

*June 19, 2023*

## News and notes

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

## General Science

- Keeping it honest: [Critical Social Justice Subverts Scientific Publishing](#).

## Research

- Plate tectonics: [Secular craton evolution due to cyclic deformation of underlying dense mantle lithosphere](#); behind a paywall, Science Daily summary [here](#).
- Plate tectonics: [A younger and protracted emplacement of the Ontong Java Plateau](#); Phys.org summary [here](#).
- Coastal geology: [Does vegetation accelerate coastal dune erosion during extreme events?](#) Phys.org summary [here](#).
- Geophysics: [The global geomagnetic field over the historical era: what can we learn from ship-log declinations?](#)

## Paleontology

- Dinosaurs: [Relict duck-billed dinosaurs survived into the last age of the dinosaurs in subantarctic Chile](#); Phys.org summary [here](#).
- More dinosaurs: [Vectipelta barretti, a new ankylosaurian dinosaur from the Lower Cretaceous Wessex Formation of the Isle of Wight, UK](#); Phys.org summary [here](#).
- Early plants: [Leaves and sporangia developed in rare non-Fibonacci spirals in early leafy plants](#); Phys.org summary [here](#).
- Plant evolution: [Reconciling fossils with phylogenies reveals the origin and macroevolutionary processes explaining the global cycad biodiversity](#); Phys.org summary [here](#).
- Amber: [Biomarkers in fossil resins and their palaeoecological significance](#); Phys.org summary [here](#).

## Glaciers and Climate Change

- The periglacial environment: [Field investigation on the spatiotemporal thermal-deformation characteristics of a composite embankment with two-phase closed thermosyphons on a permafrost slope](#); behind a paywall, Phys.org summary [here](#).

## Environmental Geology and Hydrogeology

- [Lead contamination of the deep Pacific Ocean via exchange with sinking particles](#).



June 19, 2023

## Geology and the Fate of Societies – Austria



Figure 1 – Map of Austria

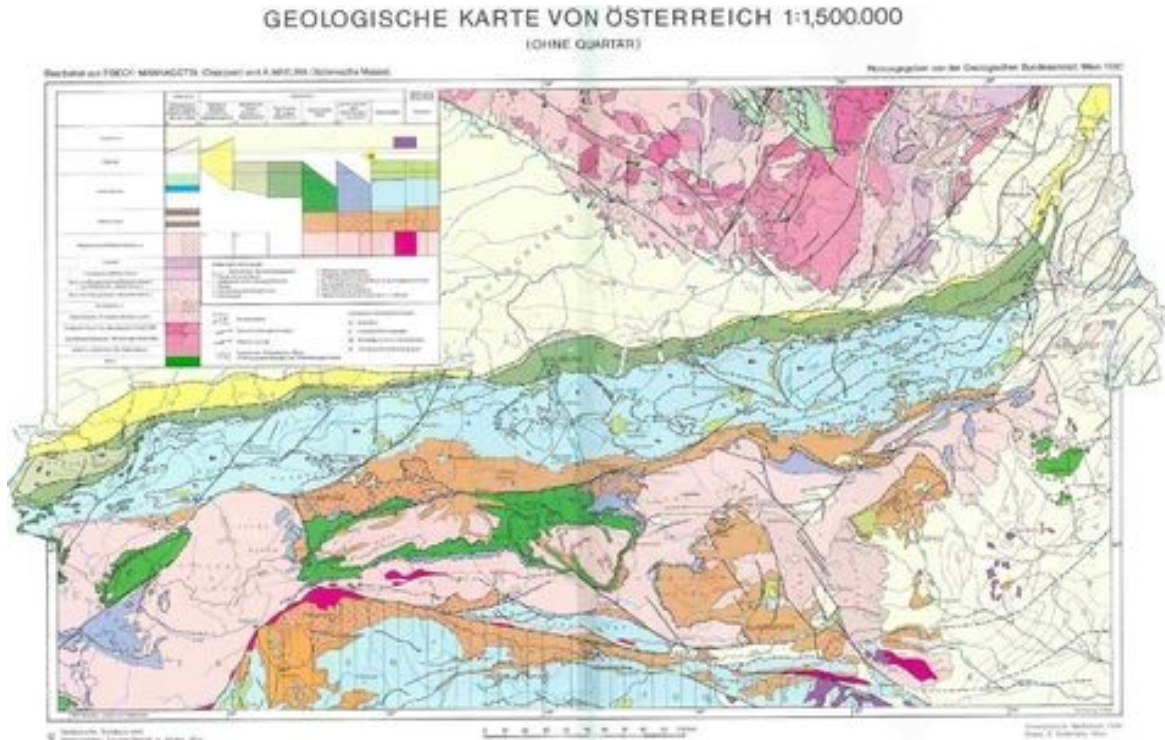
Credit: CIA World Factbook, public domain

