

January 8, 2023

## News and notes

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

## Research

- [Plate tectonics in the Archean: Observations versus interpretations](#); behind a paywall, Phys.org summary [here](#).
- Mineralogy and petrology: [Rock magnetic analyses as a tool to investigate diversity of drift pumice clasts: An example from Japan's 2021 Fukutoku-Oka-no-Ba \(FOB\) eruption](#).
- [Phanerozoic Burial and Erosion History of the Southern Canadian Shield from Apatite \(U-Th\)/He Thermochronology](#).
- [Petrogenesis and Tectonic Evolution of Huashigou Granitoids in the South Qilian Orogen, NW China: Constraints from Geochronology, Geochemistry, and Sr–Nd–Hf–O Isotopes](#).
- Ancient climate change: [Pre-Cenozoic cyclostratigraphy and palaeoclimate responses to astronomical forcing](#); sorry, behind a paywall.
- Geophysics and geopolitics: [The 26 September 2022 Nord Stream Events: Insights from Nearby Seismic Events](#); Phys.org summary [here](#).
- Groundwater: [Assessing Global Reservoir-Based Hydrological Droughts by Fusing Storage and Evaporation](#).
- Glaciers: [A glacial chronology for sub-Antarctic Marion Island from MIS 2 and MIS 3](#).
- Ocean system research: [Deep Atlantic Multidecadal Variability](#).

## Sedimentology

- [Storm-driven sedimentation and dynamics of a sediment slug in an ephemeral stream: Influence on sediment-routing systems within source](#).
- [Sedimentary environment and benthic oxygenation history of the Upper Cretaceous Austin Chalk Group, south Texas: An integrated ichnological, sedimentological and geochemical approach](#).
- [Origin of Redbeds in the Neoproterozoic Socheong Formation and Their Relation to the Dashigou Large Igneous Province](#).

## Paleontology

- [T. rex teeth to headbutting dinosaurs: Fossil finds of 2023](#).
- [Taxonomic Status of \*Nanotyrannus lancensis\* \(Dinosauria: Tyrannosauroidae\) - A Distinct Taxon of Small-Bodied Tyrannosaur](#); Phys.org summary [here](#).

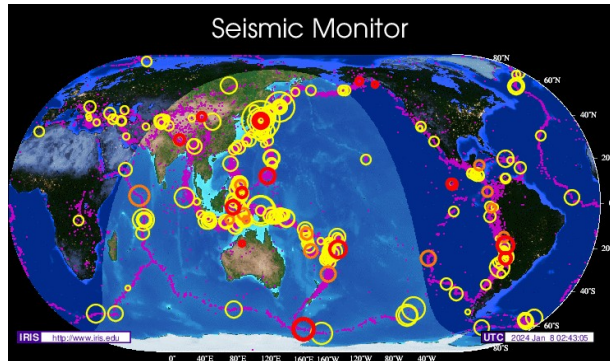
- Extinction research: [Contingency, repeatability, and predictability in the evolution of a prokaryotic pangenome](#); Phys.org summary [here](#).
- Not on [Arrakis](#), giant predatory worms,: [A giant stem-group chaetognath](#); Phys.org summary [here](#).
- England: [Colossal pliosaur sea monster skull on display in Dorset](#).
- Evolution of photosynthesis: [Oldest thylakoids in fossil cells directly evidence oxygenic photosynthesis](#); Phys.org summary [here](#).
- [U. Sask. student challenging perception of dinosaurs with 'paleoart'](#).
- Whip scorpion: [Description of a new fossil Thelyphonida \(Arachnida, Uropygi\) and further record of \*Cratosolpuga wunderlichi\* Selden, in Selden and Shear, 1996 \(Arachnida, Solifugae\) from Crato Formation \(Aptian/Albian\), Araripe Basin, Brazil](#)

