

June 5, 2023

News and notes

Before going on to discuss how geology has affected the fate of [Armenia](#), here are some news items I thought were interesting.

Recommendation

- I strongly recommend reading today's posting in [Surplus Energy Economics](#).

Research

- From the American Mineralogist: [A shallow salt pond analog for aqueous alteration on ancient Mars: Spectroscopy, mineralogy, and geochemistry of sediments from Antarctica's Dry Valleys](#); behind a paywall, get access at [Research Gate](#).
- Plate tectonics: [Calabrian forearc uplift paced by slab–mantle interactions during subduction retreat](#); Phys.org summary [here](#).
- Hydrothermal activity and sea floor manganese deposits: [Hydrothermal ferromanganese oxides around a petit-spot volcano on old and cold oceanic crust](#); Phys.org summary [here](#).
- Coastal geology: [Can California's coastline be saved? Study shows up to 70% could be wiped out by 2100](#).
- Ancient coastal geology: [Early Pleistocene River-Fed Paleocoast in Western Umbria \(Central Italy\): Facies Analysis and Coastal Models](#).
- Petrology: [Early Cretaceous trachytes and basement rocks from northeastern Mongolia: a Sr-Nd-Pb isotope study](#).
- [China is Drilling a 32,808 -foot Deep Hole into the Earth](#).

Paleontology

- Early life during the Precambrian: [Uncovering the Ediacaran phosphorus cycle](#); Phys.org summary [here](#).
- [Woman walking on California beach finds ancient mastodon tooth](#).
- [Paleontologists discover elephant graveyard in North Florida](#).
- [Oldest pterosaur remains from Australia: evidence from the Lower Cretaceous \(lower Albian\) Eumeralla Formation of Victoria](#); Phys.org summary [here](#).
- Ichthyosaurs: [Exceptional X-Ray contrast: Radiography imaging of a Middle Triassic mixosaurid from Svalbard](#); Eureka Alert summary [here](#).

- I love turtles: [The helochelydrid turtle *Helochelydra nopcsai* from the Early Cretaceous \(late Barremian – early Aptian\) fissure fills of Balve, North Rhine-Westphalia, Germany, including a large sample of granicones.](#)

Environmental Geology and Hydrogeology

- [Multi-scale mapping of Australia's terrestrial and blue carbon stocks and their continental and bioregional drivers](#); Phys.org summary [here](#).
- Remediation techniques, bugs that eat oil: [Candidatus Alkanophaga archaea from Guaymas Basin hydrothermal vent sediment oxidize petroleum alkanes](#); Eureka Alert summary [here](#).
- Water quality: [As water levels drop, the risk of arsenic rises.](#)
- Lead pollution: [Isotopes illustrate vertical transport of anthropogenic Pb by reversible scavenging within Pacific Ocean particle veils.](#)
- Groundwater chemistry: [Characterization of trace elements in thermal and mineral waters of Greece.](#)
- Subsurface radioactive waste disposal research: [Radionuclide Transport Simulations Supporting Proposed Borehole Waste Disposal in Israel.](#)

Glaciers and Climate Change

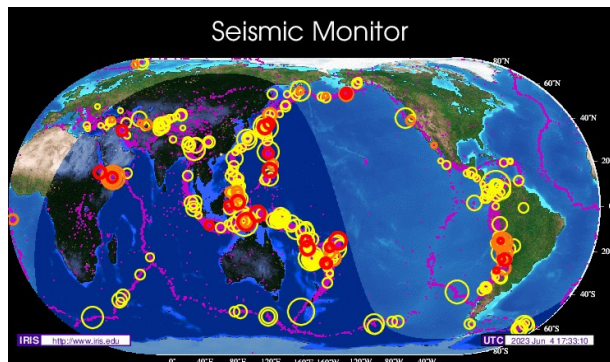
- [Greenlandic glacial rock flour can help fight climate change, show two new studies](#); two research articles [here](#) and [here](#).
- Antarctica: [Geological sketch map and implications for ice flow of Thwaites Glacier, West Antarctica, from integrated aerogeophysical observations](#); Phys.org summary [here](#).
- Periglacial environment: [Distribution and Morphometry of Thermocirques in the North of West Siberia, Russia.](#)