[The Republic of Austria](#) is a small country with a big history and it has played an important part in world history. According to the [Central Intelligence Agency \(CIA\) World Factbook](#), Austria has a total area of 83,871 square kilometres (km<sup>2</sup>) of which 82,445 km<sup>2</sup> is land and 1,426 km<sup>2</sup> is water. Austria is landlocked and is bordered by [Switzerland](#) and [Lichtenstein](#) to the west, [Germany](#) to the northwest, the [Czech Republic](#) to the north, [Slovakia](#) to the northeast, [Hungary](#) to the east, with [Slovenia](#) and [Italy](#) to the south.

The CIA World Factbook estimates the current population of Austria at 8,940,860 (a fairly precise “estimate”). Based upon country of birth: 80% of the population is Austrian, 2.6% is German, 1.9% is Bosnian-Herzegovinian, 1.8% is Turkish, 1.6% is Serbian, 1.3% is Romanian, and 10% is other. Languages spoken at home include: German 88.6%, Turkish 2.3%, Serbian 2.2%, Croatian 1.6%, and other 5.3%.

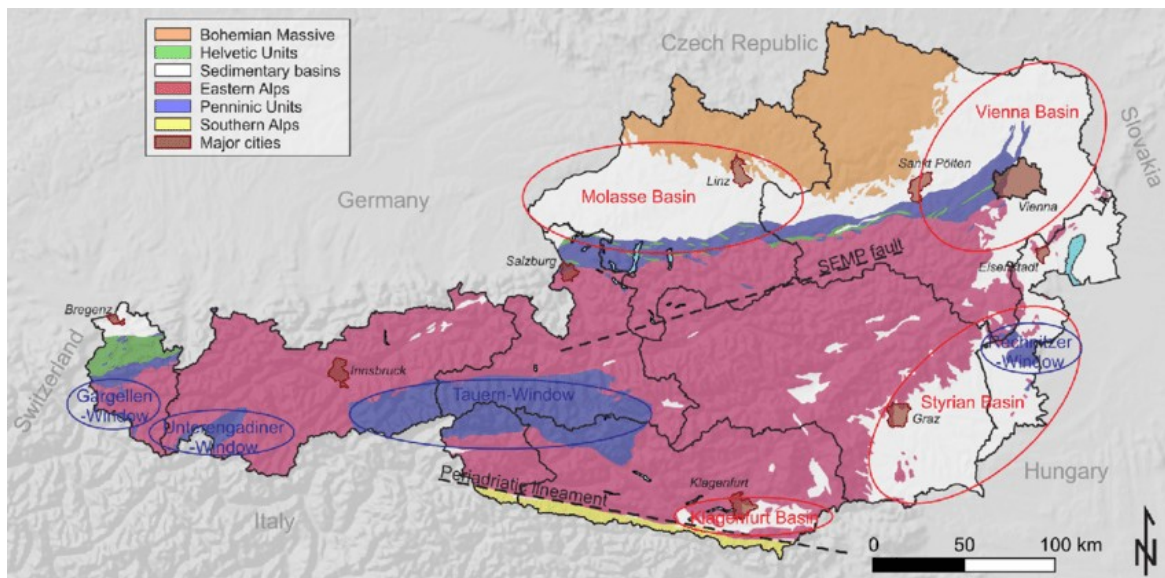
The capital of Austria is [Vienna](#), some [judge it the most beautiful city in Europe](#).

