

August 28, 2023

## News and notes

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

## Research

- Plate movements: [Metasomatism and Slow Slip: Talc Production Along the Flat Subduction Plate Interface Beneath Mexico \(Guerrero\)](#); Phys.org summary [here](#).
- More plate movements: [Deep formation of Earth's earliest continental crust consistent with subduction](#).
- [Deep carbon cycling during subduction revealed by coexisting diamond-methane-magnesite in peridotite](#); Phys.org summary [here](#).
- Fluvial geology: [Recent trends in the chemistry of major northern rivers signal widespread Arctic change](#); Phys.org summary [here](#).
- Geophysics: [Regional geomagnetic core field and secular variation model over the Iberian Peninsula from 2014 to 2020 based on the R-SCHA technique](#).
- Mineralogy: [Physico-mechanical properties and shielding efficiency in relation to mineralogical and geochemical compositions of Um Had granitoid, Central Eastern Desert, Egypt](#).
- Pretty stones: [Gem-Quality Augite from Dong Nai, Vietnam](#).
- Petrology: [Diapirs of crystal-rich slurry explain granite emplacement temperature and duration](#).
- Geotechnical engineering, blasting research: [Identification of the blasting vibration characteristics of groundwater-sealed tunnel](#).

## Sedimentology

- [Sediment routing in an incised valley during Hurricane Harvey \(2017\) in Houston, Texas, USA: Implications for modern sedimentation](#); Phys.org summary [here](#).
- Secrets in the Mississippi mud: [Multi-proxy evidence for sea level fall at the onset of the Eocene-Oligocene transition](#); Phys.org summary [here](#).
- Black shales: [Chemotrophy-based phosphatic microstromatolites from the Mississippian at Drewer, Rhenish Massif, Germany](#).

## Paleontology

- [Fossilisation processes and our reading of animal antiquity](#); Sci Tech Daily summary [here](#).
- [Incredibly Preserved 3,000-Year-Old Bees Discovered Mummified And Fossilized In Their Cocoons](#).

- [New fossils of Abelisauridae \(Dinosauria: Theropoda\) from the upper Maastrichtian of Morocco, North Africa](#); behind a paywall, Sci News summary [here](#).
- [A record of Late Jurassic vertebrates from Texas](#); Sci Tech Daily summary [here](#).
- [New reptile shows dinosaurs and pterosaurs evolved among diverse precursors](#); Phys.org summary [here](#).
- [New insights into the sea spider fauna \(Arthropoda, Pycnogonida\) of La Voulte-sur-Rhône, France \(Jurassic, Callovian\)](#); Sci Tech Daily summary [here](#).
- [Fossils of the oldest diplodocoid dinosaur suggest India was a major centre for neosauropod radiation](#); Phys.org summary [here](#).
- Evolution: [Early-Middle Jurassic source to sink evolution and its tectonic significance in northeastern Sichuan Basin](#).
- More evolution: [Multi-phase ecological change on Indian subcontinent from the late Miocene to Pleistocene recorded in the Nicobar Fan](#).
- [Pleistocene Sunda Shelf submersion-exposure cycles initiate vegetation Walker Circulation feedback](#).
- [In the Footsteps of Her Grandfather, An Artist Digs for Fossils](#).

## Glaciers and Climate

- Antarctica: [Observed Tidal Currents in Prydz Bay and Their Contribution to the Amery Ice Shelf Basal Melting](#); Phys.org summary [here](#).
- More on Antarctica: [Hunting paleoceanographic archives of ice sheet-ocean interaction in the northwestern Ross Sea, Antarctica](#).
- [Contemporary ice sheet thinning drives subglacial groundwater exfiltration with potential feedbacks on glacier flow](#); Phys.org summary [here](#).
- Global climate systems research: [Mechanical and Thermal Forcings of Asian Large-Scale Orography on Spring Cloud Amount and Atmospheric Radiation Budget over East Asia](#); Phys.org summary [here](#).
- More on global climate systems: [Recent global climate feedback controlled by Southern Ocean cooling](#); Phys.org summary [here](#).
- [‘Worthless’ forest carbon offsets risk exacerbating climate change](#).
- Learn the lessons of Dr. Frankenstein: [Geoengineering sounds like a quick climate fix, but without more research and guardrails, it’s a costly gamble – with potentially harmful results](#).

## Environmental Geology and Hydrogeology

- Pollution monitoring by NASA: [TEMPO – Nitrogen Dioxide Air Pollution Over North America](#); Phys.org summary [here](#).
- More monitoring: [Routine monitoring of western Lake Erie to track water quality changes associated with cyanobacterial harmful algal blooms](#).
- More on pollution: [Unveiling the underestimated direct emissions of nitrous acid \(HONO\)](#).
- Remediation techniques: [Systematic study of the synergistic and kinetics effects on the removal of contaminants of emerging concern from water by ultrasound in the presence of diverse oxidants](#).
- Exploring links between energy consumption and environmental quality: [Environmental quality outlook of the leading oil producers and urbanized African states](#).

