

June 10, 2024

## News and notes

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

## Geopolitics

- Georgia: [Black Sea Port Becomes Geopolitical Battleground Between China and the EU](#).
- Take with a grain of salt: [Russia Has Become 'Economic Role Model' to Rest of the World – Analyst](#).
- [France to give fighter jets to Ukraine – Macron](#).
- [Russian warships will arrive in Havana next week, say Cuban officials citing 'friendly relations'](#).
- [Washington Hits Russia's Uranium Industry](#).
- [Russia said to seek French-held uranium assets in Niger](#) and [Rosatom, Orano deny deal talks on Niger nuclear assets](#).
- [North Sea firms postpone oilfield opening after early UK election called](#).

## Bad Science

- [Academic Publisher Retracts Over 11,300 Papers and Shuts 19 Journals As It Is Overwhelmed by Fraud](#).

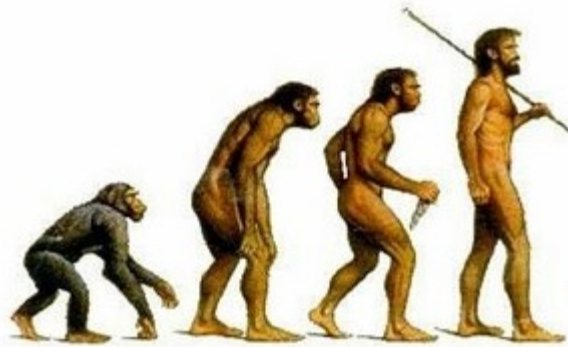
## Research

- The June issue of [Geology](#) is out.
- Petrology: [Non-Henrian behavior of hydrogen in plagioclase – basaltic melt partitioning](#).
- More petrology: [Generation of mantle-derived basaltic andesites in volcanic arcs](#).
- Stable isotope geochemistry: [An analysis of  \$\Delta^{36}\text{S}/\Delta^{33}\text{S}\$  dependence on definitions of sulfur mass-independent fractionation](#).
- More stable isotope research: [Calcium isotope constraints on a Middle Ordovician carbon isotope excursion](#).
- Geological history: [Onset of the Earth's hydrological cycle four billion years ago or earlier](#).
- Plate tectonics: [Subducting plate structure and megathrust morphology from deep seismic imaging linked to earthquake rupture segmentation at Cascadia](#); Phys.org summary [here](#).
- More plate tectonics: The [Intraplate Stress Field of West Africa](#); Phys.org summary [here](#).

## Sedimentology

- Antarctica: [A large-scale transcontinental river system crossed West Antarctica during the Eocene](#); Phys.org summary [here](#).
- Erosion: [Ecological regulation of chemical weathering recorded in rivers](#).
- [A typical point bar with atypical strata in the McMurray Formation, Alberta, Canada: Floods, tides and high suspended sediment concentrations](#).
- [Rapid growth of a carbonate island over the last millennium](#).

## Paleontology



March of Progress

Credit: hf boards, [public domain](#)

- Book review: [The Famous "March Of Progress" Image Is Wildly Wrong](#).
- Evolution: [Sexual dimorphisms in body proportions of Masai giraffes and the evolution of the giraffe's neck](#); Science Alert summary [here](#).
- [52,000 years of woolly rhinoceros population dynamics reveal extinction mechanisms](#); Sci News summary [here](#).
- [Massive early Middle Pleistocene cheetah from eastern Asia shed light onto the evolution of \*Acinonyx\* in Eurasia](#); Live Science summary [here](#).
- Ediacaran fauna: [Virtual Reality Shows How First Animals Changed Their Environment And Boosted Evolution](#).
- [Iridescent harvestmen \(Arachnida: Opiliones: Sclerosomatidae\) from the Eocene of Messel, Germany](#); Phys.org summary [here](#).
- [Fossil-hunting diver makes stunning ancient find off Florida coast: 'Very rare'](#).
- Big bird: [Skull morphology of the enigmatic \*Genyornis newtoni\* Stirling and Zeitz, 1896 \(Aves, Dromornithidae\), with implications for functional morphology, ecology, and evolution in the context of Galloanserae](#); Sci News summary [here](#).