## Geology



**Figure 2 – Geological Map of Austria**  
**Credit: Gifex, public domain**

The [geology of Austria](#) is the geology of deposits formed in the [Tethys Ocean](#) and uplifted in a series of [orogenies](#) culminating in the [Alpine Orogeny](#). Figure 2, above, summarizes the complex geology of Austria and Figure 3, below, summarizes the predominant geological structures in Austria.



**Figure 3 – Predominant Geological Structures in Austria**  
**Credit: Figure 1 in Welkenhuysen et al, 2016**

## **Quaternary**

The [Quaternary Period](#) in Austria was marked by wide scale glaciations and interglacials:

- The current [Holocene](#) interglacial beginning 11,700 years ago;
- [Wurm Glaciation](#), 115,000 to 11,700 years ago;
- [Eemian Interglacial](#), 130,000 to 115,000 years ago;
- [Riss Glaciation](#), 300,000 to 130,000 years ago;
- [Holstein Interglacial](#); 337,000 to 300,000 years ago;
- [Mindel Glaciation](#), 374,000 to 337,000 years ago;
- [Haslach-Mindel Interglacial](#), ended 374,000 years ago;
- [Haslach Glaciation](#), time span not agreed upon;
- [Gunz-Haslach interglacial](#), time span not agreed upon;
- [Gunz glaciation](#), time span not agreed upon;
- [Danube-Gunz interglacial](#), time span not agreed upon;
- [Danube glaciation](#), time span not agreed upon;
- [Biber-Danube interglacial](#), time span not agreed upon; and the
- [Biber glaciation](#), 2.6–1.8 million years ago.

Most surface deposits in Austria are glacial in origin including sedimentary terraces up to 300 meters thick in the Inn Valley.

## **Neogene and Paleogene**

During the [Neogene](#) and [Paleogene](#) periods, the Alpine portion of the Tethys Ocean closed, creating the [Penninic](#) nappes. The tectonic collisions of the Alpine Orogeny created the various ranges of the Alps such as the [Koralpe](#) and [Sausalpe](#) mountain ranges and [synclines](#) such as [Molasse](#), [Styrian](#), and [Vienna](#) basins.

Igneous rocks deposited during the Neogene and Paleogene periods include [tonalite](#), [granite](#) and [basalt](#). Sedimentary deposits during this time include the [Schoeneck Fish Shale](#), as well as [sandstones](#) and [conglomerates](#) associated with the erosion of the igneous rocks noted above. The Alpine Orogeny subducted marine and continental rock creating metamorphic [eclogite](#), [blueschist](#) and [ophiolite](#) rocks.

## **Cretaceous and Jurassic**

During the [Cretaceous](#) and [Jurassic](#) periods, the supercontinent [Pangea](#) broke up, forming the Tethys Ocean, among others. Rocks from this period in Austria include [serpentinite](#) and [breccias](#) from tectonic activity, and deep water sedimentary deposits such as [turbidites](#).

### ***Triassic, Permian and Carboniferous***

The major event during the [Triassic](#), [Permian](#) and [Carboniferous](#) periods was the [Variscan Orogeny](#), which created the supercontinent Pangea. Important igneous rocks formed in the Variscan Orogeny include basalt, granite, [pegmatite](#) and the [quartz porphyry](#). Sedimentary deposits of note from the Triassic, Permian and Carboniferous in Austria include the [dolomite](#) deposits of South Tyrol, the [Hallstatt Limestone](#) and the [Hallstatt Evaporite](#) deposits.

