minerals are coming from?](#)
- Price drop in platinum group metals: [Anglo American preps sweeping cost cuts as price rout bites](#); and....[Anglo American shares plunge after production cuts.](#)
- Pretty Shiny Things: [The Diamond Crack-Up – Russia And The African States Defeat US-EU-Israeli Plan To Drive Russian Diamonds Out Of The Market.](#)
- [Can OPEC+ Boost Oil Prices Next Year?](#)
- [Growing U.S. Oil Exports Put Lasting Pressure on Prices](#); related [U.S. Cements Position as Energy Superpower with Soaring Oil Exports.](#)
- Geopolitics and oil: [On Point: Oil War in South America: Venezuela's Maduro Threatens Guyana.](#)
- Nigeria: [Africa's Largest Oil Refinery Moves Closer to Start-up.](#)
- [The United States begins the winter with the most natural gas in storage since 2020.](#)
- [U.S. Drillers Add Oil and Gas Rigs for Fourth Week in a Row – Baker Hughes.](#)
- [Business Leaders Blast Ottawa's 'Unnecessary and Unacceptable' Oil and Gas Emissions Cap – Framework is Effectively a Cap on Production.](#)
- [Shidaowan: world's first fourth-generation nuclear reactor begins commercial operation on China's east coast.](#)
- [COP28's Shiny New Toy: Nuclear Sector Must Overcome Decades of Stagnation to Meet COP28 tripling Goal.](#)

## Environmental Geology and Hydrogeology

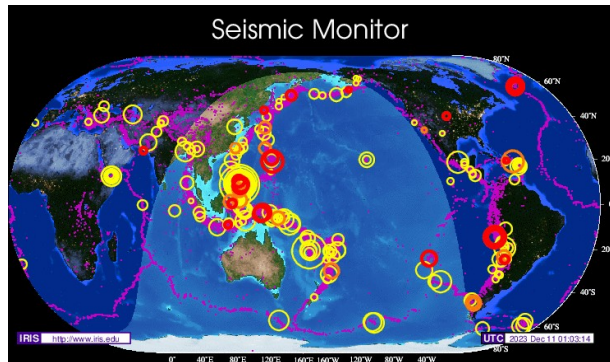
- Tracking plastic waste in the oceans: [Hyperspectral reflectance of pristine, ocean weathered and biofouled plastics from a dry to wet and submerged state.](#)
- Nuclear waste disposal research: [Phyllite/bentonite mixture—an alternative effective buffer material for a geological disposal of radioactive waste.](#)
- [Carbon capture in the Great Artesian Basin risks 'greatest environmental asset', farmers say.](#)

- [Extensive freshened groundwater resources emplaced during the Messinian sea-level drawdown in southern Sicily, Italy](#); Phys.org summary [here](#).

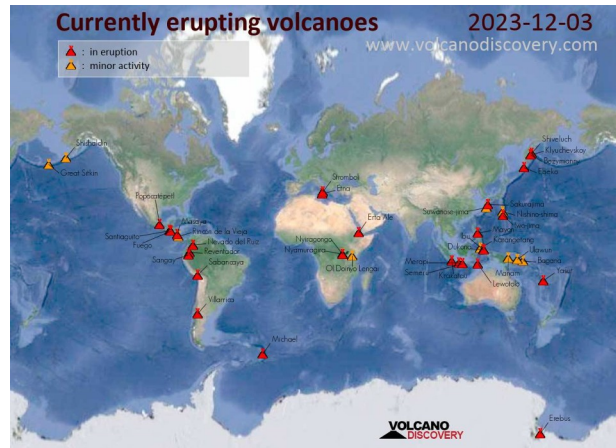
## Glaciers and Climate Change

- Long term climate change: [Toward a Cenozoic history of atmospheric CO<sub>2</sub>](#); Phys.org summary [here](#).
- [Global Carbon Budget 2023](#).

