

October 9, 2023

News and notes

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

Research

- Plate tectonics: [The influence of Cenozoic Eurasia-Arabia convergence on the Southeast Arabian Foreland Basin: new geochronological and geochemical constraints from syn-kinematic carbonate mineralization](#); KU Explorer summary [here](#).
- [Metamorphic Remnants of the Variscan Orogeny Across the Alps and Their Tectonic Significance](#).
- Oceanography: [GOBAI-O2: temporally and spatially resolved fields of ocean interior dissolved oxygen over nearly 2 decades](#).
- Geomechanics: [Deformation evolves from shear to extensile in rocks due to energy optimization](#).
- Sedimentology: [Relationships between fluvial dune cross-set thickness, planview width, and trough geometry](#).
- Geophysics: [Interplay of Three-Dimensional Instabilities and Magnetic Reconnection in the Explosive Onset of Magnetospheric Substorms](#).
- More geophysics: [Seismic Reflection Imaging of a Deep-Penetrating Red River Fault in the Yinggehai Basin, Northwest of the South China Sea](#).

Mineralogy

- [New Mineral Names: Heavy metal and minerals from China](#).
- Mineralogy of lunar samples: [Measurement of ferric iron in Chang'e-5 impact glass beads](#).
- Mineralogy of quartz: [Lattice preferred orientation of quartz in granitic gneisses from Tso Moriri Crystalline Complex, Eastern Ladakh, trans-Himalaya: evaluating effect of Dauphiné twin in dynamic recrystallization during exhumation](#).
- Machine identification of minerals: [MineralImage5k: A benchmark for zero-shot raw mineral visual recognition and description](#); behind a paywall, TechExplore summary [here](#).
- [Do Pegmatites Crystallise Fast? A Perspective from Petrologically-Constrained Isotopic Dating](#).

Geochemistry

- [Collective motion in hcp-Fe at Earth's inner core conditions](#); Phys.org summary [here](#).
- [The geochemical characteristics of Cretaceous volcanics in southern Hainan Island and implications for tectonic evolution in the South China Sea](#).

- [Ion imaging of ancient zircon.](#)
- Interaction between the oceans and the lithosphere: [Seafloor spreading and the delivery of sulfur and metals to Earth's oceans.](#)
- [Improving tephrostratigraphy and cryptotephrostratigraphy since 1 Ma of Hole U1437B in the Izu-Bonin arc, NW Pacific: Differentiation of widespread tephra with similar shard chemistries.](#)

Paleontology

- [Pleistocene fossil snake traces on South Africa's Cape south coast](#); Phys.org summary [here](#).
- Evolution of predatory behaviour in animals: [A predatory gastrula leads to symbiosis-independent settlement in Aiptasia](#); Phys.org summary [here](#).
- How dinosaurs grew: [Growth rate affects blood flow rate to the tibia of the dinosaur *Maiasaura*](#); Phys.org summary [here](#).
- Fish evolution: [A continuous fish fossil record reveals key insights into adaptive radiation.](#)
- [Calcareous dinoflagellate blooms during the Late Cretaceous 'greenhouse' world—a case study from western Ukraine.](#)

Mining and Energy

- **Free textbook!** From the Groundwater Project: [Groundwater and Hydrothermal Ore Deposits.](#)
- [Using kaolinite to discover gold, critical mineral deposits.](#)
- [Nickel foam may enhance the performance of lithium-sulphur batteries.](#)
- Another take on peak oil: [Peak crude demand is fueling anger and argument in the world of oil](#); related: [Rystad Energy Sees Oil Prices Falling To \\$60 In 2027 As Demand Peaks.](#)
- Poor little darlings: ['Company of Yesterday': Shell CEO's Plans to Refocus on Oil Induce Staff Anxiety.](#)
- [U.S. exports of natural gas set a record high in the first half of 2023.](#)