### ***Devonian and Silurian***

The significant tectonic events during the [Devonian](#) and [Silurian](#) periods in Austria were the assembly of Pangea by the northward movement of [Gondwana](#).

[Carbonate bank](#) deposits, predominately [limestone](#), formed during the Devonian. This period of time in Austria also saw the creation of [island arcs](#) as shown in the [amphibolite](#) and [gneiss](#) of the [Hohe Tauern](#) mountain range. Basin formation at the end of the Devonian allowed the creation of [coal](#) deposits in the [Tyrol](#) and [Carinthia](#).

The Silurian saw the opening the [Paleo-Tethys Ocean](#) caused by [crustal extension](#) on the northern fringe of Gondwana. Basins that opened during this time in Austria resulted in the deposition of sandstone, [shale](#), and calcareous (limestone, dolomite, [marl](#)) deposits. Also associated with the crustal extension were extrusions of basalt and [andesite](#) that later metamorphosed into amphibolite and [greenschist](#) rocks.

### ***Ordovician***

The movement of [tectonic plates](#) over time placed what is now Austria near the South Pole during the [Ordovician](#) Period. Some shale, sandstone and [greywacke](#) sedimentary rocks in Austria date from the Ordovician. Basalts and [pyroclastic flow](#) deposits of the [Blaseneck Porphyroid](#) also date from the Ordovician in Austria.

### ***Cambrian***

The oldest rocks in Austria date from the [Cambrian](#) Period although [detrital zircons](#) dating from earlier in the Precambrian have been found. During the [Cadomian Orogeny](#), smaller continental cratons, such as the [Bohemian Massif](#), [accreted](#) onto Gondwana. In Austria this is shown in the [Maissau](#) granites of the Bohemian Massif. Also, during the Cambrian, some small crustal [microcontinents](#), such as the [Moravian Superunit](#), formed with the opening of the [Rheic Ocean](#).

## **Resources**

### ***Agricultural Resources***

Austria is a wealthy country and the value of food it [exports](#) is greater than the value of food they import, as measured in Euros. According the United Nations Food and Agriculture Organization (FAO), [in 2018, Austria produced:](#)

- 2.3 million tons of sugar beet (the beet is used to manufacture sugar and ethanol);
- 2.1 million tons of maize;
- 1.3 million tons of wheat;
- 697 thousand tons of potato;

- 695 thousand tons of barley;
- 387 thousand tons of apple;
- 367 thousand tons of grape;
- 278 thousand tons of [triticale](#);
- 184 thousand tons of soybean;
- 177 thousand tons of rye (12th largest world producer);
- 132 thousand tons of onion;
- 120 thousand tons of rapeseed;
- 111 thousand tons of pear;

As well as smaller productions of other agricultural products.