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- United States Geological Survey (USGS) Volcano Watch: [Opportunities to learn about the volcanoes in your backyard in January 2024](#); if you're visiting Hawaii.
- USGS Yellowstone Volcano Observatory: [The Big Buttes of the Eastern Snake River Plain](#).
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- Volcano research, Pacific Northwest: [A 6.2 Ma-Long Record of Major Explosive Eruptions From the NW Pacific Volcanic Arcs Based on the Offshore Tephra Sequences on the Northern Tip of the Emperor Seamount Chain](#).
- Deliberately making an earthquake: [Active-Source Seismic Imaging of Fault Re-Activation and Leakage: An Injection Experiment at the Mt Terri Rock Laboratory, Switzerland](#).
- More on inducing earthquakes: [The physical mechanisms of induced earthquakes](#).
- More earthquake research: [Direct assessment of the hydraulic structure of the plate boundary at the toe of the Nankai accretionary prism](#).
- [M5.8 earthquake shakes Mexico City](#); USGS summary [here](#).
- [Active earthquake fault line found in Elk Lake area on Vancouver Island](#).

December 11, 2023

## Geology and the Fate of Societies – Burma (Myanmar)



Located in [Southeast Asia](#), the Republic of the Union of [Myanmar](#), is the next on the list for our examination of the geology and geopolitics of individual countries. Until 1989 the country was known as Burma and the [American State Department](#) still calls it Burma (Myanmar). The reasons for the two names have to do with the history of the country and the conventions of the [Burmese language](#). Rather than delve into the whole story here, check out [this website](#) if the subject interests you. For this posting, I will use the term Burma (Myanmar).

Going counterclockwise and starting on the southeast the countries surrounding Burma (Myanmar) are: [Thailand](#), [Laos](#), [China](#), [India](#), and [Bangladesh](#). West of Burma (Myanmar) are the [Bay of Bengal](#) and the [Andaman Sea](#) both of which are part of the larger [Indian Ocean](#).

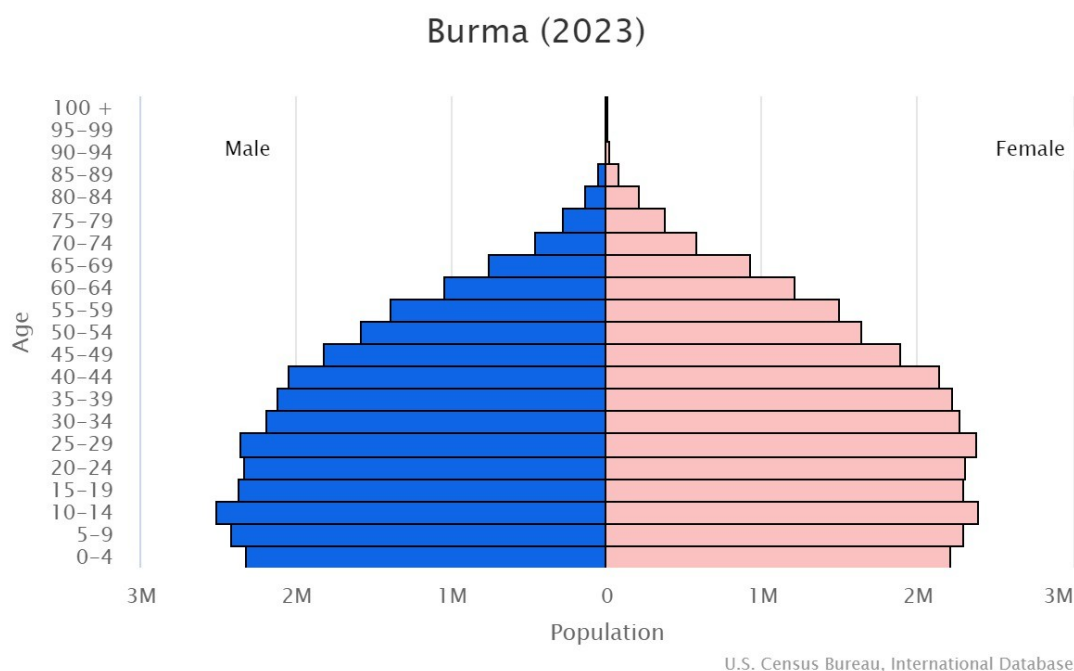
The [CIA World Factbook](#) on Burma (Myanmar) estimates their population at 57,970,293. Of that, 68% are ethnic [Burmese](#) (Bamar); of the rest, 9% are [Shan](#), 7% are [Karen](#), 4% are [Rakhine](#), 3% are [Chinese](#), 2% are [Indian](#), 2% are [Mon](#), and 5% other. Not officially recognized are the approximately 1.5 to 2 million [Rohingya](#) who mostly lived in [Rakhine State](#) many of whom were driven out in what can only be described as [ethnic cleansing](#). The languages spoken in Burma (Myanmar) mirror the ethnic composition with Burmese as the official language and more than a hundred languages among the various ethnic groups including [Chin](#), [Kachin](#), [Karen](#), [Kayah](#), [Mon](#), [Rakhine](#), and [Shan](#).

