September 11, 2023

News and notes

Before going on to discuss how geology has affected the fate of Belize, here are some news items I thought were interesting.

Humour

- Rock-solid geology puns that will make you erupt in laughter.

Research

- Plate tectonics: Himalayan valley-floor widths controlled by tectonically driven exhumation; Phys.org summary here.
- From Precambrian Research: Geochronology and chemostratigraphy of the 2.47–1.96 Ga rift-related volcano-sedimentary succession in the Karasjok Greenstone Belt, northern Norway, and its regional correlation within the Fennoscandian Shield.
- Mineralogy: Silica-water superstructure and one-dimensional superionic conduit in Earth's mantle; Phys.org summary here.
- Sedimentology and stratigraphy: Phanerozoic flooding of North America and the Great Unconformity.
- Geophysics: Modeling geomagnetic spikes: the Levantine Iron Age anomaly.

Paleontology

- New Zealand: Young boy and his dad make major fossil find in North Canterbury.
- Teen unearths 34 million-year-old whale skull on her family's Alabama timber farm.
- A new avialan theropod from an emerging Jurassic terrestrial fauna.
- We are only God's latest experiment in evolution: It's reassuring to think humans are evolution's ultimate destination – but research shows we may be an accident.
- Water dinosaurs? The ancient marine reptiles that inhabited the sea alongside 'real' dinosaurs.
- A 104-Ma record of deep-sea Atelostomata (Holasterioda, Spatangoida, irregular echinoids) – a story of persistence, food availability and a big bang; Phys.org summary here.
- Leaves and sporangia developed in rare non-Fibonacci spirals in early leafy plants; Sci Tech daily summary here.
- New theropod dinosaur from the Lower Cretaceous of Japan provides critical implications for the early evolution of ornithomimosaurs.
- The earliest evidence of deep-sea vertebrates.

Glaciers and Climate Change

- Melting of glacier ice enhanced by bursting air bubbles; Phys.org summary here.
- Going, going, gone: The final countdown? Monitoring the rapid shrinkage of the Maladeta glacier (2010–2020), Southern Pyrenees; Phys.org summary here.
- Stability inspection for West Antarctica shows marine ice sheet not destabilized yet, but may be on path to tipping; research articles here and here.
- Suppression of research: As a scientist, I'm not allowed to tell the full truth about climate change; related story: Top scientist Patrick Brown says he deliberately OMITTED key fact in climate change piece he's just had published in prestigious journal to ensure woke editors ran it - that 80% of wildfires are started by humans.

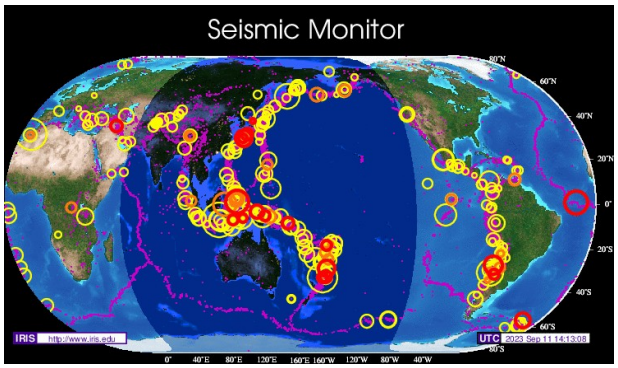
Environmental Geology and Hydrogeology

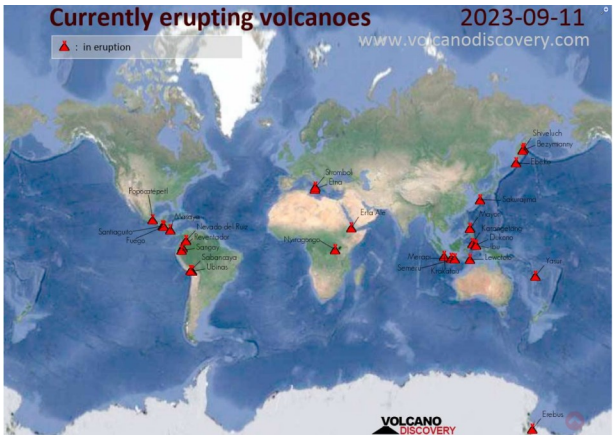
- Remediation: Regulator Yanks Thousands of Wells From Troubled Oil Company, Transfers For Cleanup.
- Drinking water quality and social vulnerability linkages at the system level in the United States; Phys.org summary here.
- Groundwater management: Africa's vast underground water resources are under pressure from climate change – how to manage them.