### Mineral Resources

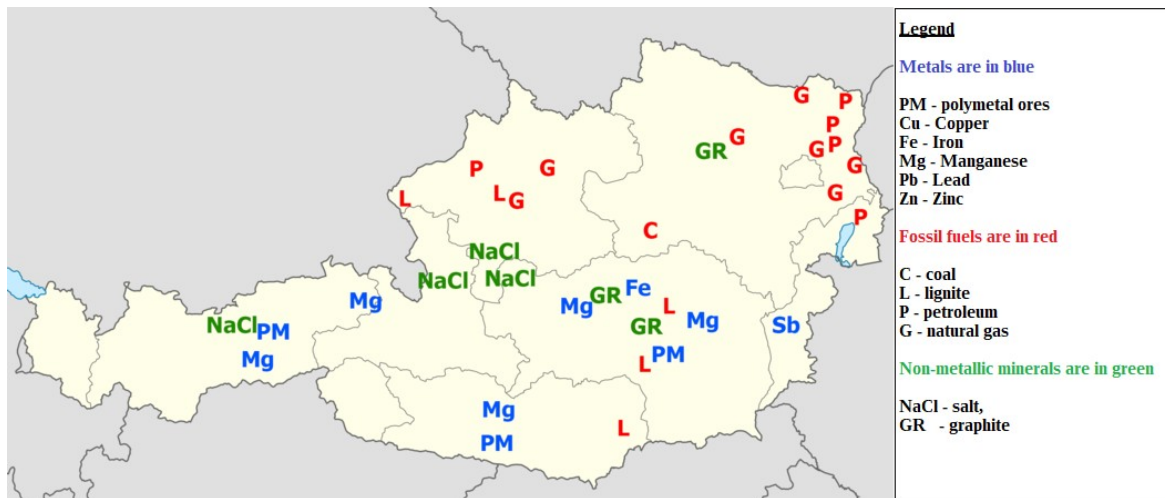


Figure 4 – Mineral Resources of Austria

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

A complete list of mineral production in Austria can be found in this [report from the USGS](#). Here are some highlights of production in 2017-2018:

### Metals

- Copper: 185,000 tonnes
- Iron: 5,269,000 tonnes
- Manganese, as magnesite; 808,000 tonnes
- Lead: 24,000,000 tonnes
- Zinc: 34,000,000 tonnes

### *Fossil Fuels*

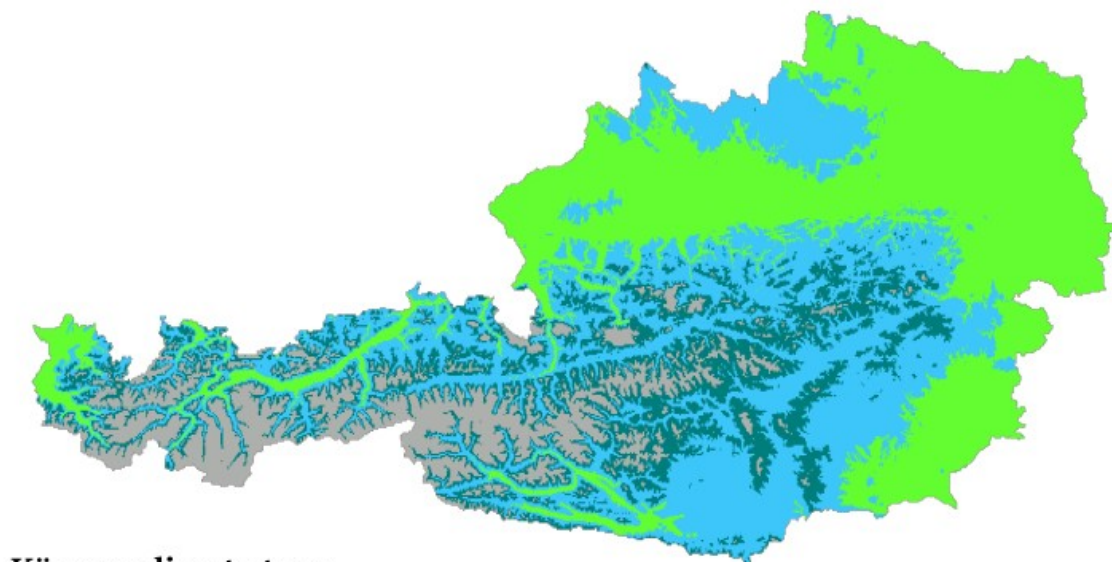
- Coal, metallurgical: 1,350,000 tonnes
- Crude oil: 4,867,000 barrels
- Liquefied natural gas: 1,288,000 barrels

### *Non-metallic Minerals*

- Salt: 2,270,376 tonnes
- Graphite: 1,000 tonnes

## Climate

### Köppen climate types of Austria



#### Köppen climate type

- |                   |                                       |
|-------------------|---------------------------------------|
| ■ EF (Ice-cap)    | ■ Dfb (Warm-summer humid continental) |
| ■ ET (Tundra)     | ■ Cfb (Oceanic)                       |
| ■ Dfc (Subarctic) |                                       |