Figure 1 – Burma (Myanmar)

Credit: [CIA World Factbook – Burma \(Myanmar\)](#), public domain

Among the people living in Burma (Myanmar) [Buddhism](#) is the predominate religion with 87.9% of the population. Among the others: 6.2% are [Christian](#), 4.3% are [Muslim](#), 0.8% follow [Animist](#) beliefs, 0.5% are [Hindu](#), and the remaining 0.3% other or none.

The demographic profile of Burma (Myanmar) is interesting, indicating drop in fertility rates, possibly as [the result of urbanization](#).



**Figure 3 – Demographic Profile of Burma (Myanmar)**

**Credit: [United States Census Bureau, International Database, Burma \(Myanmar\)](#), public domain**

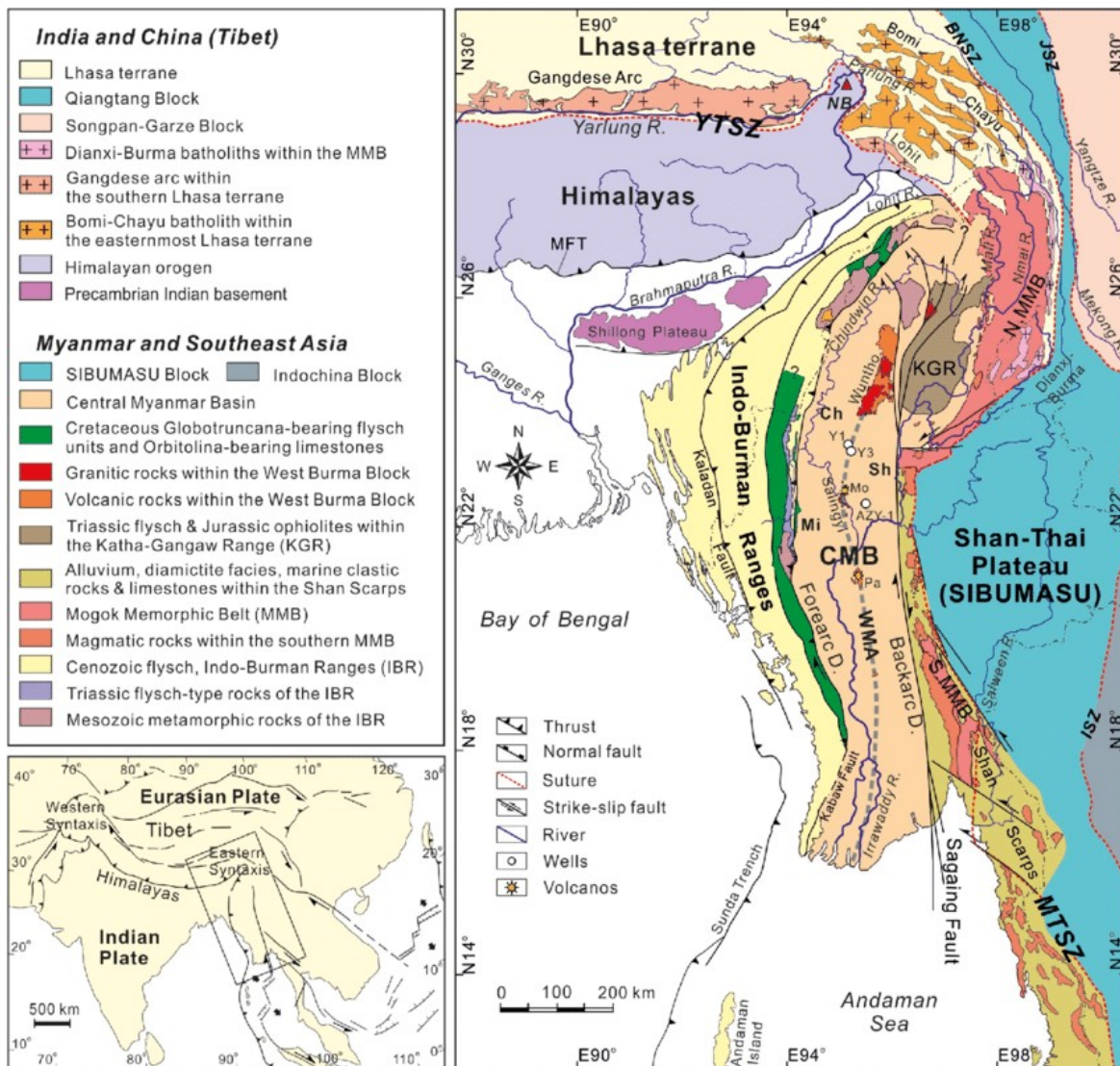
The Capital City of Burma (Myanmar) is [Nay Pyi Daw](#), population 1,160,242, located roughly in the centre of the country. The largest city in the country is [Yangon](#) (formerly Rangoon), population 5,160,512. Other large centres of population include: [Mandalay](#), population 1,225,546; [Bago](#), 491,434; [Hpa-An](#), 421,575; [Taunggyi](#), 381,636; [Monywa](#), 372,095; [Myitkyina](#), 306,949; and [Mawlamyine](#), 289,388.