## Mining and Energy

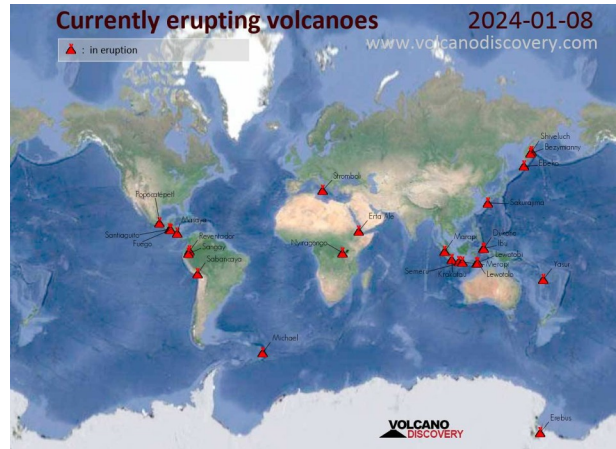
- Illegal aggregate mining: [Sand Mafias Battle for the New Gold](#).
- [Core Lithium halts mining on "tough" market conditions](#).
- [Regional rare-earth element supply and demand balanced with circular economy strategies](#).
- [Copper mine advances near Michigan's Porcupine Mountains](#).
- [Endeavour Mining says it fired CEO for 'serious misconduct'](#).
- [Tech Trade War Looms as China Restricts Rare Earth Exports](#).
- [Copper price rises on positive factory data in China](#).
- [Chinese Group Becomes No. 1 Cobalt Producer on DRC Output Hike](#).
- [Condor Resources, Teck team up at Cobreorco copper-gold project in Peru](#).
- [Uranium price hits new post-Fukushima high](#).
- [U.S. Now World's Largest LNG Exporter](#).
- National Post: [Aboriginal oilman aims to take lead on resource development: 'We cannot live in soft communism'](#).
- U.S. Energy Information Administration: [Brent crude oil prices averaged \\$19 per barrel less in 2023 than 2022](#).
- Petroleum geology: [Biomarker and isotopic characteristics of Miocene condensates and natural gases, West Delta deep marine concession, Eastern Mediterranean, Egypt](#).
- [Canada's Energy and Mining Sectors Poised for M&A Surge in 2024](#).

- [The Implications of Ontario’s Historical Oil and Gas Drilling and Abandonment Practices for Abandoning Orphan and Legacy Wells](#); article is in the PDF link.

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- United States Geological Survey (USGS) Volcano Watch: [Separating signals: What matters to seismologists?](#)
- USGS Yellowstone Volcano Observatory: [The Yellowstone Volcano Observatory reviews 2023 – the year that was!](#)
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- Volcano and earthquake research: [Seismic Velocity Variations Observed Prior to the La Palma Volcano Eruption on 19 September 2021, in Cumbre Vieja, Canary Islands \(Spain\)](#).
- Noto Peninsula, Ishikawa Prefecture, Japan:
  - From the Japan Meteorological Agency: [Information related to the 2020 Noto Peninsula Earthquake](#);
  - [M7.5 earthquake strikes western Japan, triggers tsunami](#);
  - [Tectonics of the January 1, 2024 M7.5 earthquake in Japan](#);
  - USGS summary [here](#).
- From Judith Hubbard: [Earthquake Insights Digest – Jan 4, 2024](#).
- Earthquake research: [A systematic scheme to develop dynamic earthquake rupture scenarios: a case study on the Wenchuan–Maoxian Fault in the Longmen Shan, China, thrust belt](#).
- More earthquake research: [Kinematic Afterslip Patterns](#).