- [Were jellyfish stranded on a shoreline sand ca 850 million years ago in the Amadeus Basin of central Australia?](#)

## Mining and Energy

- Geology of ore deposits: [New metamorphic constraints on the Nova-Bollinger Ni–Cu deposit, Fraser Zone, Western Australia.](#)
- [Quebec residents against graphite mine fear powering Pentagon, environmental ruin.](#)
- [Rare Earths Norway says its REE discovery is Europe’s largest.](#)
- [Demand for Canadian natural resources on a “scale never seen before,” says MAC.](#)
- [Government regulation top threat facing British Columbia mining industry – report.](#)
- Lithium extraction research: [Identifying critical features of iron phosphate particle for lithium preference](#); Phys.org summary [here](#).
- Ooh, shinny: [Diamond industry ‘in trouble’ as lab-grown gemstones tank prices further.](#)
- [Emerging Sudbury nickel-copper miner strikes milling deal with Glencore.](#)
- [Copper price falls through \\$10,000 as exchange inventories keep rising](#); related: [New copper fund revives controversial product.](#)
- [New Battery Tech Could Kill Two Major Decarbonization Challenges With One Stone.](#)
- [Colombia's Oil Industry Stuck in Death Spiral.](#)
- [The Geothermal Exploration Opportunities Map Beta \(GeoMap™\)](#); The Hill summary [here](#).

## Environmental Geology and Hydrogeology

- [Maps of heavy metals in Wellington, New Zealand soils show impacts of urbanization](#); Phys.org summary [here](#).
- [Global groundwater warming due to climate change](#); related article in [The Conversation](#).

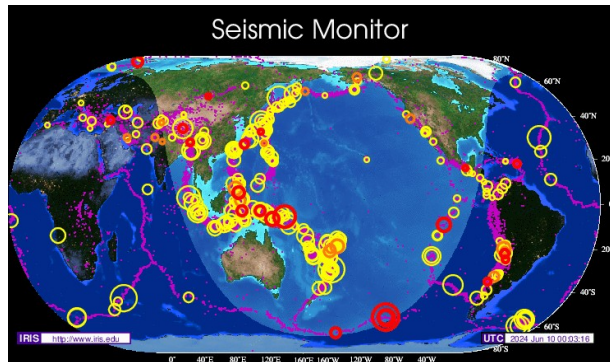
## Glaciers and Climate Change

- Periglacial environment: [No respite from permafrost-thaw impacts in the absence of a global tipping point](#); Phys.org summary [here](#).
- Almost all recent global warming caused by green air policies: [Abrupt reduction in shipping emission as an inadvertent geoengineering termination shock produces substantial radiative warming](#); Daily Skeptic summary [here](#).
- [Sensitivity of ocean circulation to warming during the Early Eocene greenhouse.](#)

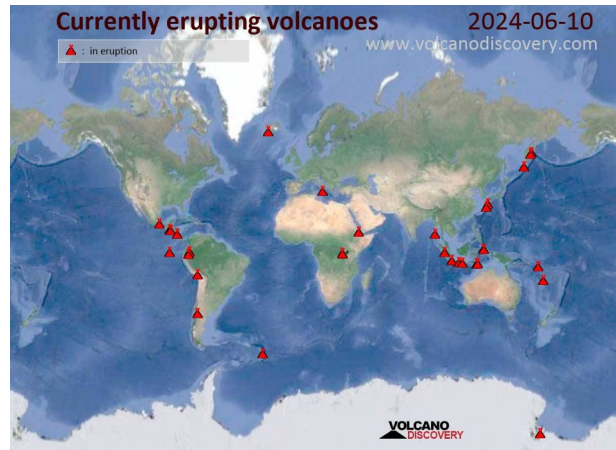
## Neat Geological Places to Visit

- [11 US National Parks where you can find fossils.](#)

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- United States Geological Survey (USGS) Volcano Watch: [Video: HVO geologists observe new fissure system](#); [Keeping up with Kīlauea](#).
- USGS Yellowstone Volcano Observatory: [McDermitt caldera: An early caldera of the Yellowstone hotspot track](#).
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- Iceland:
  - [Lava has reached Grindavíkurvegur Road and the Blue Lagoon closed](#);
  - [Lava still flowing to the north and one crater is still active](#).
- [Euro-Mediterranean Seismological Centre](#)
- [Earthquakes Monitoring Live Worldwide](#).
- [M5.8 earthquake strikes Noto Peninsula, Japan](#); USGS summary [here](#).
- Geohazards, coastal erosion: [N.C. beach house collapses underscore U.S. coastal erosion crisis](#).

### Upcoming Events

- [GeoConvention 2024, June 17 – 19, Calgary, AB Canada](#).
- If you are in Calgary for the Stampede: [Bootleggin' Breakfast 2024](#), Calgary, AB, July 9 & 11, 2024, plus [Stampede After Parties Announced!](#)
- [Goldschmidt 2024, August 18-24, Chicago IL](#), organized by the Geochemical Society and the European Association of Geochemistry.
- [Groundwater Week 2024](#), December 10-12 in Las Vegas, Nevada.