Burma (Myanmar) is currently ruled by a [military junta](#) led by President [Myint Swe](#) who took power in a [coup d'etat on February 1, 2021](#).

## Geology

The [geology of Burma \(Myanmar\)](#) is fairly complex but can be divided into three main geological provinces:

- The [Indo-Burman Ranges](#);
- The [Central Myanmar Basin](#); and
- The [Shan-Thai Plateau](#)



Simplified geological map of Myanmar and the Eastern Himalayan syntaxis, showing major terranes, terrane boundaries, geological units and major modern rivers (modified after Mitchell et al., 2012 and Robinson et al., 2014). YTSZ, Yarlung-Tsangpo Suture Zone; BNSZ, Bangong-Nujiang Suture Zone; JSZ, Jinsha Suture Zone; ISZ, Inthanon Suture Zone; MTSZ, Meso-Tethys Suture Zone; NB, Namche Barwa; STD, South Tibet Detachment; MCT, Main Central Thrust; MBT, Main Boundary Thrust; MFT, Main Frontal Thrust; Sh, Shwebo subbasin; Ch, Chindwin subbasin; Mi, Minbu subbasin; CMB, Central Myanmar Basin; WMA, Western Myanmar Arc; Pa, Mt. Popa; Mo, Mt. Monywa.

Figure 2 – Simplified geological map of Burma (Myanmar)