Mining and Energy

- Visualizing the World's Largest Lithium Producers; from Visualcapitalist.com
- Northwest Ontario: Lithium mine developer seals deal with a global battery customer.
- Lithium discovery in US volcano could be biggest deposit ever found.
- Copper mining project in Alaska: Northern Dynasty updates Pebble PEA, adds southern access route.
- Must have found some more child slaves: China's CMOC to boost Congo copper output after ending row with Gecamines.
- RANKED: Top gold producers of H1 2023.
- Visualizing Mining's Footprint in British Columbia.
- Pretty rocks: Alrosa says mines largest gem-quality diamond in Russia in a decade.
- How we chanced upon what may be the world's largest white hydrogen deposit.
- Russian Oil Shipments Skyrocketing.
- Exploration activity up: U.S. Drillers Add Oil Rigs for First Time Since June, Baker Hughes Says.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor **Active Volcano Map**

- USGS Volcano Watch: Tilt measurements still vital to volcano monitoring after more than a century.
- Smithsonian / USGS Weekly Volcanic Activity Report.
- Visit active volcanoes at your own risk: New Zealand judge dismisses charges against White Island volcano owners.
- Hunga Tonga–Hunga Ha'apai research: Fast and destructive density currents created by ocean-entering volcanic eruptions and Anatomy of a volcanic eruption undersea; both are behind a paywall; Phys.org summary here
- Volcano research: Bubble-enhanced basanite–tephrite mixing in the early stages of the Cumbre Vieja 2021 eruption, La Palma, Canary Islands.
- Volcano research: Hydrothermal signature on episodic deflation/inflation ground tilt at Aso Volcano.
- Volcanoes and geophysics: Delineation of shallow volcanic structures from audio-frequency magnetotelluric data beneath Ulleung Island, East Sea (Sea of Japan).
- Kilauea alert level elevated after new eruption spews fountains of lava at summit crater.
- Rescuers seek survivors from the Morocco earthquake that killed over 2,000; Judith Hubbard's posts on the earthquake here and here; USGS summary here.
- More from Judith Hubbard: M6.3 earthquake strikes below central Chile; USGS summary here.
- Wildfires: The US is spending billions to reduce forest fire risks – we mapped the hot spots where treatment offers the biggest payoff for people and climate.