June 10, 2024

## Geology and the Fate of Societies – Ecuador



**Figure 1a – Ecuador**

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



**Figure 1b – Location Map**

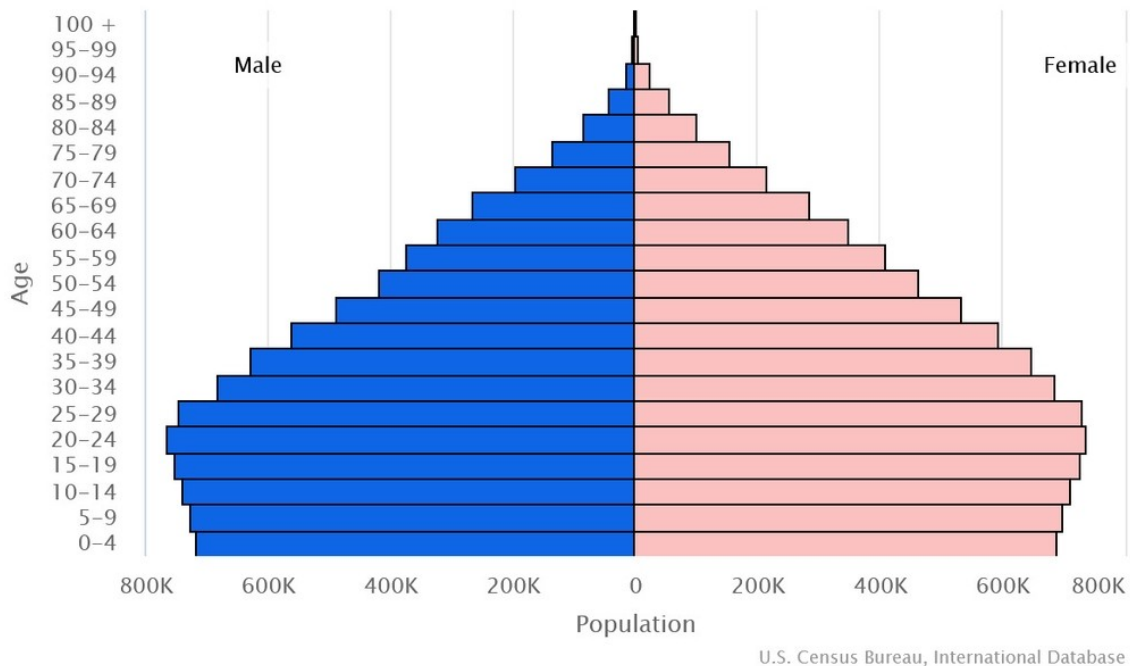
**Credit:** [CIA World Factbook](#), public domain

The Republic of [Ecuador](#) is in the northwest part of [South America](#); it is bordered by [Columbia](#) to the north, [Peru](#) to the east and south, and the [Pacific Ocean](#) to the west. Ecuador includes the [Galapagos Islands](#) in the Pacific Ocean. According to the [Central Intelligence Agency](#) (CIA), the total area of [Ecuador](#) is 283,561 square kilometres (km<sup>2</sup>) including the Galapagos Islands. Of the total area, 276,841 km<sup>2</sup> is land and 6,720 km<sup>2</sup> is water.

Ecuador is a unitary presidential [republic](#); the President is [Daniel Noboa](#), and the Vice President is [Verónica Abad Rojas](#). The legislature consists of a single house, the [National Assembly](#). The Capital City is [Quito](#) (metropolitan population 2,889,703), and its largest city is [Guayaquil](#) (metropolitan population 3,618,450).

Also according to the CIA, 18,309,984 people live in Ecuador. Of the approximately 18.3 million people in Ecuador, 77.5% are [Mestizo](#) (mixed Indigenous and White); 7.7% are [Montubio](#) (a distinct mixed race group); 7.7% are [Indigenous](#); 4.7% are considered or [Afro-Ecuadorian](#), Black, or [Mulatto](#); 2.2% are considered [White](#); and the remaining are something other. [Spanish](#), spoken by 98.6% of the population, is an official language together with indigenous languages [Kichwa](#) (Quechua) and [Shuar](#).

The largest religious group in Ecuador are [Roman Catholics](#) at 68.2% of the population. [Protestant Christians](#), make up 19% of the population; 1.4% are [Jehovah's Witnesses](#); and the remaining are either no religion or something other.



**Figure 2 – Demographic Profile of Ecuador**  
**Credit: U.S. Census Bureau, International Database, public domain**

The demographic profile of Ecuador shows a population that is stabilizing. The median age is 28 years; the total fertility rate is 2.21 births/woman, and the annual population growth rate is 0.94%. Life expectancy for both sexes is 74.9 years. 64.8% of total Ecuadoran population lives in urban areas. Almost half of the population is in the basins and valleys of the [Andes Mountains](#), together with large concentrations also found along the western coastal strip. Few people live in the rainforests of the east.