January 8, 2023

## Geology and the Fate of Societies – Cambodia

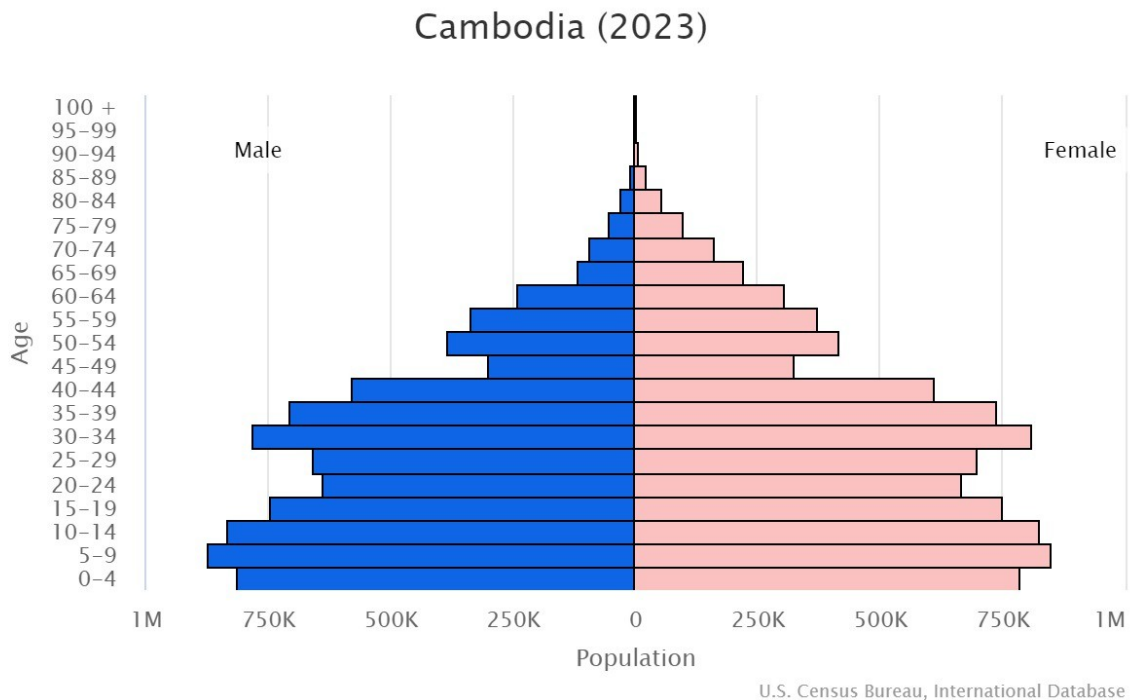


Figure 1 – Cambodia

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

The Kingdom of [Cambodia](#) (Preăh Réachéanachâkr Kâmpŭchéa in the [Khmer language](#)) is a country in [Southeast Asia](#) and the next on our [list](#) of countries that we are looking at in our examination of the geology and geopolitics of individual states. The countries surrounding Cambodia are, going clockwise, [Thailand](#), to the northwest; [Laos](#), to the north; and [Vietnam](#), to the east. According to the American [Central Intelligence Agency](#) (CIA) [World Factbook](#) on the country, Cambodia has a total area of 181,035 square kilometres (km<sup>2</sup>) of which 176,515 km<sup>2</sup> are land and 4,520 km<sup>2</sup> are water. To the southwest, Cambodia has an ocean boundary on the [Gulf of Thailand](#).

Also according to the [CIA factbook](#), 16,891,245 people live in Cambodia. Of these almost 17 million people, 95.4% are ethnic [Khmer](#); among the remainder, 2.4% are ethnic [Cham](#), 1.5% are ethnic [Chinese](#) and the remaining 0.7% are other ethnicities including 0.5% [Vietnamese](#). Most people in Cambodia, 95.8%, speak Khmer as their native language. Other languages used in Cambodia include 0.6% Chinese ([Teochew](#), [Cantonese](#), [Hokkien](#), [Hainam](#), [Hakka](#), [Standard Chinese](#)); 0.5% [Vietnamese](#); and 0.2% other. Almost all Cambodians, 97.1%, are Buddhist; the rest are Muslim 2%, Christian 0.3%, and unspecified other 0.5%.