September 11, 2023

Geology and the Fate of Societies – Belize

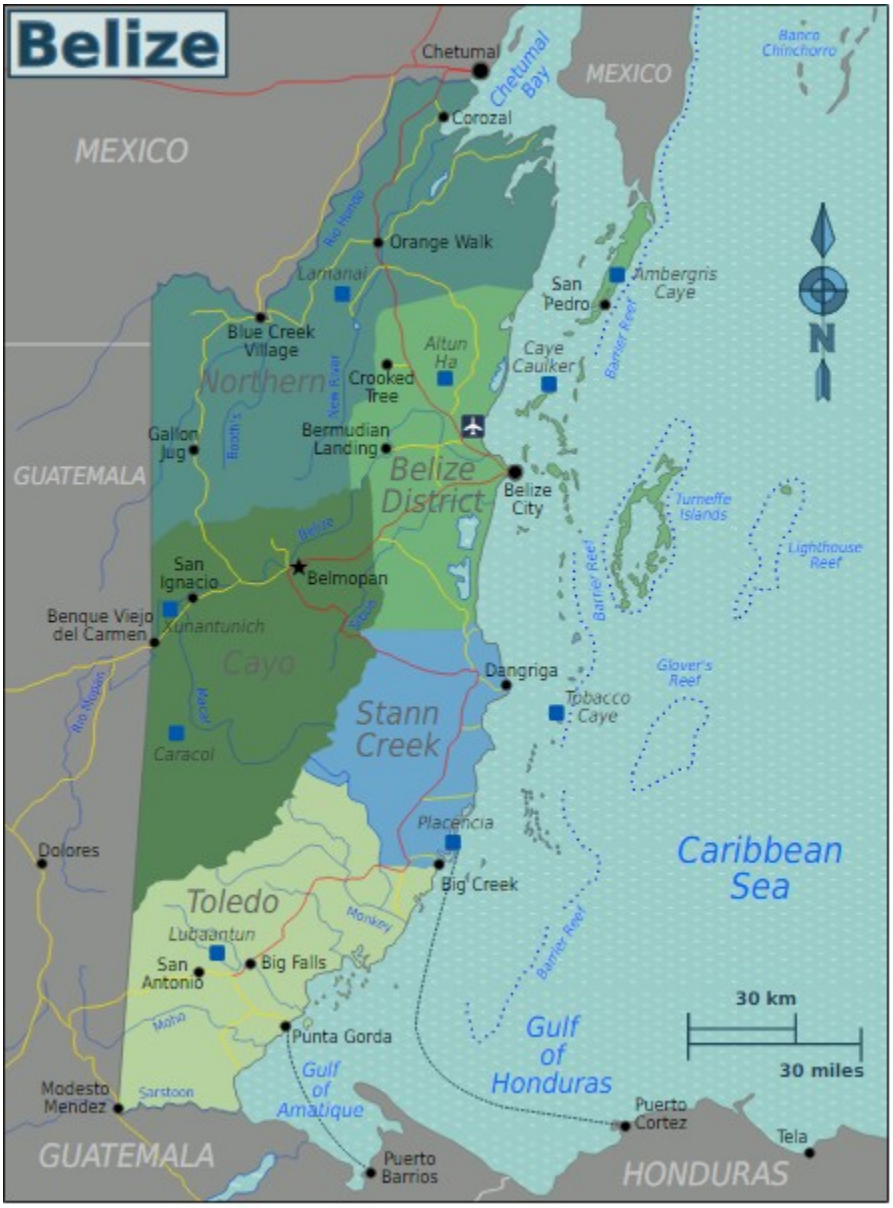


Figure 1 – Regional Map of Belize
Credit: Burmesedays, Creative Commons Attribution-Share Alike 3.0 Unported license

Belize lies on the east side of the Yucatan Peninsula. To the east if the Caribbean Sea. To the southeast, across the Gulf of Honduras, is the Republic of Honduras; to the south and west is Guatemala and to the northwest and north is Mexico. According to the United States Central Intelligence Agency World Factbook, the total area of Belize is 22,966 square kilometres (km^2), of which 22,806 km^2 is land and 160 km^2 is water.

The CIA World Factbook estimates the population of Belize at 419,137. The ethnic background of the country includes Mestizo (52.9%), Creole (25.9%), Maya (11.3%), Garifuna (6.1%), East Indian (3.9%), Mennonite (3.6%), White (1.2%), Asian (1%), other and unknown (1.5%). Some people identified with more than one group so the percentages add up to more than 100%. English is the official language although Spanish, Creole, Maya, German (mostly Mennonite Low German), and Garifuna are also spoken.

The capital city of Belmopan (pop. 13,939) and the largest city is Belize City (pop. 57,169). Belize is a parliamentary democracy within the British Commonwealth. The Head of State is King Charles III, the King is represented in Belize by Governor General Dame Froyla Tzalam and the current Prime Minister is John (Johnny) Briceño. They must be doing something right since Belize has been ranked as one of the happiest countries in the world.