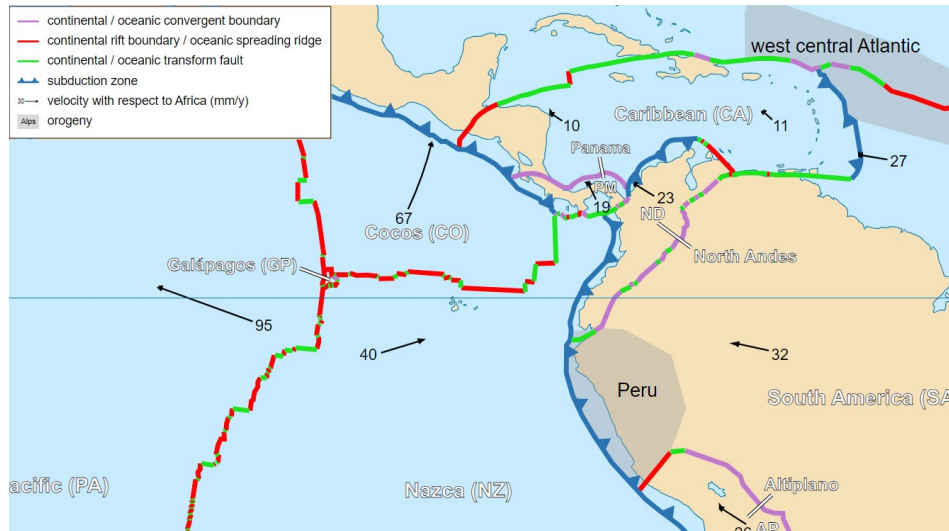
Emigration from Ecuador is common, especially during times of economic stress. In recent years, many of the people seeking entry to the [United States](#) from [Mexico](#) are from Ecuador. Ecuador also hosts refugees from Columbia and [Venezuela](#).

In terms of [education](#), 93.9% of the Ecuadoran population can read and write. While Ecuadoran law requires about 9 years of education per child, children in rural areas are likely to attend 7 to 8 years while in urban areas 10 to 11 years of education are more common. About 14% of young people go on to post-secondary education. Tuition at state post-secondary institutions is free.

To round out the general facts on Ecuador, here are links to a couples of interesting videos:

- [Political and Cultural Geography of Ecuador](#); and
- [Brief Political History of Ecuador](#).

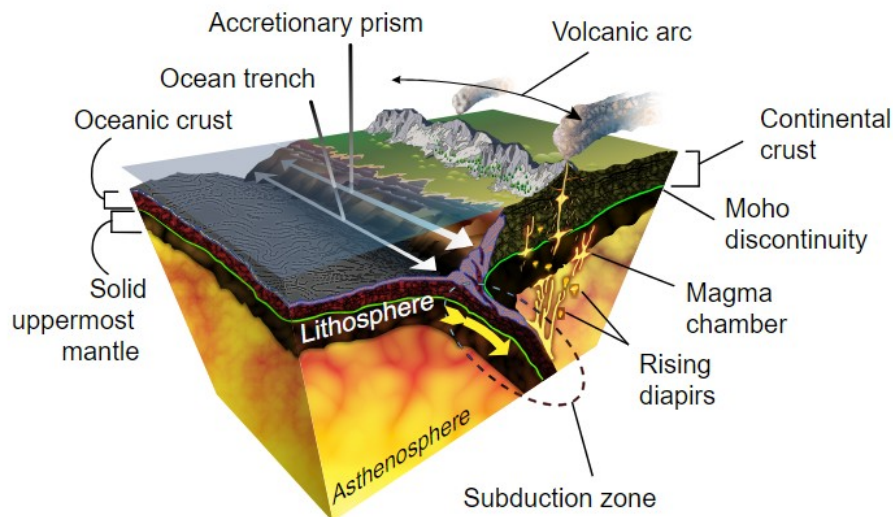
## Geology



**Figure 3 – Extract of Detailed Tectonic Plate Boundaries**

**Credit:** Eric Gaba (Sting), [Creative Commons Attribution-Share Alike 2.5 Generic license](#)

A good way to understand the [geology of Ecuador](#) is to first look at the tectonic framework. The heart of the Ecuadoran geology is in the Andes Mountains and the [Andean Orogeny](#) that formed them. The Andes were formed by the [subduction](#) of [oceanic crust](#) under the [South American Plate](#). The oceanic crust subducting under Ecuador is the [Nazca Plate](#), which is moving east.



**Figure 4 – Tectonic Subduction**

**Credit:** KDS4444, [Creative Commons Attribution-Share Alike 4.0 International license](#)

In Ecuador, the [Andean Orogeny](#) brought together tectonic blocks of [continental crust](#) in a complex process known as [accretion](#). This process began in the [Early Cretaceous](#) when [island arcs](#) accreted onto the main body of northwestern South America as the oceanic crust subducted under the continental crust. The [Cordillera Real](#) of Ecuador was originally a [belt of volcanoes](#) that accreted onto South America during this time. You can see the belts of [tectonic terranes](#) in the geological map of Ecuador, Figure 5, below.