Environmental Geology and Hydrogeology

- [Microplastics in the mud: Finnish lake sediments help us get to the bottom of plastic pollution.](#)
- Waste management: [Revolutionizing Plastics Chemical Recycling with Table Salt](#); Phys.org summary [here](#).
- [Opinion: What Industry Knew About the Perils of PFAS.](#)
- More on PFAS: ['Forever chemicals' are eternal no more thanks to a pollution destroying device from Tacoma startup.](#)

Geology

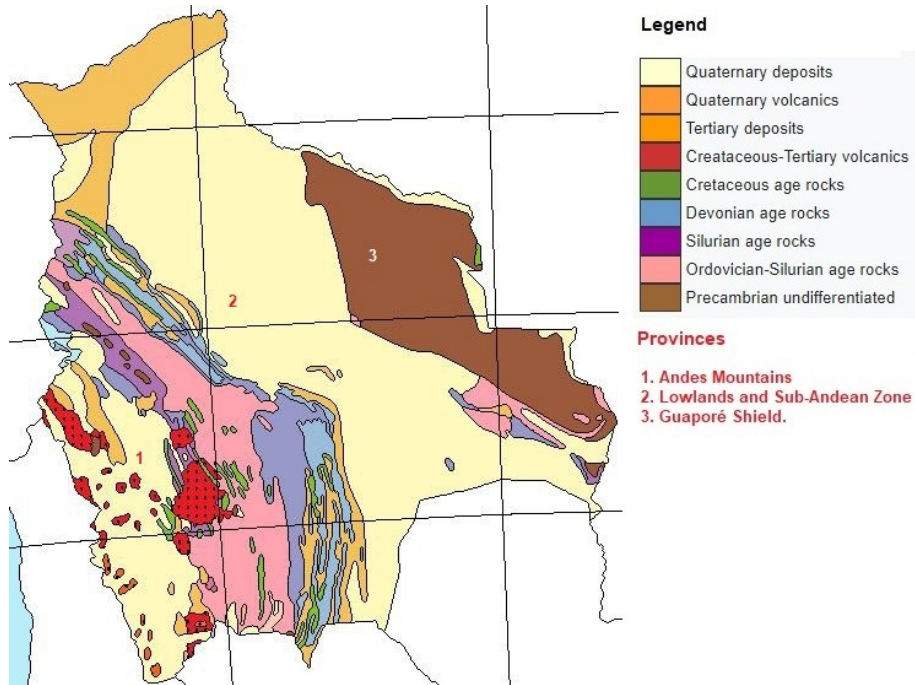


Figure 2 – Geology of Bolivia

Credit: [Chiton magnificus](#), [Creative Commons Attribution-Share Alike 3.0 Unported license](#)

The following is a summary of the [geology of Bolivia](#), follow up on the links for more details.

Structurally, you can divide the geology of the country into three main geological provinces: the [Andes Mountains](#), [Lowlands and Sub-Andean Zone](#), and the [Guaporé Shield](#)(also called the Brazilian Shield).

The Andes



Figure 3 – Bolivia Altiplano

Credit: [ogwen](#), [Creative Commons Attribution-Share Alike 3.0 Unported license](#)

The [Andean Orogeny](#) that raised the Andes Mountains began with uplifts that started during the [Jurassic](#), 200 million years ago. Geologists generally mark the beginning of [the current phase of the Andean Orogeny](#) during the [Paleogene](#), 50 million years ago. The orogeny continues till today. The Andes geological province is further divided into three subprovinces:

- The [Western Cordillera](#), a series of active and extinct volcanoes;
- The [Altiplano Plateau](#), an [intermontane sedimentary basin](#) between the Andes mountain ranges; and
- The [Eastern Cordillera](#), also called the [Bolivian Tin Belt](#), an arc of intrusive igneous rocks, [plutons](#).