Geology

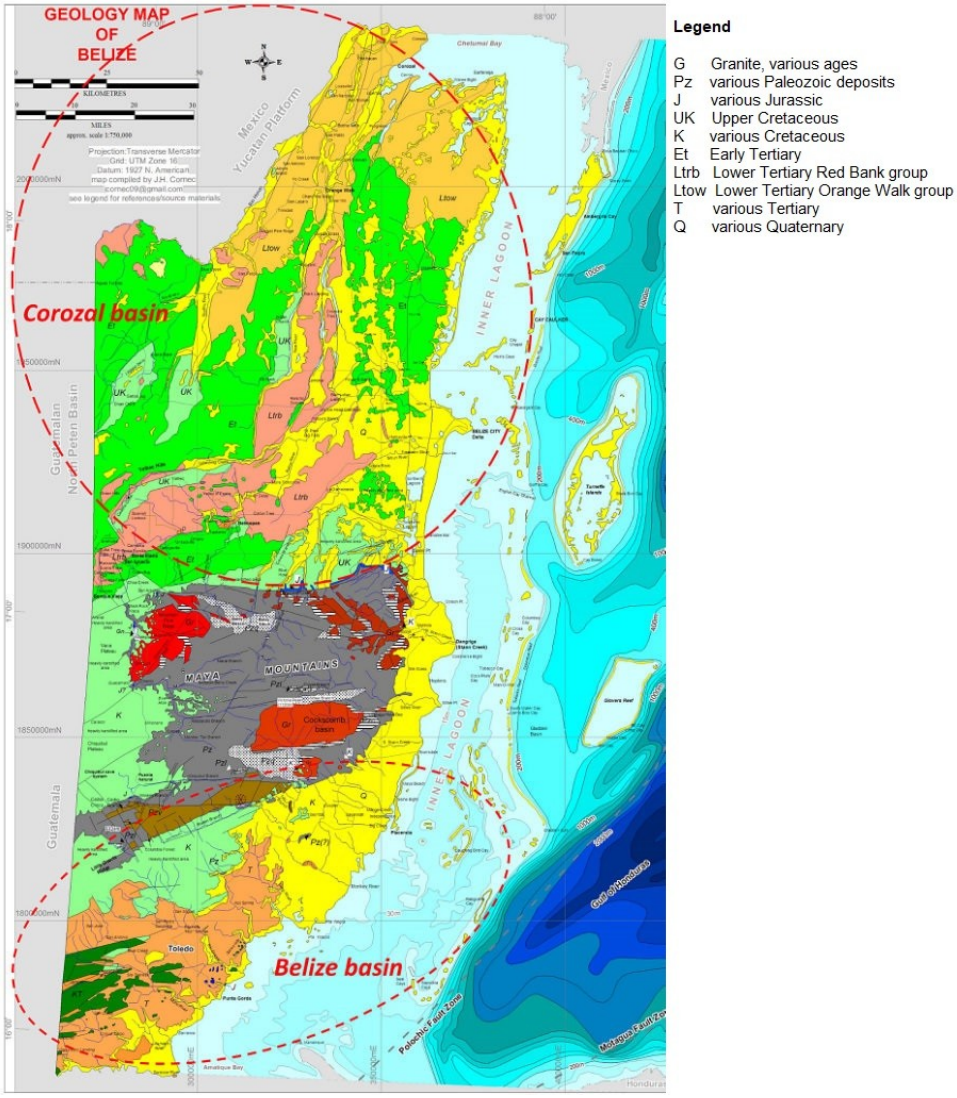


Figure 2 – Geology Map of Belize
Credit: based upon Geology Map of Belize, Ministry of Economic Development

Belize sits on the southern edge of the North American Plate near the boundary with the Caribbean Plate and the Cocos Plate. The boundary between the North American and Caribbean plates is the a transform or strike-slip boundary that runs from the border area Belize, Guatemala (Motagua Fault) and Honduras. The boundary between the North American and the Cocos Plate is a subduction zone.

We can summarize the geological history of Belize as follows:

- Maya Block basement formation started during the Grenville orogeny, Calymmian to Tonian;
- Pangaea started to rift during Middle Triassic to the Early Jurassic;
- Gulf of Mexico seafloor spreading began during the Middle Jurassic;
- Caribbean Sea seafloor spreading started during the Early Cretaceous;
- The subduction of the Chortis Block into southwestern Mexico stoped later in the Early Cretaceous;
- Greater Antilles Arc collision into Maya Block began during the Late Cretaceous;
- From the Late Cretaceous into the Paleocene, the Chortis Block collided with the Maya Block;
- At the end of the Cretaceous, 66 million years ago, the Chicxulub asteroid impact on Maya Block occurred;
- Cayman Trough rifting started during the Eocene and slowed down during the Oligocene and Miocene;
- Later in the Miocene, the Farallon Plate began rifting, the Cocos Plate subduction into Chortis Bloc began; and the East Pacific Rise had a period of super-fast spreading; and
- From the Miocene into the Pliocene, the Isthmus of Panama formed.
- Numerous coral reefs formed off the east coast of Belize during the Quaternary.