The [major terranes in Ecuador](#) are, from east to west, are:

- Various continental and continental margin rocks, ranging in age from [Paleozoic](#) to [Quaternary](#);
- Oceanic terranes, island arc volcanics and sediments, [Cretaceous](#) in age;
- Continental volcanic arc deposits, Cretaceous to Quaternary in age; and
- Post accretionary sediments: [greywackes](#), [sandstones](#), and [conglomerates](#).

The [Galapagos Islands](#) are almost entirely volcanic deposits, [Neogene](#) and Quaternary in age.

## Resources

### *Agriculture*



**Figure 6 – Calves on a Pasture at El Chaupi Organic Dairy Farm, Ecuador**  
**Credit: [Julia Rubinic](#), [Creative Commons Attribution 2.0 Generic](#) license**

According to the CIA World Factbook 29.7% of the land in Ecuador is used for agriculture (4.7% [arable land](#), 5.6% [permanent crops](#), and 19.4% permanent [pasture](#)). Of the remainder, 38.9% is forest and the remaining 31.4% has other or no use. About 10,000 km<sup>2</sup> of agricultural land is irrigated.

Major cereal crops in Ecuador include [maize](#), grown since ancient times, but also [rice](#) and [wheat](#). Native to the Andes, [potatoes](#) are a common crop. Tropical specialty crops such as [bananas](#) ([world's largest exporter](#)), [cacao](#) (for chocolate), and [coffee](#) are also grown, especially for export. The [African oil palm](#) is grown for vegetable oil. Perishable crops grown for export via air cargo include flowers, [strawberries](#), [asparagus](#), and [snow peas](#). Other cash crops include [sugarcane](#) and [tobacco](#).

The large area of permanent pasture is an indication that livestock production is important. Different areas of the country tend to specialize in particular livestock production. For example, pastures in lowland areas are used to raise beef [cattle](#), whereas dairy cattle, [pigs](#), and [guinea pigs](#) are raised in highland areas. [Chickens](#) are raised everywhere and [goats](#) are commonly raised in the south.

Statistics on agricultural production from the [United Nations Food and Agriculture Organization](#) (FAO) can be found [here](#). The FAO also publishes other information on [food availability in Ecuador](#). For example, 37.3% of the Ecuadoran population suffered from moderate to severe food insecurity in 2022.

### Forests



**Figure 7 – Ecuadoran Cloud Forestry**  
**Credit: User:Hjvannes, Creative Commons Attribution-Share Alike 3.0 Unported license**

As noted above, 38.9% of the land area in Ecuador is forest. There are [three main forest types](#) in the country:

- 1) The [Amazon rainforest](#) – 62% of the country’s forest;
- 2) The [Montane](#) (sierra) forests that are on the western and eastern slopes, at lower and upper levels, and towards the Andean high peaks – 21% of the forest in the country; and
- 3) The [tropical rainforest](#) in the coastal plains of the Pacific region – 17% of Ecuadorian forests.

Also of interest in Ecuador, within the Amazon region, are the [Cloud Forests](#).

Timber production includes species such as [eucalyptus](#), [mangroves](#), [pines](#), [cedars](#), [walnut](#), and [balsa wood](#). Statistics on forest production from the FAO in Ecuador can be found [here](#).

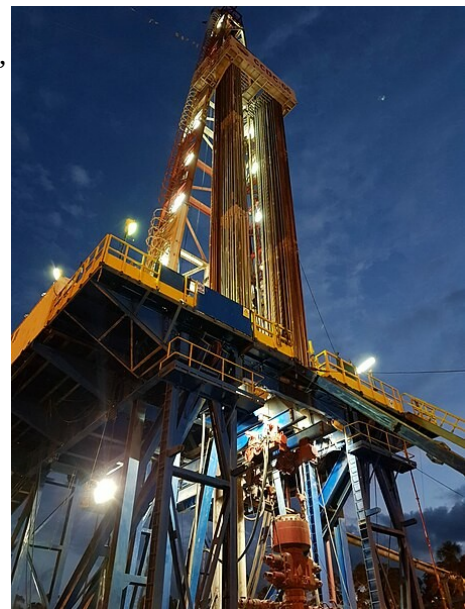
### Mineral Resources

Metallic [mineral production](#) in Ecuador includes [antimony](#), [copper](#), [gold](#), and [silver](#).

- Copper is produced at the [Mirador Mine](#) in Zamora-Chinchipe Province;
- Gold is produced at the [Fruta del Norte Mine](#), Zamora-Chinchipe Province, the [Bella Rica Mine and La Guanache-Tres de Mayo Mine](#) in Azuay Province, and the [Zaruma Mine](#) in El Oro Province.