Lowlands and Sub-Andean Zone

The province that makes up the Lowlands and Sub-Andean Zone is a feature commonly called a [foreland basin](#). The [Andean Foreland Basin](#), called the [Madre de Dios Basin](#) in Bolivia, is further subdivided into three subprovinces:

- The Bolivian [Fold and Thrust Belt](#), east of the Eastern Cordillera, includes exposures of [Silurian](#) and [Ordovician](#) age [strata](#);
- The Eastern Lowlands, also called the [Chaco–Tarija](#) Basin, includes deposits from the early [Paleozoic](#) to the [Cenozoic](#) with considerable petroleum potential; and
- The Northern Lowlands, also called the [Ucayali Peneplain](#), is an area eroded fairly flat in the [Amazon River](#) basin that is mostly covered by Paleogene, [Neogene](#) and [Quaternary](#) deposits.

Guaporé Shield

A subprovince of the larger [Amazonian Craton](#), the [Guaporé Shield](#) in Bolivia is made of crystalline [Precambrian](#) rocks overlain by Paleogene-Neogene [laterites](#) and Quaternary [alluvial](#) basins. The Guaporé Shield underlies the Chaco–Tarija Basin, forming a [geologic basement](#). The overall geology of the shield is not well known. The province hosts one of the world's largest iron ore deposits, [El Mutún](#), near the border with Brazil.

Resources

Agricultural Resources

As noted above, 34.3% of Bolivia or 371,572 km² is agricultural land. Of this 38,999 km² is arable land, 2,167 km² is permanent crops and 330,407 km² is permanent pasture. The [major crops of Bolivia](#) include sugarcane, soy, maize, potatoes, sorghum, banana, rice, and wheat, with smaller yields of other agricultural products, such as tangerine, cassava, orange, beans, sunflower seed, and cotton. Bolivia's most lucrative agricultural product continues to be [coca](#) (for [cocaine](#)) of which Bolivia is currently the world's third largest cultivator.

Livestock production was mostly cattle but included chickens, pigs, sheep, goats, llamas, alpacas, vicuñas, and buffalo. Statistics from the [United Nations Food and Agriculture Organization](#) are [here](#).

Bolivia is a poor country where approximately 39 percent of Bolivians live in poverty, so [food security is a significant issue](#).



Figure 4 – Potatoes at the Weekly Market in Cochabamba

Credit: [kiki-bolivien](#), [Creative Commons Attribution-Share Alike 2.0 Generic](#) license

Forestry Resources

Of Bolivia's total land area of 1,083,301 km², 52.5% or 568,733 km² is forest, so the [Bolivian forest](#) is important to the country. Like many a poor country, people exploit the forest for fuel and timber, just to make a living, often in an uncontrolled manner. This has led to [concerns for deforestation](#). [Legal controls](#) on forest exploitation exist, however, some of the officials charged with regulating the harvest are themselves [complicit in illegal exploitation](#). More data on forestry in Bolivia is [here](#).

Mineral Resources

Bolivia is a globally significant supplier of ores and mineral concentrates. It is one of the world's leading producer of tin and silver. Bolivia is also a significant producer of antimony, arsenic, boron ([ulexite](#)), lead, tungsten, and zinc. Other mineral commodities produced in the country included (but were not limited to) barite, bismuth, bentonite, boric acid, cement, copper, crude petroleum, gold, gypsum, rock salt, and tantalum. About 21% of the world's reserves of antimony are in Bolivia.



Figure 5 – Lithium mine at Bolivia’s Uyuni Salt Flat

Credit: [Oton Barros](#), [Creative Commons Attribution-Share Alike 2.0 Generic](#) license

In 2019 the USGS estimated Bolivia’s resources of lithium at 9 million tonnes. The major [lithium deposit](#) currently being mined is at the [Uyuni Salt Flat](#). With the interest in [electric vehicles](#), Bolivia’s lithium resources are getting a lot of attention, as in this recent article: [Bolivia's lithium is like white gold in the Salar de Uyuni](#).

Statistics on mineral production in Bolivia is at the USGS document on [The Mineral Industry of Bolivia](#).