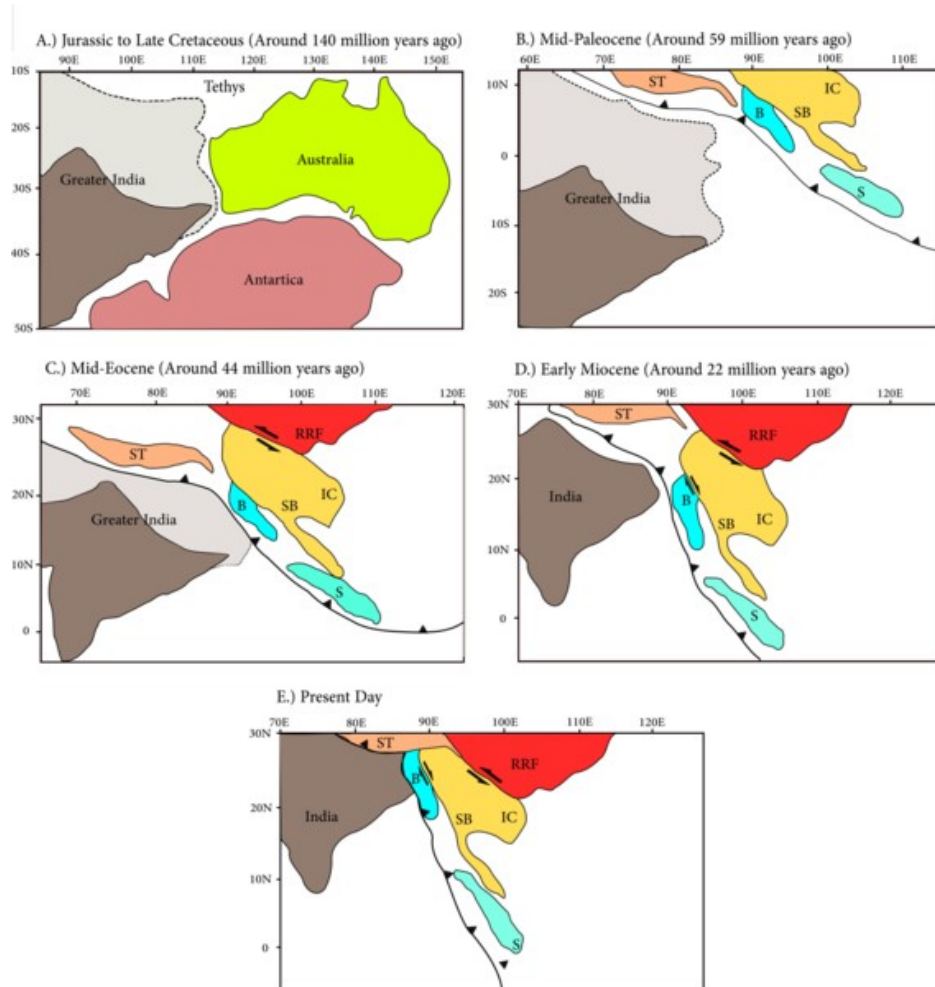
Credit: Figure 9 in Zhang et al, 2019, CC BY 4.0

The geological features of Burma (Myanmar) were formed as the result of the [Himalayan Orogeny](#) where the [Indian Plate](#) moved north into the [Eurasian Plate](#) and squeezing the [Burma Plate](#) into the [Sunda Plate](#) (Southeast Asia) as follows:

- The [Gondwana Supercontinent](#) began [rifting](#) beginning in the [Jurassic](#) and continuing into the [Late Cretaceous](#);

- b) By the middle of the [Paleocene](#), around 59 million years ago (Mya) India and Southeast Asia began their "soft collision";
- c) India and Southeast Asia began their start of "hard collision" during the middle of the [Eocene](#), around 44 Mya;
- d) During the [Miocene](#), India, South Tibet and Burma collided; the Burma Plate and Shan-Thai Plateau then rotated clockwise to the present position.

Figure 3 shows this tectonic evolution graphically.



**Legend**

- ST=South Tibet
- IC=Indochina
- RRF=Red River Fault
- B= Burma Plate
- S=Sumatra
- SB= Shan-Thai Plate

**Figure 4 – Geological Evolution of Myanmar**

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

As I pointed out before, the geology of Burma (Myanmar) is complex and if you want more details, follow up with some the links provided starting with the Wikipedia summary [here](#).

## Resources

### Agriculture



**Figure 5 – Rice Paddies in Rural Myanmar**

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

[Agriculture in Burma \(Myanmar\)](#) is the major activity of most people living in the country; about 65% of the population is employed in food production. The major crops include

- rice,
- corn (maize),
- pulses (beans and lentils),
- peas, onions,
- groundnuts (peanuts),
- sugarcane,
- oil seeds (sesame and [niger seeds](#))
- together with various spices (coriander, ginger, turmeric, red chili).

Major livestock types are cattle, water buffalo, goats, sheep, oxen, chickens, and pigs. Fishing is also a major source of food. You can find the statistics on food production in Burma (Myanmar) [here](#).

Although Burma (Myanmar) has very productive agriculture, food insecurity exists. According to the [World Food Program](#), political instability and bad weather (e.g. [Cyclone Mocha](#) in 2023) has exacerbated

existing [food security problems](#), especially in Rakhine State where the government is persecuting the Rohingya population.