Geologically, Belize consists of three main zones:

- The Maya Mountains, in the centre;
- The Corozal Basin, to north of the Maya Mountains; and
- The Belize Basin, to the south of the mountains.

The Maya Mountains includes some of the oldest rocks in Belize and contains nine major units:

1. Maya Block, crystalline basement, Ediacaran to Cambrian;
2. Baldy Unit, sandstone, quartzite, and phyllite, Cambrian to Silurian;
3. Mountain Pine Ridge Pluton, granite, Ordovician to Silurian;
4. Bladen Formation, rhyolite, dacite, and tephra, Silurian to Devonian;
5. Macal Formation, sandstone and shale, Late Carboniferous (Pennsylvanian) to Permian;
6. Hummingbird-Mullins Pluton, granite, Triassic;
7. Cockscomb-Sapote Pluton, granite, Triassic;
8. Todos Santos, sandy shales, Jurassic to Cretaceous;
9. Coban Limestone, limestone and dolomite, Cretaceous to Holocene.

The geology of the Corozal and Belize basins are best shown graphically, as in Figure 3, below.

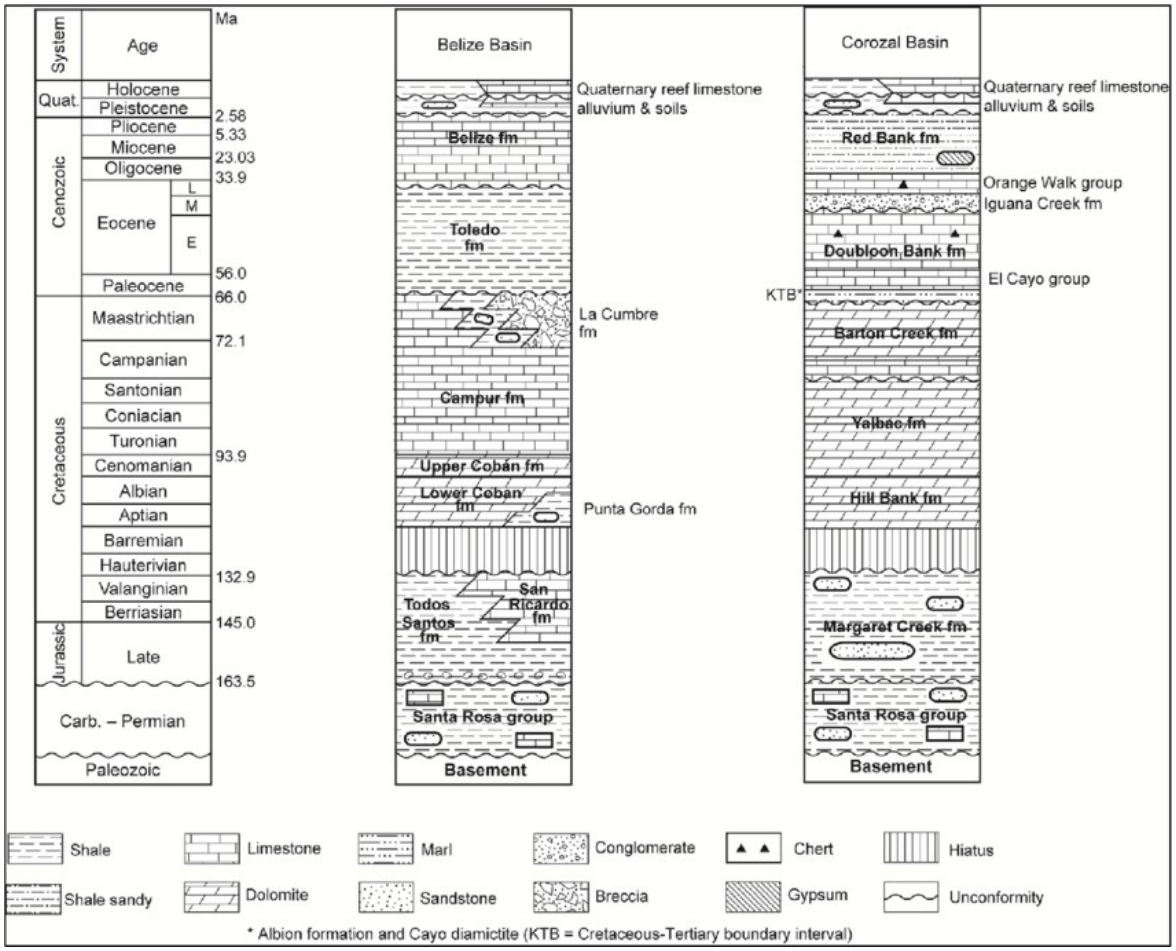


Figure 3 – Stratigraphy of the Belize and Corozal Basins
Credit: Figure 2 in Fisher & King, 2015

In researching this section I came across a couple of interesting features of the geology of Belize:

- One of the geological units in Belize is a diamicton overlying the Santa Rosa Formation from the Paleozoic Era; diamicton is another name for glacial till, so there must have been a glaciation in the ancestral Mayan Mountains during the Paleozoic.
- The limestone formations in Belize often contain karst topography, off shore the caves and cenotes associated with the karst formed the Great Blue Hole.

Resources

Agricultural Resources