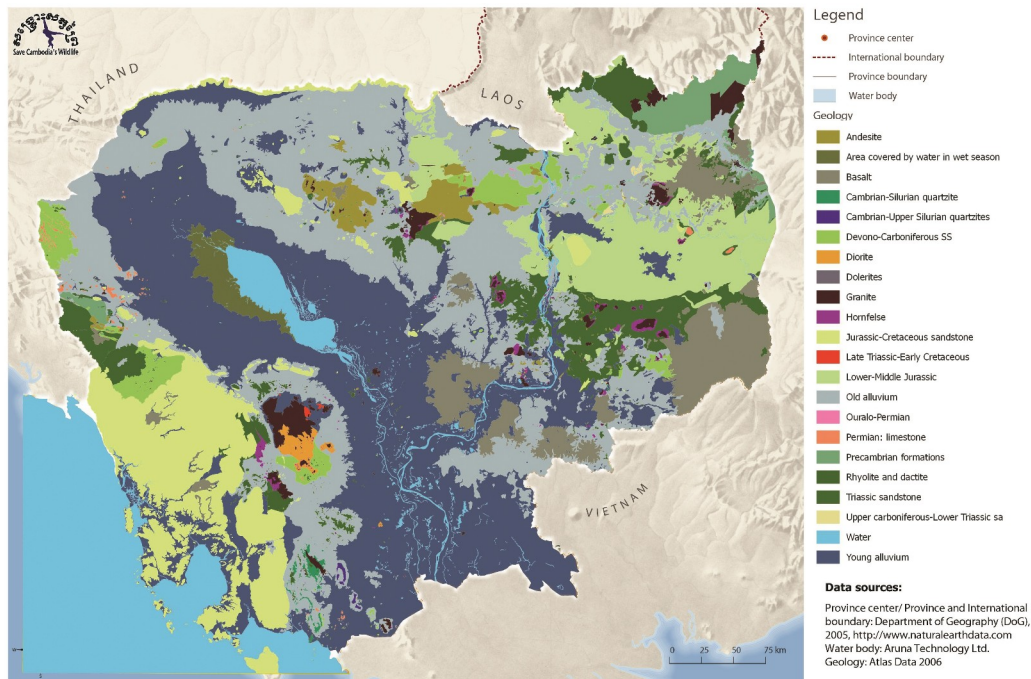
**Figure 2 – Demographic Profile of Cambodia**  
**Credit: [United States Census Bureau, International Database](#), public domain**

The demographic profile of Cambodia shows the effects of the [genocidal policies](#) carried out by the [Khmer Rouge](#) in the late 1970's as well as the consequent population re-bond. One result is that the population is mostly young.

Cambodia is a parliamentary [constitutional monarchy](#). The King of Cambodia is [Norodom Sihamoni](#) (crowned in 2004) and the Prime Minister is [Hun Manet](#). The parliament consists of an upper house called the [Senate](#) and a lower house called the [National Assembly](#); the President of the Senate is [Say Chhum](#) and the President of the National Assembly is [Khuon Sodary](#).

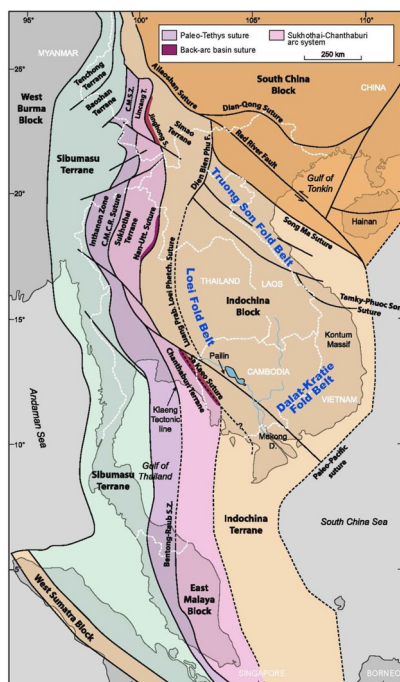
Although the structure of the Cambodian government is that of a parliamentary democracy, in fact, only a single party, the [Cambodian People's Party](#), has ruled the country since [current constitution](#) was adopted in 1993. Many of the officials running the country are former members of the [Khmer Rouge](#), including Prime Minister Hun Sen.