Industrial minerals produced in Ecuador includes [barite](#), [cement](#), [kaolin clay](#), [feldspar](#), [pumice](#), industrial [silica](#), [construction aggregate](#) (sand, gravel, and crushed stone).

Ecuador is also a big producer of petroleum and natural gas, producing 172,599,000 barrels of oil and 310 million cubic metres of natural gas in 2021.



**Figure 8 – Drilling Rig in Ecuador**  
**Credit: EP Petroecuador, Creative Commons Attribution-Share Alike 4.0 International license**

Natural gas is produced offshore in the [Amistad](#) field, Gulf of Guayaquil. Petroleum is produced in about 112 fields including:

- About 26 active fields including the [Auca Field](#) in Orellana Province, and the [Shushufindi Field](#) in [Napo Province](#) operated by Empresa Pública de Hidrocarburos del Ecuador (EPHE);
- Some 85 fields in the Amazon basin with operations in [Guayas](#), Napo, [Orellana](#), and [Sucumbios](#) Provinces operated by Petroamazonas EP, a subsidiary of EPHE; and
- The [Sacha oilfield](#) in Sucumbios Province, operated by Operaciones Rio Napo, a subsidiary of EPHE.

In 2023 the people of Ecuador [voted to halt oil drilling](#) in Amazon reserve.

For further information on the mineral resources in Ecuador, check out the [USGS Minerals Yearbook](#) and the [Mindat.org summary on Ecuador](#). (Mindat doesn't have an interactive minerals map for the country).