### *Forestry*



**Figure 6 – Teak Logs in the Irrawaddy River**  
**Credit: [Anne-Carole Fooks](#), [public domain](#)**

Burma is a major supplier of teak to the world market; by the end of 2020, the number of teak trees in Burma (Myanmar) [amounted to approximately 45.6 million](#). Other forest products include bamboo and ironwood. Burma appears to be [harvesting their forest resources responsibly](#), planting as many, or more, trees than are harvested.

### *Mineral Resources*



**Figure 7 – Yenangyaung Oil Wells, 1910**  
**Credit: [Arnold Wright](#), [public domain](#)**

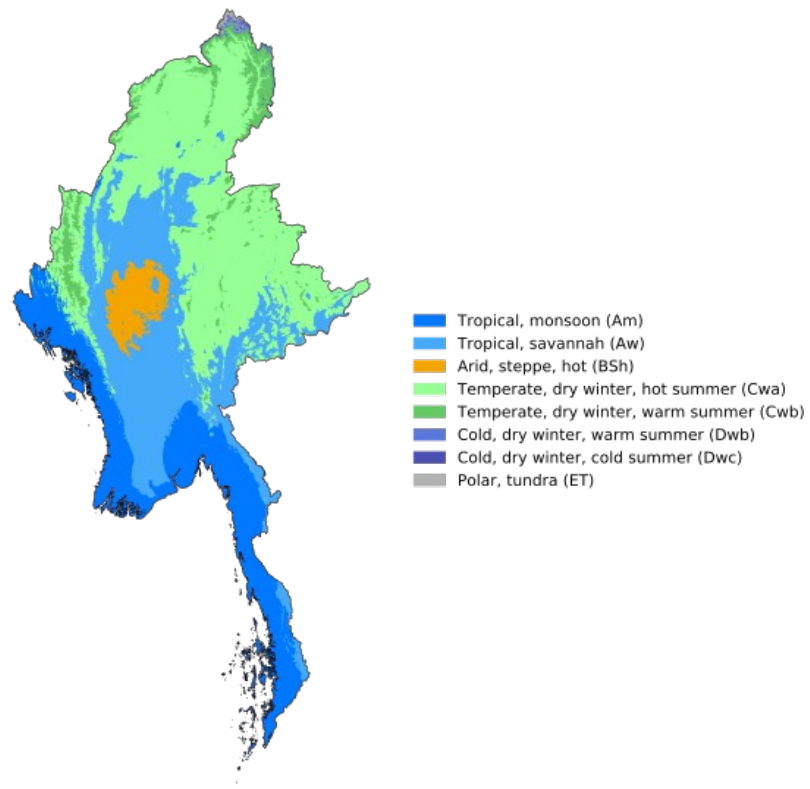
Burma (Myanmar) is rich in many mineral resources including gold, rare earths and tin. Fossil fuel production includes coal, natural gas and petroleum. [Statistics for production of these minerals in 2019](#) were:

- gold – 250 kg
- rare earths – 25,000 tonnes
- tin – 42,000 tonnes
- coal – 1,941,558 tonnes lignite and 11,704 coke
- natural gas – 18,800 million cubic metres
- petroleum – 3,059,000 barrels

The USGS discussion on the mineral industry of Burma (Myanmar) is [here](#).

## Climate

Köppen-Geiger climate classification map for Myanmar (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 8 – Köppen-Geiger Climate Map for Burma (Myanmar)**

**[Credit: from Figure 1 in Beck et al, 2020, Creative Commons](#)**

**[Attribution-Share Alike 4.0 International license](#)**

As a mountainous country, the [climate in Burma \(Myanmar\)](#) varies with elevation and distance from the sea. On the highest peaks, there is a [tundra climate](#), and, going down slope, we find cold climates ([Dwb](#) and [Dwc](#)). Below the high mountains are dry-winter subtropical climates ([Cwa](#) and [Cwb](#)). In the north central area of the country is an area of hot, arid, steppe ([Bsh](#)) while towards the west, near the Bay of Bengal and Andaman Sea, are tropical savanna and tropical monsoon climates ([Aw](#) and [Am](#)).

If you plan to visit Burma (Myanmar) you might want to visit [this site](#) and [this site](#). Given the troubles in the country, it's a risky place visit.