## Geology



**Figure 3 – Geological Map of Cambodia**  
**Credit: Open Development Cambodia, CC BY-SA 4.0**

As shown on Figure 3, the [geology of Cambodia](#) is fairly complex. One way to understand it is through the [tectonic history](#) of the country. Cambodia is situated on the [Indochina Terrane](#) in Southeast Asia which [rifted](#) northward from the northwestern part of the super-continent [Gondwana](#) during the [Middle Devonian](#). The Indochina Terrane is part of the [Sunda Plate](#) and is made up of a number of [tectonic fold belts](#).



As shown in Figure 4, there are two fold belts that underlie the more recent deposits in Cambodia:

- The [Loei Fold Belt](#), in the western part of the country; and
- The [Dalat-Kratie Fold Belt](#) in the eastern part of the country.

The Loei Fold Belt comprises the succession of pre-[Silurian](#) to Silurian [phyllite](#), [Devonian cherts](#) with layers of [shale](#) and [limestone](#), [Permian](#) fossiliferous limestone, chert, [sandstone](#) and [meta-rhyolitic](#) to [meta-andesitic tuffaceous](#) rocks.

The Dalat-Kratie Fold Belt is composed of a [Precambrian](#) basement, [Triassic–Cretaceous](#) sedimentary rocks, Cretaceous [granitic](#) rocks, and [Cenozoic](#) intraplate [basaltic](#) rocks.

**Figure 4 – Tectonic Map of Indochina**  
**Credit: Figure 1 in Shellnutt et al, 2023**

Overlying the fold belt deposits are sedimentary formations ranging in age from [Jurassic](#) to modern Cenozoic [alluvial](#) deposits, especially those associated with the [Mekong River](#).

## Resources

### *Agriculture*



**Figure 5 – Rice Harvesting in Cambodia**

**Credit: [Christine Zenino](#), [Creative Commons Attribution 2.0 Generic](#) license**

[Cambodian agriculture](#) is very productive to the point that they have, at times, been a major exporter of agricultural products. In 2018 they [exported](#) 4.2 million tons of agricultural products. Agriculture is largest part of the country's economy and employs the most people.

The major crop is [rice](#), called paddy in the official [statistical survey](#) from 2020 when the total national production was estimated at 4.68 million tonnes. Other staple crops included [maize](#), [cassava](#), [sweet potatoes](#), [groundnuts](#), [soybeans](#), [sesame seeds](#), and [beans](#). Fruit crops include [mangoes](#), [bananas](#), [custard apples](#), [dragon fruits](#), [durians](#), [guavas](#), [jackfruits](#), [jambolen plums](#), [longans](#), [milk fruits](#), [papayas](#) and [pineapples](#). Commercial crops include [rubber](#), [sugarcane](#), [cotton](#), and [tobacco](#).

The most important livestock production in Cambodia is for draft animals, [water buffalo](#) and [oxen](#), without which the rice crop is impossible. Animals raised solely for food are [hogs](#) and [chickens](#). The main source of animal protein in the Cambodian diet is from fish such as [perch](#), [carp](#), and [lungfish](#) that are

harvested from the numerous rivers and lakes in the country such as the Mekong River and the [Tonle Sap](#). A common use for fish is making the fermented fish delicacy called [prahok](#).

Despite its agricultural potential, Cambodia had at least [three major famines in the 20<sup>th</sup> century](#) all of which were the direct result of government mismanagement or deliberate genocide. As if that wasn't bad enough, since most farmers in Cambodia are [subsistence farmers](#), bad weather, such as the [current drought](#), can devastate agricultural production.

### *Forestry*



**Figure 6 – Mixed Bamboo and Semi-evergreen Forest in [Keo Seima Wildlife Sanctuary](#)  
Credit: [Pygathrix nigripes](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license**

[Forest in Cambodia](#) covers about 45% of the country. Cambodia officially [produced](#) around 813,000 m<sup>3</sup> of raw logs in 2020. While the state officially governs forestry, local use, with or without state sanction, continues to meet local needs for timber and charcoal. The result of the forest management has been a loss of forest cover – [approximately 2.2 million hectares of tree cover between 2001 and 2018](#). While there are [plans in place](#) to reverse the deforestation, the [realities of local community needs](#) may make this difficult.