According to the United Nations Food and Agriculture Organization, about 0.8 million hectares, or 38% of the land area in Belize is suitable for agriculture. Of this, only about 15% is being farmed every year.

There are three main types of agriculture in Belize:

a) An export sector for sugar, banana, citrus, and marine products;

b) A small-scale farm sector, producing food mainly for local consumption; and

c) A large-scale commercial sector.

The agricultural production statistics for 2021 from the Government of Belize are here.

Forestry Resources

Much of Belize is covered in tropical forest. Important products include mahogany, pine, cedar, and rosewood for lumber and chicle sap from the sapodilla tree (used for chewing gum). While there is a lot of forest in Belize, there is concern for sustainable forestry including a concerted effort to buy up land to take it out of forest production. Forest production and deforestation statistics are available here.

Mineral Resources

The geological resources of Belize include aggregate resources such as clay, barite, sand and gravel, granite, gypsum, quartz sand, dolomite and limestone. There may be deposits of molybdenum in the Maya Mountains. Sites with high quality silica deposits have been identified. A few rubies are said to have been discovered in the south of the country during colonial times The main mineral production in Belize is petroleum where 263,000 barrels of oil were produced in 2019 mostly from the Spanish Lookout Oil Field. Currently, Belize does not permit off-shore oil exploration.

Climate

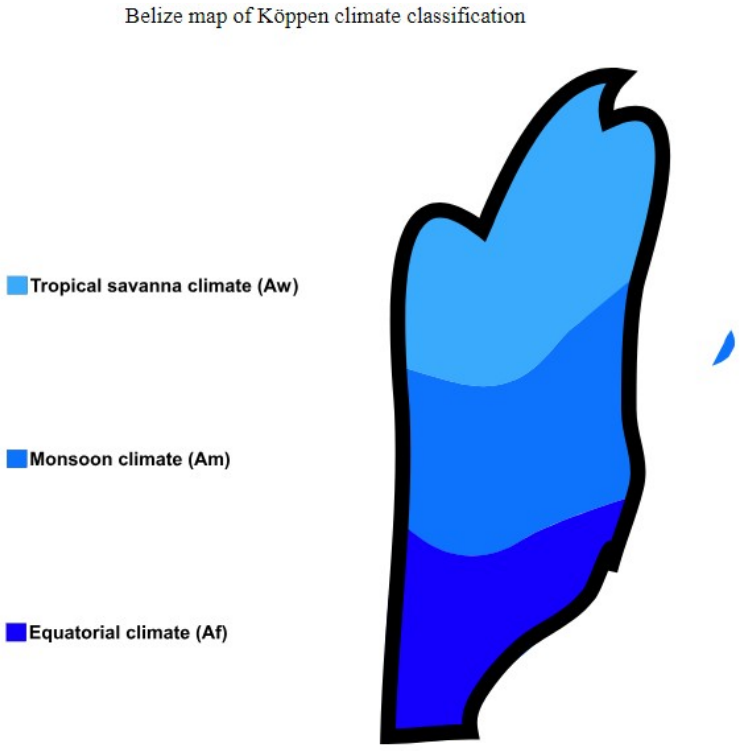


Figure 4 – Köppen Climate Classification Map of Belize
Credit: Ali Zifan, Creative Commons Attribution-Share Alike 4.0 International license