Mining and Energy

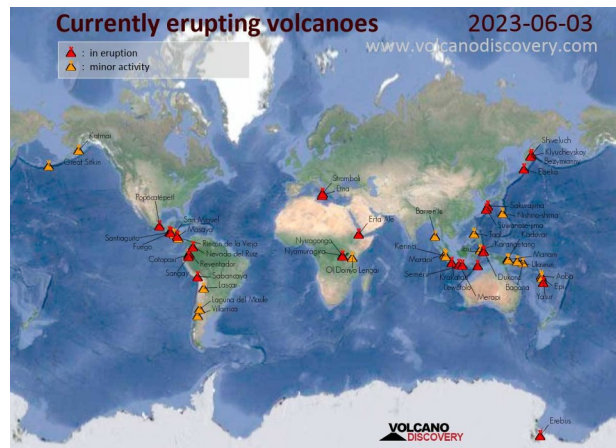
- The [Atlas of Australian Mine Waste](#); Phys.org summary [here](#).
- Exploration techniques: [Sensing prior constraints in deep neural networks for solving exploration geophysical problems.](#)
- Mineral deposit research: [Niobium, Critical Metal, and Progeny of the Mantle](#); behind a paywall but you can request a PDF through [Research Gate](#).
- Porphyry copper deposits: [Tourmaline Breccias from the Río Blanco-Los Bronces Porphyry Copper District, Chile: Constraints on the Fluid Source and the Utility of Tourmaline Composition for Exploration.](#)
- Cobalt deposits: [Cobalt mineralogy at the Iron Creek deposit, Idaho cobalt belt, USA: Implications for domestic critical mineral production.](#)

- Ore deposit geology: [Crustal architectural controls on critical metal ore systems in South China based on Hf isotopic mapping.](#)
- Extraction research: [Protein helps separate rare earths more efficiently than new tech.](#)
- [OPEC+ discussing deepening oil production cuts.](#)
- Exploration activity: [US oil rig count falls by most since September 2021, Baker Hughes says.](#)
- Opinion: [A Matter of Fact: The Trans Mountain Expansion is Good for Canada.](#)
- Reservoir research, [Development characteristics and main controlling factors of Carboniferous volcanic reservoirs in the Shixi area, Junggar Basin.](#)
- More research: [Distribution characteristics of organic matter in the Fengcheng Formation in Mahu Sag, Junggar Basin: implications for hydrocarbon generation model in alkaline lacustrine deposition.](#)
- Natural gas reservoir: [Implication of the micro- and lithofacies types on the quality of a gas-bearing deltaic reservoir in the Nile Delta, Egypt.](#)

Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

- From the United States Geological Survey (USGS): [Volcano Watch — Volcano monitoring from space: InSAR time series success in Alaska.](#)
- [M5.8 earthquake near the northern Sagaing Fault shakes Myanmar.](#)
- USGS Report: [M 5.9 Earthquake in the Gulf of Aden.](#)
- Man-made earthquakes: [Could the rush for lithium near California's Salton Sea trigger earthquakes?](#)
- [NASA researchers detect tsunamis by their rumble in the atmosphere.](#)

