

November 20, 2023

News and notes

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

Research

- Carbon cycle and sedimentation: [High rates of rock organic carbon oxidation sustained as Andean sediment transits the Amazon foreland-floodplain](#); Phys.org summary [here](#).
- Plate tectonics: [A hydrogen-enriched layer in the topmost outer core sourced from deeply subducted water](#); Phys.org summary [here](#).
- [Melting and defect transitions in FeO up to pressures of Earth's core-mantle boundary](#); Phys.org summary [here](#).
- [The Khida terrane – Isotopic evidence for Paleoproterozoic to Neoproterozoic basement in the eastern Arabian Shield](#).
- [Tungsten isotopes in Baffin Island lavas: Evidence of Iceland plume evolution](#).
- [Rare evidence for the existence of a Hadean enriched mantle reservoir](#).

Sedimentology and Stratigraphy

- Sedimentology: [Organic sulfur from source to sink in low-sulfate Lake Superior](#); Phys.org summary [here](#).
- Stratigraphy: [U–Pb zircon ages, mapping, and biostratigraphy of the Payette Formation and Idaho Group north of the western Snake River Plain, Idaho: Implications for hydrocarbon system correlation](#).

Paleontology

- [New Mosasaur found at Canadian Fossil Discovery Centre dig site](#).
- [Bite and tooth marks on sauropod dinosaurs from the Morrison Formation](#); Phys.org summary [here](#).
- [Exceptional Early Jurassic fossils with leathery eggs shed light on dinosaur reproductive biology](#); Phys.org summary [here](#).
- [A new alvarezsaurid dinosaur \(Theropoda, Alvarezsauria\) from the Upper Cretaceous Baruungoyot Formation of Mongolia provides insights for bird-like sleeping behavior in non-avian dinosaurs](#); Sci. News summary [here](#).
- [The evolutionary origin of the durophagous pelagic stingray ecomorph](#); Sci. News summary [here](#).

- Big bird: [The moa footprints from the Pliocene – early Pleistocene of Kyeburn, Otago, New Zealand](#); Phys.org summary [here](#).
- [Earliest known Gondwanan bird tracks: Wonthaggi Formation \(Early Cretaceous\), Victoria, Australia](#); Sci. News summary [here](#).
- [Nitrogen isotopes reveal independent origins of N₂-fixing symbiosis in extant cycad lineages](#); Phys.org summary [here](#).
- De-extinction: [Texas Might Be Home To Woolly Mammoths Sooner Than You Think](#).

Crooks and Crimes

- [Gold stolen from Toronto airport was not insured, Air Canada claims in denying responsibility](#).
- India, [Bengaluru: Female deputy director of Karnataka geology department found murdered](#); more on her [here](#).

Mining and Energy

- [World's Largest Bentonite Deposits, world record in Wyoming](#).
- Gold mineralogy: [Superimposed Gold Mineralization Events in the Tuanshanbei Orogenic Gold Deposit, Central Jiangnan Orogen, South China](#).
- [A lithium mine for EV batteries is coming to Arkansas, says Exxon](#).
- [Lithium mining in Africa reveals dark side of green energy](#).
- [Economic Concerns Put Oil Prices on Track for a Fourth Consecutive Weekly Loss](#).
- [With decent oil prices, why aren't many drilling rigs working? The CAOEC responds](#).
- [The U.S. Just Recorded Its Highest Oil Production Month In History](#).
- [Chinese Giant Sinopec Starts Production From Asia's Deepest Oil and Gas Well](#).
- [Massive Montney play ramping up with Canadian LNG exports on the horizon](#).
- [Saudi Aramco Starts Tight Gas Production At South Ghawar Field](#).
- [Sweden plans new nuclear reactors by 2035, will share costs](#).

Environmental Geology and Hydrogeology

- [A measurement-based upstream oil and gas methane inventory for Alberta, Canada reveals higher emissions and different sources than official estimates](#).
- [Non-invasive 3D analysis of microplastic particles in sandy soil — Exploring feasible options and capabilities](#); Phys.org summary [here](#).
- [In Situ PFAS Treatment Technology Wins Europe's Most Prestigious Remediation Award](#).

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Geology and the Fate of Societies – Brunei



Figure 1 – Map of Brunei Darussalam
Credit: [CIA World Factbook – Brunei](#), public domain

[Brunei](#), Negara Brunei Darussalam in the Malay language, is a small state on the north side of the island of [Borneo](#) in [Maritime Southeast Asia](#). It shares Borneo with [Malaysia](#), which completely surrounds Brunei, and [Indonesia](#). To the north of Brunei is the [South China Sea](#).