Climate

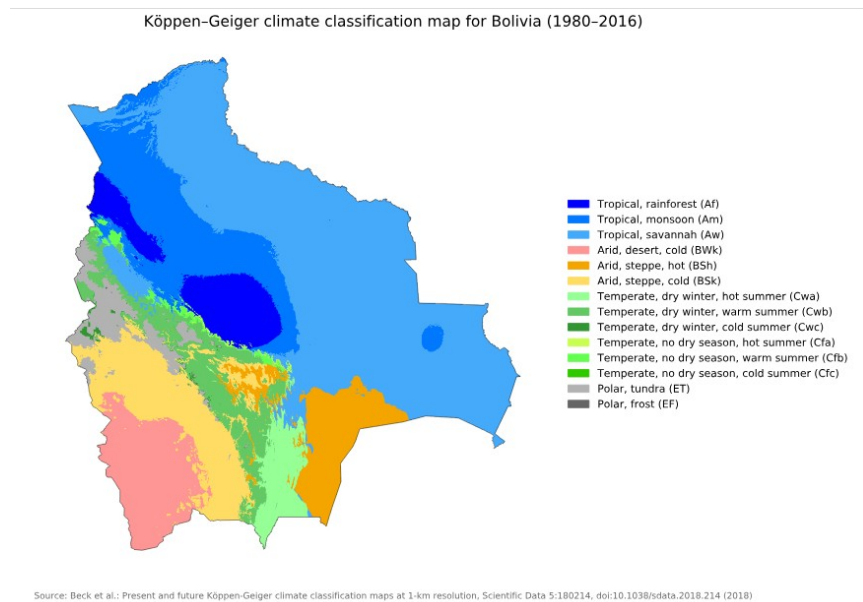


Figure 6 – Köppen-Geiger Climate Map of Bolivia's

Credit: [Beck et al](#), 2020, [Creative Commons Attribution 4.0 International](#) license

As a country located in the mountains, Bolivian climate is largely controlled by elevation. Climates vary from [tropical rainforest](#) at the lowest elevations in the Amazon Basin, to [polar tundra](#) and [polar frost](#) at the top of the Andes mountains. So, if you [plan to visit Bolivia](#), check the particular climate of the places you plan to visit.

History and Geopolitics



Figure 7 – Territorial loss map of Bolivia
Credit: [Library of Congress](#), public domain

You can divide the [history of Bolivia](#) into three general periods:

- The [Pre-Columbian period](#) from around 10,000 B.C. to the Spanish Conquest in 1532;
- The period of [Spanish colonization](#) from 1532 to the [Bolivian war of independence \(1809–1825\)](#); and
- The post colonial period of independence ([1809–1920](#), [1920–1964](#), [1964–1982](#), [1982–present](#)).

Geopolitically, one of the most significant events for Bolivia was the loss of access to the Pacific Ocean in the [War of the Pacific, 1879 to 1884](#). Other wars and disputes with their neighbours also stripped Bolivia territory, as summarized in Figure 7, above.

The history of Bolivia shows the dangers of living with ambitious neighbours. In the Pre-Columbian times, polities such as the [Inca Empire](#) extended their dominion over the people populating modern day Bolivia. The [vast quantities of gold](#) accumulated by the Inca made them an [irresistible magnet for ambitious adventurers](#) such as [Francisco Pizarro](#). The Spaniards ruthlessly exploited Bolivia for its mineral deposits, especially the silver mine at [Potosí](#). Having achieved independence from the Spaniards,

the new rulers of Bolivia found themselves in disputes with other former Spanish colonies. While currently peaceful, the new mineral bonanza of lithium will act as a magnet for ambitious outsiders.

The ambitious outsiders include not only the immediate neighbours but more distant powers such as the [United States](#) and, in more recent times, China. Bolivia's [relationship with the United States](#) has been rocky, with the [Bolivians often suspicious of American intentions](#). In more recent years, Bolivia has entered into trade [relations with China](#); access to [Bolivia's lithium production](#) seems to be reason for China's interest.

A poor country with rich natural resources, Bolivia is in for a dangerous future. Ambitious and desperate international actors could make Bolivia a battleground in [future resource wars](#).

That kind of wraps up this geopolitical post. Check out the links if 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.