June 5, 2023

Geology and the Fate of Societies – Armenia

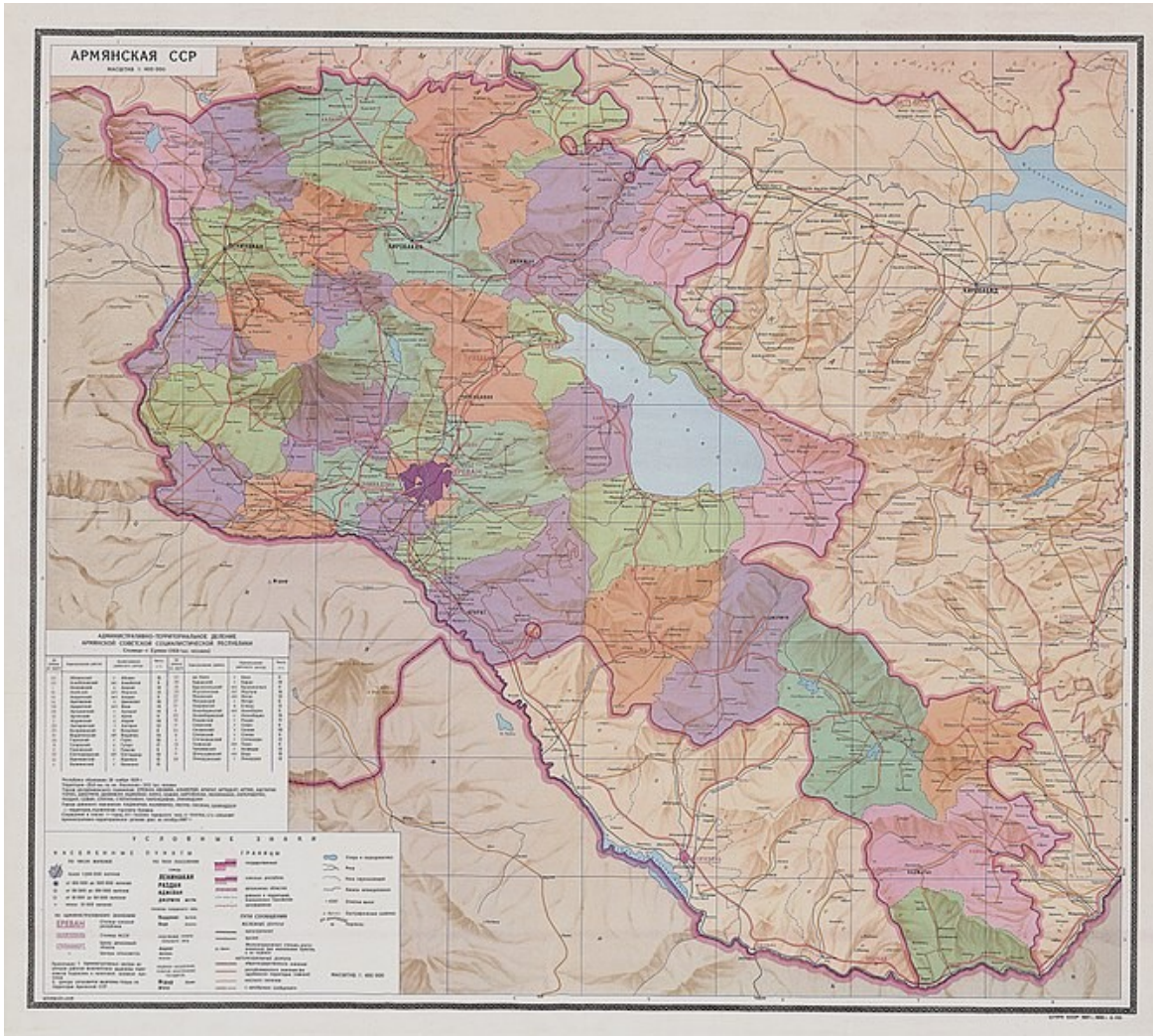


Figure 1 – Map of the Armenian Republic, 1988

Credit: ГЯГК СССР, public domain

[Armenia](#) is an ancient country in the [Caucasus Mountains](#) with a history that goes back to the [Bronze Age](#). [The CIA Factbook](#) estimates the population of Armenia as 2,989,091 and lists the area of the country as 29,743 km², of which 28,203 km² is land and 1,540 km² is water. Armenia is a mountainous country, and only a small portion of its territory is located below 1,000 meters above sea level (masl).

Armenia is an [ethno-state](#) where most, 98.1%, of the people are a single nationality, in this case [Armenian](#). The remaining people include 1.2% [Yezidis](#) and 0.7% others. It is bordered by [Turkey](#) to the west, [Georgia](#) to the north, the [Lachin corridor](#) (under a [Russian peacekeeping force](#)), [Azerbaijan](#) to the east, with [Iran](#) and the Azerbaijani [exclave](#) of Nakhchivan to the [south](#).

Geology

Much of the geology of Armenia has its origins in the deposits of the ancient [Tethys Ocean](#) that were formed into the [Armenian Plateau](#) of the Caucasus Mountains during the [Alpine Orogeny](#) some 25 million years ago.

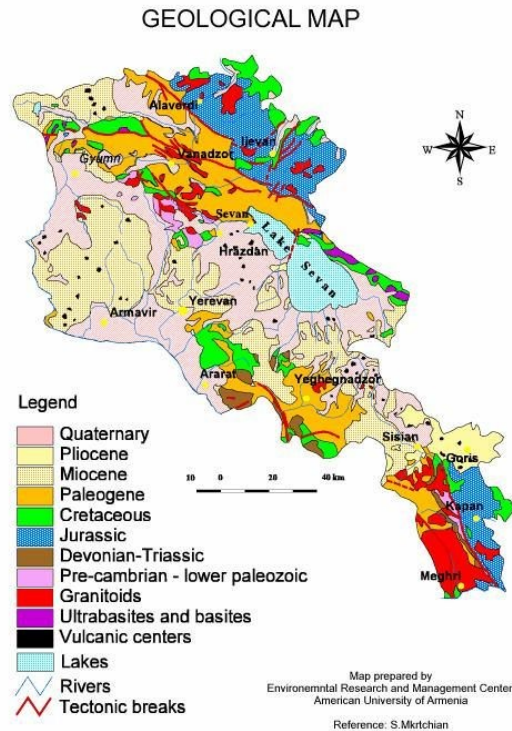


Figure 2 – Geological Map of Armenia

Credit: [American University of Armenia](#), public domain

The geological map in Figure 2 is fairly basic, the USGS has prepared a more detailed geological map that you can download [from this site](#).