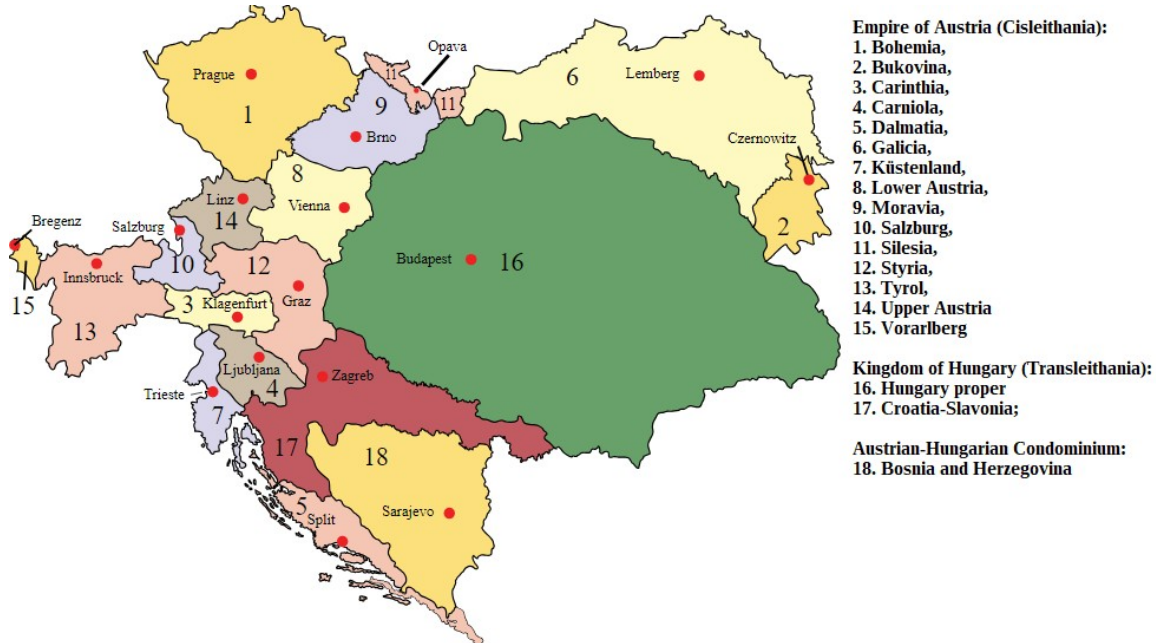
\*Isotherm used to separate temperate (C) and continental (D) climates is  $-3^{\circ}\text{C}$   
Data source: Climate types calculated from data from WorldClim.org

**Figure 5 – Köppen Climate Types of Austria**

**Credit: Adam Peterson, [Creative Commons Attribution-Share Alike 4.0 International](https://creativecommons.org/licenses/by-sa/4.0/) license**

[Climate in Austria](#) is, in large part, controlled by elevation. The warmest areas are at the lowest elevations whereas the coldest areas at the high elevations. Overall, Austria enjoys a pleasant continental climate with warm summers and snowy winters.

## History and Geopolitics



**Figure 6 – Austro-Hungarian Empire in 1914**

**Credit: [IMEowbot](#), public domain**

Austria has a [long history](#) and the modern republic and is a [successor state](#) of a previous large scale polity, the former [Austro-Hungarian Empire](#) (Figure 6, above).