### *Mineral Resources*



**Figure 7 – Quarry on Koh Rong Sanloem Island, Cambodia  
Credit: [Treehill](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license**

All current mineral production in Cambodia is for industrial minerals, here are the statistics for 2019 from the [USGS 2019 Minerals Yearbook for Cambodia](#)

- Cement, hydraulic.....7,870,000 tonnes
- Salt, sea salt.....30,000 tonnes
- Sand and gravel, industrial, silica.....1,050,000 tonnes
- Gravel, construction.....210,000 tonnes
- Unspecified.....37,000,000 tonnes
- Stone, crushed, .....24,000,000 tonnes

Cement production came mostly from the [Kampot Cement Co. Ltd.](#) (2.49 mt), [Battambang Conch Cement Co. Ltd.](#) (2.07 mt), [Chip Mong Insee Cement Corp.](#) (1.87 mt), and [Cambodia Cement Chakrey Ting Factory Co.](#) [Salt production](#) comes mostly from evaporation ponds in [Kampot](#) and [Kep](#) Provinces.

The government of Cambodia issued exploration leases for metallic minerals. There is a copper project at [Stung Treng Province](#). Gold projects include the [Phum Syarung Mine](#), [Okalla East and Okalla West](#) deposits, and the [Okvau Gold project](#).

Leases for petroleum exploration were issued to [KrisEnergy Ltd.](#) to develop the offshore Apsara oilfield, [however it failed to be profitable](#). The Cambodian government also issued leases to [EnerCam Resources Singapore](#) Pty to explore and develop petroleum the [Kampong-Som Basin](#).

## Climate

Cambodia map of Köppen climate classification

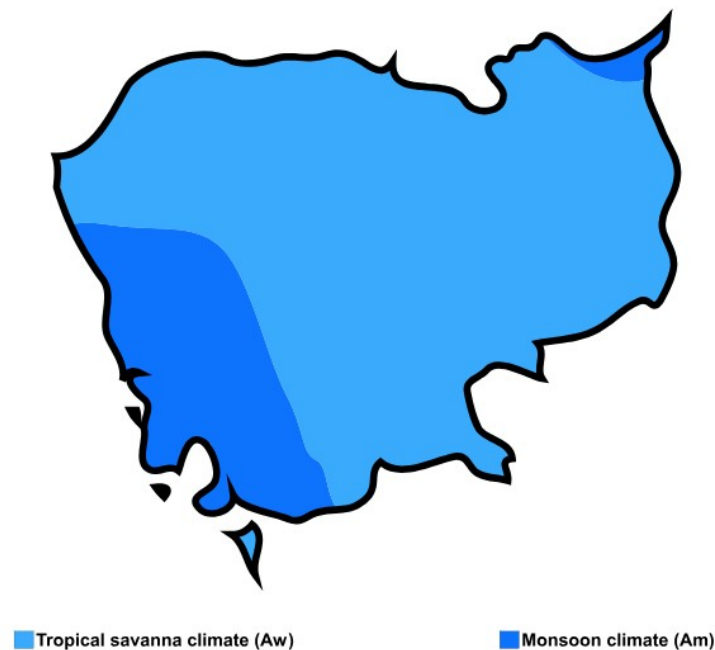


Figure 8 – Köppen Climate Classification Map for Cambodia  
Credit: [Ali Zifan](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

Cambodia has a hot tropical climate. Most of the country has a [tropical savanna \(Aw\)](#) climate whereas the southwest and extreme northeast has a [tropical monsoon climate \(Am\)](#). If you plan to travel to Cambodia, you might want to check out [this site](#), [this site](#) and [this site](#).