Geologic deposits in Armenia range in age from [Proterozoic](#) to [Quaternary](#), as follows:

Quaternary deposits include:

- Alluvial, lacustrine and glacial gravels, sandstones and clay;
- Volcanic lava, cinder cone deposits, [tuffs](#), [volcaniclastics](#) and [travertine](#).

[Pliocene](#) deposits include:

- Volcanic lava, tuffs and volcaniclastics;
- Conglomerates, sandstones, clay and [diatomaceous](#) clay.

[Oligocene-Miocene](#) deposits include:

- Volcanic rocks and tuffs;
- Gypsum and halite [evaporites](#);

- Sandstones and clay.

[Eocene](#)-Oligocene include:

- Conglomerates, sandstones siltstone, slates, and clay;
- Volcanic, volcanics, [porphyry](#) and tuffs;
- Limestone and [marl](#).

[Cretaceous](#) deposits include:

- Sandstone, siltstone and conglomerates;
- Volcanic and volcanics;
- Limestone and marl.

[Jurassic](#) deposits include:

- Limestone, dolomite and [quartzite](#);
- Sandstone, shale, [breccia](#), conglomerate;
- Volcanic, volcanics and porphyry;
- [Schist](#).

[Triassic](#) deposits include:

- Terrigenous carboniferous rocks and dolomitic limestones.

[Permian](#) deposits include:

- Limestone and bituminous schist.

Upper [Paleozoic](#) deposits include:

- Limestone, sandstone, schist, and quartzite.

Proterozoic-Early Paleozoic deposits include:

- Schist, limestone and marble;
- Volcanic rocks.

Intrusive rocks include:

- Miocene [dacite](#), [andesitic dacite](#), [trachyrhyolite](#);
- Oligocene [porphyritic granite](#), [granodiorite](#), and [monzonite](#);
- Eocene-Oligocene granodiorite, monzonite, [diorite](#), [granite](#), monzonite, [gabbro](#), [gabbro-diorite](#), [pyroxenite](#), [pseudo-leucite](#), [nepheline](#), and [alkali syenite](#);

- Eocene subvolcanic [quartz porphyry](#), [albite](#), and [rhyolite-dacite](#);
- Late Cretaceous-Eocene granite, granodiorite, diorite, gabbro, and albite;
- Jurassic-Cretaceous [ophiolite](#) complex, gabbro-pyroxenite, [peridotite](#), [dunite](#) and [serpentine](#);
- Mesozoic [leucocratic granite](#), [migmatite](#), [microcline](#) granite, diorite, gabbro-diorite, and [granite-gneiss](#); and
- Paleozoic metamorphosed gabbro and pyroxenite.

Armenia has some some interesting fossils, check out [Dinosaurs of Armenia](#) at Fossil Fandom.

One of the earliest scientific papers on the geology of Armenia is a 1906 thesis by Felix Oswald for a Doctorate of Science degree from the University of London and available for download [here](#).

Resources

Agricultural Resources

About 72% of Armenia's land area, some 2.1 million hectares (ha), is used for [agricultural purposes](#). However, much of this is pasture land. Approximately 480,000 ha is cultivable land, of which 452,900 ha is arable land and 27,300 ha is used for orchards and vineyards.

In 2018 [Armenia produced](#)

- 415 thousand tons of potatoes
- 199 thousand tons of other vegetables
- 187 thousand tons of wheat
- 179 thousand tons of grape
- 138 thousand tons of tomatoes
- 126 thousand tons of watermelons
- 124 thousand tons of barley
- 109 thousand tons of apples
- 104 thousand tons of apricots (12th largest world producer)
- 89 thousand tons of cabbages
- 54 thousand tons of sugar beets
- 52 thousand tons of peaches
- 50 thousand tons of cucumbers
- 39 thousand tons of onions

[Livestock production](#) in 2006 reached 66,800 tons of meat (slaughter weight), 620,000 tons of milk, and 464 million eggs.

Overall, [Armenia is generally self-sufficient in food](#).