## History and Geopolitics

### *A Complicated History*



One can summarize the [history of Burma \(Myanmar\)](#) in as follows:

- [Prehistory](#);
- The [Pyu city-states](#), ~2<sup>nd</sup> Century BC to ~9<sup>th</sup> Century AD;
- The [Mon Kingdoms](#) in Lower Burma, ~6<sup>th</sup> to 9<sup>th</sup> Century AD;
- The [Pagan \(or Bagan\) Kingdoms](#), 849–1297
- An interregnum that included many small kingdoms, and the intrusion of the [Mongols](#) and [Shan](#) peoples;
- The [Ava Kingdom](#), 1364–1555;
- The [Hanthawaddy Pegu](#), 1287–1539, 1550–52;
- The [Shan States](#), 1287–1563;
- The [Arakan State](#), 1287–1785;
- The [Toungoo dynasty](#) (1510–1752)
- The [Konbaung dynasty](#) (1752–1885)
- The [Anglo-Burmese wars](#);
- [British Burma](#), 1886 – 1948;
- Independent Burma: [1948 – 1962](#); [1962 – 1988](#), the [1988 Uprising](#), the [State Peace and Development Council](#), 1990 – 2006, the [2007 Saffron Revolution](#), political reforms [2011–2015](#), on-going troubles [2021](#) and civil war [2022 to present](#).

Figure 10 – The Great Kingdom of Arimadranapure, Circa 1210 AD, [Credit: Hybernator, Creative Commons Attribution-Share Alike 3.0 Unported license](#)

It is a complex history and there are many interesting features and personalities. So you might want to follow up on the links provided for more information. For a good description of the Pagan / Bagan Kingdoms, you also could listen to Paul Cooper's [podcast on the Bagan Empire](#). If you like poetry, Rudyard Kipling wrote a [poem on the experiences of a British soldier](#) during the Anglo-Burmese wars.

### *Geopolitics – A Troubled Present*



**Figure 11 – Protest Sign, February 8, 2021**

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

The history of Burma (Myanmar) in recent years [has been troubled](#), to say the least. An unhappy land, it has many internal problems:

- Many of the non-Burmese ethnic groups, such as the Shan, are in [open revolt](#) against the central government;
- [Refugees from the conflict](#) are creating a humanitarian crises;
- The central government's own army is [buckling under the strain of the conflict](#) in the Shan territories;
- Burmese in the major cities [continue to protest](#) against their government, so far peacefully;
- People within the ruling junta have been [sponsoring and profiting from the trade in illegal drugs](#);

These internal problems have implications for the neighbours of Burma (Myanmar):

- China, India, Thailand, Laos and Bangladesh are unlikely to want to see more [refugees fleeing Burma \(Myanmar\)](#) into their countries.
- [China](#) and [India](#), as the two great powers in the region, are unlikely to look favourably on continued disorder in Burma (Myanmar);
- The drug trade is a public health menace in the countries where the junk is sold; besides the problems with drug addiction, the use of intravenous drugs spreads fatal diseases such as [HIV/AIDS](#) and [Hepatitis B](#).
- In the wider world: countries such as [Canada](#), the states of the [European Union](#), the [United Kingdom](#), and the [United States](#), have imposed sanctions on the ruling junta of Burma (Myanmar) because of their treatment of the Rohingya people and other human rights abuses.

The 2021 coup d'état and subsequent disorder has [complicated the geopolitics of Southeast Asia](#). Both [China and India are competing](#) for influence with the government of Burma (Myanmar). So far, the military junta is leaning towards the Chinese, and, indeed, [are relying on them for support](#). However, despite, or perhaps because of China's help, the problems in [Burma \(Myanmar\) continue to grow](#). Meanwhile, India is finding the disorder in Burma (Myanmar) [a threat to their own stability](#).

So where does this end? Disorder has a way of growing dangerous to the neighbours and the temptation to intervene to settle the problem must be great. If India intervenes, it will almost certainly trigger a war with China. On the other hand, the Chinese could intervene directly, should the ruling junta in Burma (Myanmar) prove to be a dangerous embarrassment. The Indians, or indeed anyone else, are unlikely to go to the aid of the junta, but they might be tempted to "help" the Chinese stabilize the situation. Whatever happens, there is great deal of danger in the situation.

That kind of wraps up this short look at Burma (Myanmar). As I have already mentioned, if any of this interests you, follow up on the links for a start.

## 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.