## History and Geopolitics

### *A History of Great Accomplishments and Great Tragedy*



**Figure 9 – Map of Southeast Asia ca. 900 CE, Showing the Khmer Empire, in red**  
**Credit: [Javierfv1212](#), [Creative Commons CC0 1.0 Universal Public Domain Dedication](#)**

The [history of Cambodia](#) is a long one. The following eras summarize its history:

- [Prehistory](#), from the [Paleolithic](#) to the 1<sup>st</sup> Century BC;
- The [Funan Kingdom](#), 1<sup>st</sup> Century BC to ca. 627 AD;
- The [Chenla Kingdom](#). 6th century to 802;
- The [Khmer Empire](#), 802 to 1431;
- The [Post-Angkor Period](#), 1431 to 1863;
- The [French colonial period](#), 1863 to 1953;
- The reign of [Prince Norodom Sihanouk](#), 1953 to 1970;
- [Civil War](#) and [Republic](#), 1970 to 1975;
- [Democratic Kampuchea](#) and the [Khmer Rouge genocide](#), 1975 to 1979;
- [Cambodian–Vietnamese War](#), 1977 to 1979;
- [Vietnamese occupation](#), 1979 to 1993
- The establishment of the [modern Cambodian state](#) in 1993 following the withdrawal of Vietnamese forces in 1989 and the conclusion of peace talks.

It's a fairly interesting history, with times of great accomplishment and also times of horrific tragedy. If you like podcasts, you might want to listen to Paul Cooper's excellent look at the [Khmer Empire of medieval Cambodia](#).

### *Geopolitics, Caught in the Middle of Many Problems*



**Figure 10 – Thailand / Cambodia Border 2006**

**Credit: [eric molina](#), [Creative Commons Attribution 2.0 Generic](#) license**

The main internal problem of Cambodia is persistent poverty; while they have made [great strides in reducing poverty](#), there will always be work to do in this area. On the United Nations Development Program [Human Development Index \(2021\)](#), Cambodia rates 146 Out of 191; fairly low on the list of poor countries.

Compounding the problems of poverty are the problems of governance. De-facto one party states like Cambodia are prone to problems with [corruption](#). Besides the simple problem that it is dishonest, corruption can be seen as a form of [malinvestment](#) that diverts capital away from its best use, thus actively preventing improvements in people's lives. Unfortunately, Cambodia scores poorly on measures of corruption: [Transparency International](#) rates Cambodia 157 out of 180 on its [Corruption Perceptions Index](#) (2021), pretty low down on the list.

Externally, Cambodia has a mixed relationship with its immediate neighbours. Cambodia's relationship with Thailand includes a shared cultural heritage going back to the [ancient Khmer Empire](#); this shared cultural heritage has led to some [cultural disputes](#). One observer calls the relationship between the two

countries as being one of [love and hate](#). We can hope that the two countries can learn from their shared heritage to [avoid future conflicts](#).

With regards to Vietnam, [Cambodia has a number of issues](#) including a border that has not been completely surveyed; ethnic Vietnamese migrants in Cambodia, and the hangover of resentments stemming from the 1979-1989 occupation of Cambodia by the Vietnamese Army. So far, they seem to be keeping the peace.

Further afield, Cambodia finds itself in the [Great Power competition](#) between [China](#) and the [United States](#). Since the end of the Vietnamese occupation, the current government has had a [close relationship with China](#), recently strengthened [by a visit between the two countries' leaders](#). Cambodia is deeply involved with China's [Belt and Road Initiative](#). [Cambodia's trade with China](#) mostly consists of Chinese imports into Cambodia, an unsustainable trade deficit. Cambodia may find itself an economic vassal of China, if these trends continue.

Cambodia's relationship with the United States is not so close. The United States claims a [good relationship with Cambodia](#) and is working to alleviate poverty in Cambodia. Given the [history of their relationship with United States](#), the Cambodians may prefer to keep the Americans at a distance.

That winds up this short look at Cambodia. Their history shows a remarkably gentle people with some episodes of absolutely horrible behaviour. Modern travellers remark on how [pleasant the people of Cambodia are](#), that they are often honest and hard working. This gives me hope for a better future for this country. Follow up in the links if anything in this post interests you further.

### **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.