Mineral Resources

Mineral resources produced includes [molybdenum](#), copper, gold, lead silver and zinc. Industrial minerals include [basalt](#), [diatomite](#), granite, [gypsum](#), limestone, and [perlite](#).

In 2018 [Armenia produced](#):

- 68,928 tonnes of copper concentrates and 8,831 tonnes of primary blister smelter copper;
- 7,275 tonnes of ferroalloys and ferromolybdenum;
- 5,000 kg of gold;
- 18,000 tonnes of iron and steel products;
- 5,422 tonnes of molybdenum concentrate;
- 281 kg of rhenium;
- 18,700 kg of silver;
- 6,500 tonnes of zinc.
- 546 tonnes of hydraulic cement;
- 21,029 tonnes of bentonite clay;
- 229,396 carats of industrial diamonds;
- 20,000 tonnes of diatomite;
- 20,387 tonnes of gypsum
- 42 tonnes of lime;
- 22,583 tonnes of salt; and
- 58,906 tonnes of crushed stone.

There are around seven copper-molybdenum mines, three copper mines, 13 gold and gold-polymetallic mines, 2 polymetallic mines and 2 iron ore mines. As well, there are around 670 mines for construction and aggregate minerals. There are also an additional 115 deposits of various deposits that have been discovered.

One thing that came up in looking into the mining industry in Armenia is that it has often not been done in an [environmentally responsible fashion](#). Some of this has been due to lax practices that were tolerated during Soviet times and some due to simple neglect. Since the end of Soviet rule, mining firms have [often battled with locals](#) over environmental destruction due to mining.

Climate

Overall, the Armenian climate is continental, with cold winters and hot summers. It is also a dry climate with precipitation is not usually abundant.

Temperature and precipitation is dependent on altitude. With increasing altitude, the climate becomes colder and precipitation (rain and snow) increases. At lower elevations, rainfall is scarce and the summer is very hot. The western region, around the capital Yerevan and where the elevation is less than 1,000 masl, is also the driest region with where precipitation less that 300 mm per year

Cold air masses predominate in the winter, and after having reached the country from the north, they tend to stagnate in the valleys, causing severe frosts. Spring is unstable and when there are the most frequent rains. Summer is dry and sunny, but with some afternoon thunderstorms in the mountains.

An interesting feature of Armenian climate are dry and warm down-slope winds similar to the [Föhn](#) or [Chinook](#). These winds ameliorate the winter but can also increase summer heat.

Köppen-Geiger climate classification map for Armenia (1980-2016)

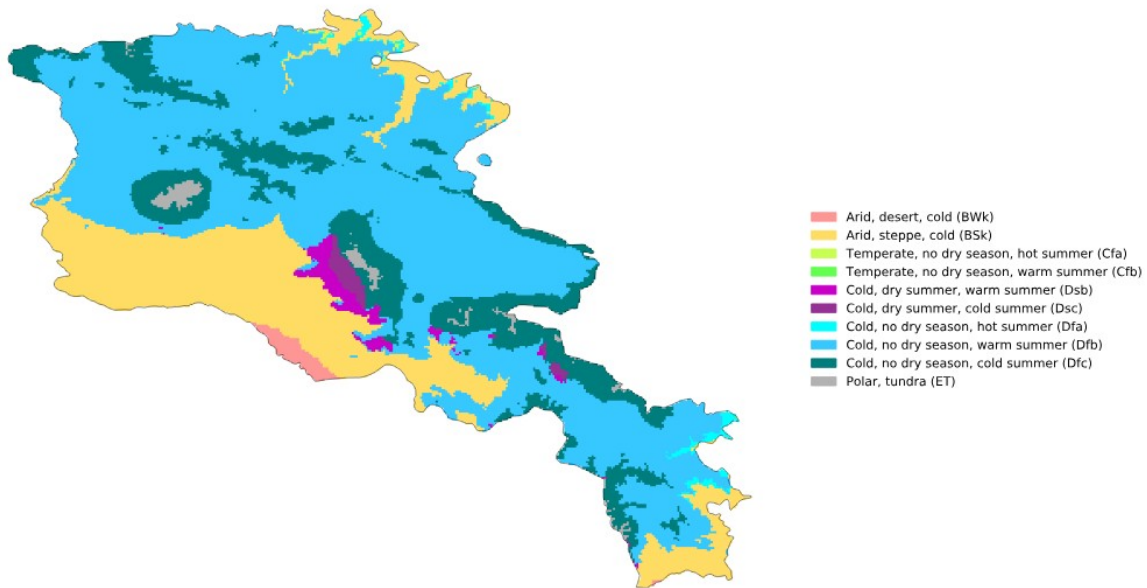


Figure 3 - Köppen-Geiger Climate Classification Map for Armenia
Credit: Beck et al, 2018, Creative Commons Attribution 4.0 International license