## Climate

Ecuador map of Köppen climate classification

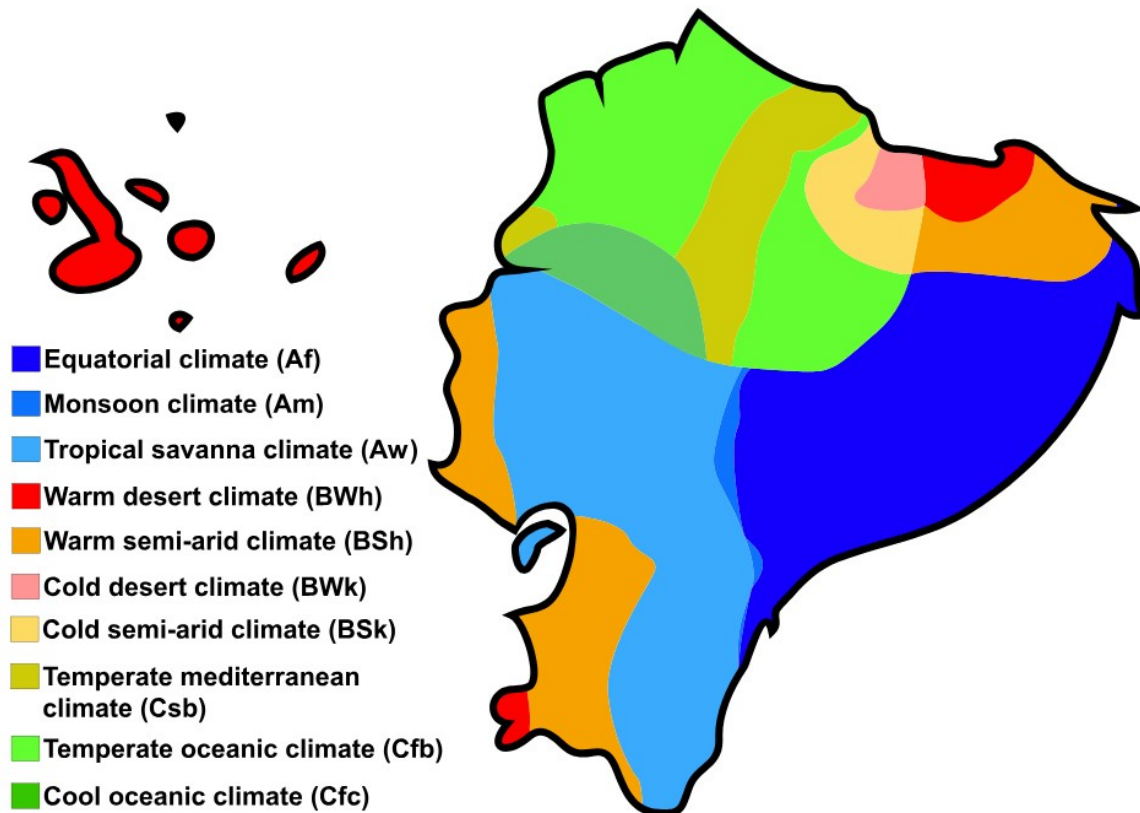


Figure 9 – Köppen Climate Classification Map of Ecuador

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

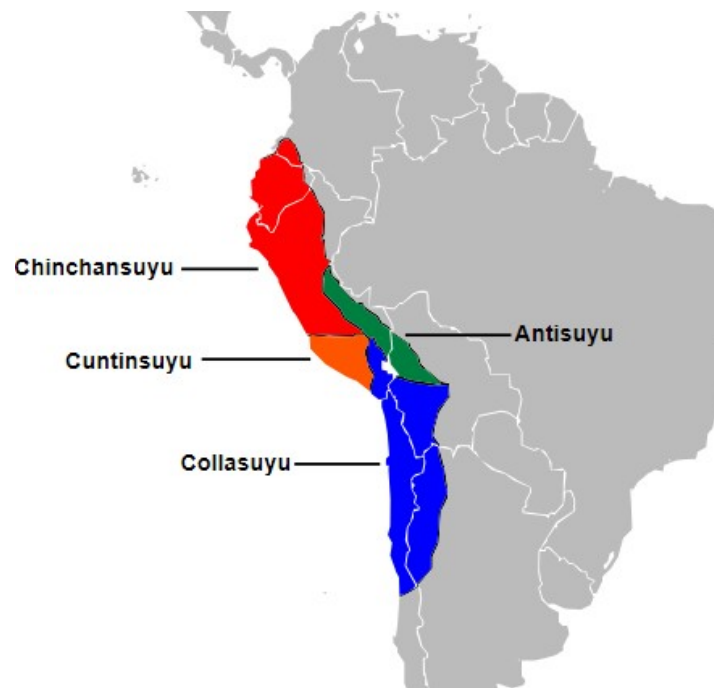
The CIA World Factbook on [Ecuador](#) describes the climate as “tropical along coast, becoming cooler inland at higher elevations; tropical in Amazonian jungle lowlands”. The Köppen climate classification

map for Ecuador shows a varied climate that includes equatorial climate ([Af](#)), monsoon climate ([Am](#)), tropical savanna climate ([Aw](#)), warm desert climate ([BWh](#)), warm semi-arid climate ([BSh](#)), cold desert climate ([BWk](#)), cold semi-arid climate ([BSk](#)), temperate Mediterranean climate ([Csb](#)), temperate oceanic climate ([Cfb](#)), and cool oceanic climate ([Cfc](#)).

Given the variety of climate, Ecuador may be a pleasant place to visit. Travel advisories ([here](#) and [here](#)) warn of high rates of crime as well as dangers from drug trafficking cartels in the vicinity of the Columbian border and [minefields near the Peruvian border](#). On January 9, 2024, the Government of [Ecuador declared a nationwide state of “internal armed conflict”](#) to allow security forces to better respond to a sharp increase in gang violence across the country. If you still want to go, check out [Climates to travel](#) and [Lonely Planet](#). Also, if you want to just visit the Galapagos Islands, check out this [site](#).

## History and Geopolitics

### *History*



**Figure 10 – Inca Empire in South America**

**Credit:** Earnold12, [Creative Commons Attribution-Share Alike 4.0 International](#) license

The [history of Ecuador](#) can be divided into four convenient divisions:

- Ecuador prior to the arrival of the Spaniards;
- The Spanish conquest and dominion;
- Independence from Spain as part of Gran Colombia;
- Independence as the Republic of Ecuador including various border disputes in the neighbours.

[Pre-Columbian Ecuador](#) included a number of [indigenous cultures](#). By the time of European contact, Ecuador was part of the [Inca Empire](#).

In 1530, 163 Spaniards under [conquistador Francisco Pizarro](#) overthrew the Inca Empire. The [Spanish conquest](#) of the Incas was aided by a [civil war](#) that occurred immediately before Pizarro arrived and also by the new diseases and weapons that the Spaniards brought with them, although smallpox preceded their arrival and was an underlying cause of the Inca Civil War.

By 1544, the Spanish colony in what is now Ecuador was part of the [Spain's colonies in the New World](#) under the [Viceroyalty of Peru](#). Local Spanish government was organized under the [Quito Audiencia](#). In 1720, the Spanish re-organized their South American holdings and the Quito Audiencia became part of the [Viceroyalty of New Granada](#).

The Spanish settled the country and set up [encomienda](#) estates. Under this system, the Spaniards ruled as landowners with the native population providing the labour force – slaves or serfs depending on how you want to present it. This suited the Spanish elite well, the enslaved natives not so well. The Spaniards also tended to marry, or just have children with, local women thus developing the current mixed race population of the country.

The Spanish authorities tended to look down on the local elites in their colonies, the [Criollos](#) having no friends at the Spanish court and the best positions in the colonial government were reserved for those who came straight from Spain, the [Peninsulares](#). The tensions between these elite factions broke out into [open revolt in 1809](#). Spanish troops crushed the revolt, but in 1822 a more [successful revolt](#) resulted in independence from Spain. Initially, Ecuador was part of the [Gran Colombia](#) federation that included modern day Columbia, Panama, and Venezuela. In 1830, following [war](#) between newly independent Peru and Gran Colombia, Ecuador became an independent country.