According to the [CIA World Factbook on Brunei](#), the country consists of two sections with a total of 5,765 square kilometres (km²) of which 5,265 km² is land and 500 km² is water. Also, the estimated population of Brunei is 484,991, approximately 26% of whom are immigrants. The ethnic breakdown of the country is 67.4% [Malay](#), 9.6% [Chinese](#), and 23% other.

The official language of Brunei is [Malay](#) including dialects such as [Brunei Malay](#), [Tutong](#), [Kedayan](#), and [Belait](#). [English](#) and various Chinese dialects (e.g. [Hokkien](#), [Hakka](#), [Cantonese](#), and [Standard Chinese](#)) are also used together with the indigenous languages [Murut](#), [Dusun](#), and [Brunei Bisaya](#). The majority, 82.1%, of Bruneians are [Muslim](#). Of the remainder, 6.7% are Christian, 6.3% Buddhist, and 4.9% other.

The age structure of the population is:

- 0-14 years: 21.83% (male 54,523/female 51,334);
- 15-64 years: 71.07% (male 164,957/female 179,721); and
- 65 years and over: 7.1% (2023 est.) (male 16,748/female 17,708).

The government of Brunei is a [Sultanate](#), an Islamic [absolute monarchy](#). The Sultan and Prime Minister is [Hassanal Bolkiah](#); the Crown Prince and the Senior Minister is [Al-Muhtadee Billah](#). The government also includes a [legislative council](#).

Geology

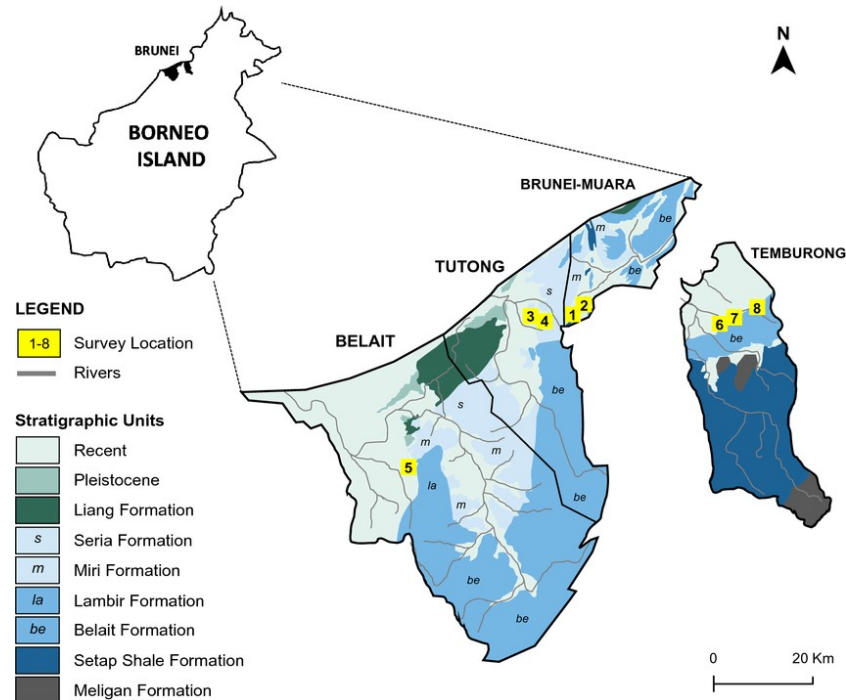


Figure 2 – Geology of Brunei
 Credit: Figure 1 in [Azffri et al, 2022](#)

The [geology of Brunei](#) is part of a larger [geology of the island of Borneo](#). Borneo was formed by a series of [continental collisions](#) between the [Asian](#), [India–Australia](#), and [Philippine Sea](#) and [Pacific](#) plates over the last 400 million years. These collisions were a combination of [arc-continent collisions](#), [continent–continent collisions](#) and [subduction–accretion](#).

The geology of Brunei is primarily made up of [Cenozoic](#) rocks overlying deeper rock units on the island of Borneo. These rocks date from the [Paleogene \(Oligocene\)](#) through the [Quaternary \(Holocene\)](#) and are up to 15 kilometers thick.

The oldest rocks in Brunei are parts of the Paleogene [Meligan Formation](#) and [Temburong Formation](#); these two formations are the deformed remnants of floodplain sediments. An [unconformity](#) separates the older rocks from younger [Neogene](#) (Middle [Miocene](#) and [Pliocene](#)) rocks; these sediments are divided into the [Setap](#), [Belait](#), [Miri](#), [Seria](#) and [Liang](#) formations.

The Setap Formation is marine [shale](#), while the Belait Formation includes thick [sandstones](#) and some reef [limestone](#). Both the Miri and Seria Formations include sandstones and shales. The Liang Formation contains [clastic](#) sediments deposited by meandering rivers and contains [gastropod](#) and [crustacean](#) fossils. There are many [fault-bounded traps](#) in this sedimentary series that often contain oil and gas.