Modern humans first began living in the region of Austria during the [Paleolithic](#), displacing and/or [exterminating](#) the previous [Neanderthal](#) humans who lived in the area. [Neolithic](#) farmers of the [Linear pottery culture](#) began to move into the area around 5500 – 4500 B.C. Later, during the Bronze Age, the [Hallstatt Culture](#) flourished, getting rich in trade from the [Hallstatt salt mines](#). Around 800 to 400 B.C., Celtic tribes established the [Noricum](#) kingdom, which was conquered by and incorporated into the [Roman Empire](#). With the [collapse of the Western Roman Empire around 500 A.D.](#), various war bands, predominately [Germanic](#) but also including tribes such as the Turkic [Avars](#) and the Slavic [Carantanians](#), wandered [through the former Empire](#), pillaging and establishing local chiefdoms and other ephemeral polities. One such war band, the [Bavarii](#), established rule over the former Roman province of Noricum until the [Franks](#), under [Charlemagne](#), incorporated the Bavarii lands into their [Frankish Empire](#).

The Frankish Empire under Charlemagne became the [Holy Roman Empire](#) when [Pope Leo III](#) crowned him Holy Roman Emperor on Christmas Day in 800 A.D. The [Holy Roman Empire](#) included much of modern Germany and Austria.

In 1273, [Rudolf of Habsburg](#) became Holy Roman Emperor. The [Hapsburg family](#) kept ownership of the title of Holy Roman Emperor by various means until 1806, when the Empire was dissolved during the [Napoleonic Wars](#) as no longer having any meaning or utility.

The Hapsburgs did not confine their activities to Germany. After [numerous wars](#) with the aggressive [Ottoman Turkish Empire](#), Austria moved its territory eastward. Austria also participated [in the breakup of the old Polish state](#) and acquired more territories that way. The Hapsburgs were also famous for [marrying their way into new territories](#). By good luck, and diplomacy, the Hapsburgs ended up ruling a huge area of Central and Eastern Europe.

It all fell apart in the [mad catastrophe](#) of the [First World War](#).

After the First world War, the Austro-Hungarian Empire split into a number of successor states: Austria, Hungary, [Czechoslovakia](#), [Poland](#), and [Yugoslavia](#). The new Austrian republic had many troubles after 1918 and, in 1936, [Germany incorporated Austria](#) into the [Third Reich](#). After the bigger catastrophe of the [Second World War](#), Austria became an independent republic again, but only after a ten year occupation by the [Soviet Union](#) and the [United States](#). Officially neutral during the so-called [Cold War](#), Austria joined the [European Union](#) in 1995.

### *Note on Charlemagne*



**Figure 7 – Charlemagne, empereur d'Occident (742-814)**  
**Credit: [Louis-Félix Amiel](#) (1802–1864), [public domain](#)**

An interesting coincidence is that Charlemagne's old empire pretty well lines up with the boundaries of the current European Union. Some ideas, good or bad, don't entirely go away and Charlemagne is sometimes considered the [Father of Europe](#). There may be more to the title than rhetoric since Charlemagne had many [wives, concubines and consequent children](#); the vagaries of human sexuality almost ensures that [most Europeans are, in some way, related to Charlemagne](#).

### **Current Condition**

Austria's lies on the European side of [Mackinder's World Island](#). As a part of the European Union, it has a fair amount of independence but also has the advantages of being within a large free-trade zone, much as it had when it was the ruler of the Austro-Hungarian Empire. Overall, Austria appears to have done

well economically in a union with like-minded nations with which Austria shares political and cultural values.

Membership within the European Union also brings a level of security that a smaller nation like Austria could not normally afford on its own. It's going to need it. The fallout from [breakup of the former Yugoslavia](#) continues today, for example with the issue of [Kosovo](#) that we looked at in the posting on [Albania](#). Another problem that can disturb the peace of Austria is the [continuing war in Ukraine](#).

Finally, like many other developed nations, Austria is a destination for refugees fleeing all sorts of wars and civil disturbances. [Austria is home to around 160,000 protection holders \(by mid-2022\) and welcomed an additional 90,000 refugees from Ukraine in 2022 \(as of December 2022\)](#). Not all Austrian are happy with [this situation](#) and it has caused [political problems in Austria](#).

That kind of wraps it up for our brief look at Austria. If any of this interests follow up on some of the links.

### **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.