An important event in the early 1800's in Ecuador, at least to geologists, was Charles Darwin's [visit to the Galapagos Islands in 1835](#). Based upon his observations during the [voyage of HMS Beagle](#), Darwin later wrote his famous work, [On the Origin of Species](#) in 1859, the book that gave us [modern evolutionary theory](#).

Life was far from peaceful for newly independent Ecuador, you can find a list of their foreign conflicts [here](#). Within the Republic of Ecuador, conflicts within the Criollo elite defined the internal politics in the early years, [1830-1860](#). This conflict resulted in a period of anarchy 1859 followed by a conservative reaction under the leadership of [Gabriel García Moreno](#). Between [1860 and 1895](#), the conservative factions were in control of the country. In 1895, following the death of Moreno, liberal factions under the leadership of [Eloy Alfaro](#), took control of Ecuador. The [liberal era](#) lasted until 1925. In 1925, factional strife overthrew the liberal regime; this factional strife lasted from [1925 to 1944](#). During this time of [José María Velasco Ibarra](#) (Velasco) became president in 1934 and dominated politics in Ecuador, often as president, until his final term ended in 1972. In between Velasco presidencies other men held the office, often being overthrown in coup d'état. During this time of internal turmoil, Ecuador was also involved in a [border dispute with Peru](#), a dispute that led Ecuador to invade [Peru in 1941](#). The war was settled in the [Rio Protocol](#).

From [1944 to 1960](#) Velasco switched places with other politicians including [Galo Plaza Lasso](#). [After 1960](#) political life became unstable, with serial military governments under various leaders holding power until 1979. [Democratic elections](#) in 1979 led to the presidency of [Jaime Roldós Aguilera](#) (Roldós) during which Ecuador entered into the [Andean Common Market](#). A [war broke out](#) with Peru in 1981 after

Roldós was killed in a plane crash. The accident that killed Roldós was attributed by some to Peruvian agents or [the CIA](#), depending on who you talked to. A number of political regimes ruled in the years following the death of Roldós. To add to their troubles, a [devastating earthquake](#) struck the country in March 1987.

[Economic troubles](#) and political disputes [continue to afflict](#) Ecuador until the present. Relations with Peru have not been peaceful, the [Cenepa War](#) broke out in 1995. In 2000, the [Ecuadorian military staged a coup d'état](#). Also in 2000, the Ecuadorans adopted the United States dollar as their own official currency in attempt to stabilize the economy. Last year, Ecuador [deployed infantry troops to the Peruvian border](#).

The military junta transferred rule to civilians in 2002, however, the situation rarely remained stable for long and there has been considerable political churn with the [latest crisis being in 2023](#). [Internal political disputes](#) seem to be more [popular than football](#) in Ecuador, at least among the managerial class.

### ***Geopolitics – Unfinished Business***



**Figure 11 – Peruvian [M113 APC](#) Deployed to the Ecuadoran Border**  
**Credit:** [Ministerio de Defensa del Perú](#), [Creative Commons Attribution 2.0 Generic](#) license

It is clear from Ecuador's history that the country is a troubled place. Internal political disputes often become violent and it is difficult for any government to maintain order for long. [Crime](#), both petty and organized plagues the country. The government is not much better, the country ranks fairly poorly on the corruption index from [Transparency International](#). One of the issues identified as a problem in dealing with corruption is [infiltration by organized crime](#) – judges and police can be bought. Clearly, the Ecuadorans have much work to do to clean up their act.

As if internal problems are not enough, Ecuador continues to have [periodic border disputes](#) with Peru. Whether or not this can be [settled peacefully](#) is open to question – the history suggests that it won't be permanently settled anytime soon.

Ecuador's problems with Columbia stem from a [spill-over of Columbia's drug cartels into Ecuador](#). While seemingly a law-enforcement problem, the trade in cocaine from the Andes region is powered by strong demand for the drug in its [biggest markets: the United States and Western Europe](#). Markets engender powerful forces and it is difficult to work against them. Law enforcement officials, judges and police, are often faced with the choice of take the bribe or take a bullet ([plata o plomo](#)). The amount of money available almost makes corruption inevitable.

This brings us to the Great Powers. The United States is a [major trading partner with Ecuador](#) and has a [strong interest in Ecuador's peace and stability](#). However, as a major market for cocaine, the USA is also a destabilizing actor in the region. Finally, the Chinese have a trade interest in Ecuador, having recently signed a [free trade deal](#) between the two countries. Time will tell if that interest grows into something else. The Chinese are already seeking to [increase their influence](#) on the countries in [America's back yard](#). The Chinese have lots of motives for this including distracting the Americans from other areas of mutual rivalry.

That winds up this very short description of Ecuador. Follow up on the links if any of this interests you.

### **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.