History and Geopolitics



Figure 4 - Map of Arshakuni Armenia, Around the Year 150 AD
Credit: Sémhur, Creative Commons Attribution-Share Alike 4.0 International, 3.0 Unported, 2.5 Generic, 2.0 Generic and 1.0 Generic license

[The history of Armenia](#) goes back to the Bronze Age when [Indo-European](#) speaking peoples migrated into the Armenian Plateau. For some of the time they formed independent political entities (polities) and

at other times they were part of larger empires. This situation is at the heart of Armenian geopolitics, they live next to more powerful neighbours and must find an accommodation to preserve their autonomy.

Important phases in Armenian history include:

- The earliest Armenian polity was the [Kingdom of Urartu](#);
- The conquest of Urartu by the Assyrians in 714 BC and the later incorporation of Armenia into the Persian and Macedonian empires.
- Foundation of an Armenian state under the Artaxiad dynasty in 190 B.C.
- After 1 AD the western part of Armenia became part of the Roman Empire in 1 AD with eastern part being a somewhat autonomous part of the Sassanian and Parthian (Persian) Empires.
- In 301, Armenia became the first nation to adopt Christianity as a state religion.
- During the Middle Ages, Armenia was fought over by the Eastern Roman (Byzantine) Empires and various Muslim caliphates, Arab, Turkish and Persian.
- Sometimes Armenians would form an independent state, such as [Cilicia](#) (1198–1219 AD), but these independent states would eventually be swallowed up by larger empires.
- In 1828, following the [Russian – Persian War](#), part of Armenia was incorporated into the Russian empire; this is the area that makes up most of the modern Armenian state.
- In 1914-1918, the Armenian communities in the Ottoman empire were [destroyed in a genocide](#).
- Following the [Russian Revolution](#) of 1917, Armenia was independent from 1917 to 1920, when they were [incorporated in the Soviet Union](#).
- In 1991, following the collapse of the Soviet Union, Armenia became an independent republic.

Current Condition

Armenia is currently an independent republic. Their biggest geopolitical issue is how to maintain their independence. Armenia's Russian neighbour is probably their biggest challenge. As the major power of the [World Island](#), Russia will always have an interest in the affairs of the smaller states around their periphery, such as Armenia. Iran (Persia) and Turkey also have interests in Armenia, and relations with them present a challenge.

Another geopolitical headache for Armenia is the [conflict regarding Nagorno-Karabakh](#). The population of Nagorno-Karabakh is largely ethnic Armenian but Nagorno-Karabakh lies mostly within Azerbaijan. The troubles began in 1988, when the people living in Nagorno-Karabakh demanded that the territory be made part of the then Armenian Soviet Socialist Republic. Following the breakup of the Soviet Union, armed conflict broke out between Armenia and Azerbaijan; a war that lasted until 1994. Another war broke out in 2020, with the Russians arranging a ceasefire that included the stationing of Russian peace keeping troops. Aggravating the territorial dispute is that the [Azeris \(Azerbaijanis\)](#) are a Turkish people and the Armenians have long memories of the genocide carried out by Turks against the Armenians

during World War 1. Given the depth of feeling on both sides of the conflict, it is likely to continue again if the Russians are not able to maintain their peace keeping force due to the Ukrainian war now underway.

The Russian intervention in the Nagorno-Karabakh dispute shows another threat to Armenian independence, namely that neighbouring powers may choose to intervene in any dispute that Armenia to further their own aims. Armed conflict near one's border is undesirable, so Russia, Iran and Turkey all have an interest in the Nagorno-Karabakh dispute. Also, each of these powers have historical interests in Armenia and may want to re-incorporate Armenia into their territory. For Armenia, the trick might be to play off one against the other. Alternatively, it might be better to closely align with the power whose culture is friendliest to Armenia. This would point to Armenia throwing it's lot in with Russia since both Iran and Turkey are Moslem and unlikely to look kindly on Armenia's national Christian religion. On the other hand, Russian nationalists often take a protective view of Armenian Christians. I expect that Armenia will seek to maintain close relations with Russia, as the least bad of other alternatives.

That winds it up for this short look at Armenia. If this interests you, follow up on the links and check things out for yourself.

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.