Resources

Agricultural Resources



Figure 3 – Paddy Field, Brunei

Credit: [Amri HMS](#), [Creative Commons Attribution 2.0 Generic](#) license

Approximately 10,020 hectares (ha) of land in Brunei are used for agriculture, of which about 5,240 ha are used for crops and the remainder, about 4,780 ha, are used for livestock. Livestock production includes chickens (both broilers and egg producers), cattle, sheep and goats. Brunei is a Moslem country so no pigs are officially raised in the country. Crop production includes vegetables, fruits, paddy rice, ornamental plants, and cut flowers. Detailed statistics on the agriculture industry are available [here](#).

Brunei appears to have ensured that [most of their population is well fed](#). However, this [appears to be a knife edge situation](#). The future will depend on good management and the ability of the country to import food when needed using revenues from oil production.

Forestry



Figure 4 – Peradayan Forest Reserve

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

Around [80 percent of Brunei's land is under forest cover](#) and around 40 percent has been unaffected by human activity. There is a strictly limited harvest, 100 000 cubic meters of timber per annum and around 20% of the land is protected from any forestry harvesting.

Mineral Resources



Figure 5 – Brunei Pump Jack

Credit: [DeltaSquad833](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

Except for some 290,000 tonnes (2019) of cement production, [the mineral industry in Brunei](#) is entirely petroleum and natural gas, almost all of which is exported. In 2019, Brunei produced 39,600,000 barrels (bbls) of crude oil, 28,000,000 bbls of refinery products, and 11,800 million cubic meters of marketable natural gas.

Climate

The [climate of Brunei](#) (or Brunei Darussalam) is equatorial, i.e. hot, humid and rainy throughout the year.

History and Geopolitics



Figure 6 – Sultan Omar Ali Saifuddin Mosque

Credit: [sam garza](#), [Creative Commons Attribution 2.0 Generic](#) license

History of a Sultanate



Figure 7 - Map of Brunei Sultanate at its greatest extent in year 1521

Credit: [Delirium333](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

The [history of Brunei](#) is an interesting one. The [earliest history of Brunei](#) is obscured by lack of documentation. There is [evidence](#) that Brunei traded with China in the 6th Century AD and the area came under the influence of India through its allegiance to the Hindu [Majapahit](#) empire, based in Java.

Beginning around 1368, the [Sultanate of Brunei](#) grew and dominated much of northern Borneo. The Brunei Sultanate grew prosperous and introduced Islam to all their domains. However, it was not to last. Disputes with the neighbouring [Sultanate of Sulu](#), ongoing [piracy](#), together with internal disputes over succession, led to a decline in the power and influence of the Brunei Sultanate. In 1888, Sultan [Hashim Jalilul Alam Aqamaddin](#) appealed to the [British](#) for help and Brunei became a British protectorate.

The [British ruled Brunei](#) through the Brunei Sultans until 1959, when limited self government was allowed. By 1983, Brunei became fully independent, with the Sultan becoming the absolute ruler. Notable events during the British rule include the [discovery of oil in 1929](#), the subsequent development of the petroleum industry, and the [occupation of Brunei](#) by [Imperial Japan](#) 1941-1945.

The current Sultan of Brunei, Hassanal Bolkiah, rules an apparently prosperous and peaceful country. A local version of [Sharia Law](#) is in force, with some severe penalties on the books for adultery, apostasy, blasphemy, and other offences. Legal punishments on the books include death by stoning, amputation of hands or feet, or caning. However, aside from caning, none of the severe punishments have been enforced since 1957. Still, if you are looking to live on the wild side, [you should be careful if you visit Brunei](#).

Geopolitics of an Oil Rich Country

Oil wealth can be both a blessing and a curse. A responsible government, acting in its people's best interest, can invest such wealth in any of a number of beneficial projects such as education, health care, and infrastructure. An irresponsible government can squander its wealth on personal expenditure by the ruler that ignores the needs of the people. So far, Brunei appears to be ruled in a responsible manner. Perhaps the Sultan takes the admonitions of [the Prophet](#) seriously and aspires to be a [good ruler as prescribed by Moslem teaching](#).

However, the curse of oil wealth includes not only the weaknesses of fallible human rulers but also the unwanted attraction by ambitious foreign actors. In the South China Sea, the most significant, and ambitious actor, is [China](#). China's [ambitions in the South China Sea](#) have become well known in the last few years and it will be difficult for Brunei to retain its independence without some concessions to Chinese interests. Who knows, perhaps the Sultans of Brunei will make a deal with the Chinese just like they made a deal with the British. Alternatively, it could become part of another great power struggle, such during [World War II](#). Whatever happens, Brunei will remain a prize because of its oil.

That kind of wraps up my short look at Brunei. If any of this interests you, follow up on the links for more information.

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.