The climate in Belize is tropical. The hot and rainy season is from June to October, while a cooler season prevails from November to February. During the cooler season, northeast trade winds prevail. Rainfall during the cooler season decreases so that from February to April it's the driest period of the year.

History and Geopolitics

Figure 5 – Dawn in Ambergris Caye, Belize
Credit: Serge Melki; Creative Commons Attribution 2.0 Generic license

This is a short summary of Belize history, a more detailed discussion is here. The earliest recorded inhabitants of Belize were the Maya who developed a sophisticated civilization in Southern Mexico, Belize and Guatemala. Mayan civilization grew out of prior cultures beginning about 2500 B.C. The peak of their civilization was about 250 A.D. after which they experienced a series of famines and wars that reduced their population. Whether this was a dramatic fall or a more gradual decline is open to debate, as are the details of the "collapse".

Whatever the details of the decline of the Maya, when the Spaniards arrived in early 16th century, they found a group of people living among magnificent ruins with the memory, and sometimes the documentation, of an earlier grand culture. The Spaniards cared not a whit for the old civilization and its literature. A long, protracted struggle between the Mayans and the Spaniards lasted from the arrival of the Spaniards until the conflict generally ended in 1697. Among the atrocities of the Spanish-Mayan war was the burning of most of the written Mayan literature in 1562.

A fairly wealthy polity, New Spain, as the Spanish territories were called, was a target for one of the favourite sports of the 17th and 18th centuries – piracy. One of these pirates, Edward "Blackbeard" Teach founded a settlement at Cayo Cosina in 1717. Teach's settlement eventually led to the founding of British Honduras in 1862.

Figure 6 – Edward Teach Commonly Call'd Black Beard
Credit: Unknown author, public domain

The time between Blackbeard's founding settlement and the eventual legal establishment of the colony of British Honduras in 1862 was a period of barely constrained anarchy. The pirates carried on their sport and others settlers established sugar plantations using slave labour. Some of the slaves escaped to found

the Garifuna. The official establishment of a British colony ended the period of anarchy although plantation slavery officially ended in 1833. British Honduras remained a British colony until 1981, when it became independent as Belize.

The biggest geopolitical challenge for Belize is their neighbour Guatemala. As far as the Guatemalans are concerned, Belize is still an illegitimate pirate state unjustly carved out of New Spain, of which Guatemala is a legal successor state. Belize, on the other hand, maintains that whatever the history, they are now a legal state with a distinct people.

The cultural distinctions between Belize and Guatemala are striking. Belize is a parliamentary democracy with some legal protections for human rights. Guatemala, on the other hand, has a history of death squads and military dictatorship. The inhabitants of Belize have every reason to fear Guatemalan aggression.

The other big players in Belize's neighbourhood are Mexico and the United States. Relations between Mexico and Belize are currently peaceful and mutually beneficial. While we cannot rule out an aggressive Mexican regime in the future, Mexico has enough problems for now without taking on a substantial English-speaking population (ask them about Texas).

The United States is another issue. As the hegemon in the Western Hemisphere, the United States has interfered with most of the countries of Central America, except for Belize. In the past, Belize was British concern and the Americans were content to let the British solve any problems there. Currently, relations between the United States and Belize are described as strong and friendly. Only the future will tell if that can last, although Belize has the advantage of not being a big prize. As long as they keep in the good graces of the Americans, they should be safe from American interference. Who knows, maybe the Americans can help them with the Guatemalans.

That wraps it up for my discussion of Belize. If it interests you, follow up on the links and find out more about this fascinating place.

Standard Caveat