## Mining and Energy

- [Lithium in SK, Part 20: Hub City Lithium again finds some of the high concentrations in Canada, announcing second test well results](#).
- Ore geology: [The genesis of metamorphosed Paleoproterozoic massive sulphide occurrences in central Colorado: geological, mineralogical and sulphur isotope constraints](#).
- More ore geology: [Role of volatiles in intrusion emplacement and sulfide deposition in the supergiant Norilsk-Talnakh Ni-Cu-PGE ore deposits](#).
- [U.S. Drillers Cut Oil Rigs for Ninth Month in a Row – Baker Hughes](#).
- [BP Urges More Oil, Gas Investment While Speeding Energy Transition](#).
- From the United States Energy Information Administration: [Prices and higher well productivity drive up U.S. crude oil production forecast](#).
- Petroleum chemistry research: [Review on detection method, main source and geological application of diamondoids in crude oil](#).

## Geologists

- Joseph Burr (J.B.) Tyrrell: [History Hunter: Early geologist made his mark in the Klondike](#).
- Luigi Palmieri: [A Defiant Volcanologist Survived 5 Eruptions while Living on Mount Vesuvius](#).
- [NASA Selects Geology Team for the First Crewed Artemis Lunar Landing](#).
- [Aloha to the University of Hawai'i's Newest Geology Professor](#).

## Interesting Videos

- [Fantastically Folded Rocks and the Beautiful Butte Fault, A Major Structure in the Grand Canyon](#).



August 28, 2023

## Geology and the Fate of Societies – The Baltic States



Figure 1 – Estonia, Latvia, and Lithuania  
Credit: U.S. Government, [public domain](#)

After completing the [posting on the geology and fate of Belarus](#), it occurred to me that the three [Baltic States](#) of [Estonia](#), [Latvia](#) and [Lithuania](#) should be discussed together since they have overlapping geology and share a similar geopolitical situation. I will also touch on the [Russian enclave of Kaliningrad](#) since in its current political status and in its previous incarnation as [East Prussia](#), it has had much influence on the Baltic States. Around the Baltic States are: to the west is the [Baltic Sea](#), west of which is [Sweden](#); north of the states is [Finland](#), northeast is [Russia](#), southeast is [Belarus](#) and south is [Poland](#). Let's take a look at the Baltic States individually.

### Estonia

According to the [Factbook for Estonia](#), published by the United States Central Intelligence Agency (CIA), the country has a total area of 45,228 square kilometres (km<sup>2</sup>) of which 42,388 km<sup>2</sup> is land and 2,840 km<sup>2</sup> of which is water. The land area includes some 1,520 islands in the Baltic Sea.

The [CIA Factbook estimates the population](#) of Estonia at 1,202,762. The ethnic breakdown of the population is 68.7% Estonian, 24.8% Russians, 1.7% Ukrainian, 1% Belarusian, 0.6% Finnish, and 3.2 % unspecified or other.

The main language is [Estonian](#), a [Uralic](#) language closely related to [Finnish](#) and [Karelian](#) and more distantly related to the [Finno-Ugric](#) languages of Siberia and [Magyar](#) (Hungarian).

### Latvia

The [CIA Factbook for Latvia](#) indicates that the country has a total area of 64,589 km<sup>2</sup> of which 62,249 km<sup>2</sup> is land and 2,340 km<sup>2</sup> is water. The [CIA Factbook](#) estimates the Latvian population at 1,821,750. The ethnic breakdown is 62.7% Latvian, 24.5% Russian, 3.1% Belarusian, 2.2% Ukrainian, 2% Polish, 1.1% Lithuanian, and 4.4%, unspecified or other. The main language is Latvian, a [Baltic](#) language within the [Indo-European](#) language family.

## Lithuania

The [CIA Factbook for Lithuania](#) list the total area of the country at 65,300 km<sup>2</sup> of which 62,680 km<sup>2</sup> is land and 2,620 km<sup>2</sup> is water. The [CIA Factbook](#) estimates the Lithuanian population at 2,655,755. The ethnic breakdown is 84.6% Lithuanian, 6.5% Polish, 5% Russian, 1% Belarusian, and 2.9% other or unspecified. The main language is [Lithuanian](#), another Baltic language.

## Geology



Figure 2 – Geological Map of the NW East European Platform

Credit: Figure 1 in [Tuuling, 2019](#)

Figure 2, above, shows the general geology of the Baltic States. Geologically, the Baltic States sit on the northwest part of the [East European Platform](#). The main structures are the Baltic [Homocline](#), an area where the formations have fairly uniform [dip](#) towards the northwest; the basin of the Baltic [Syncline](#) and the Mazurian-Belorussian [Anticline](#).

One way to visualize the geology is shown in Figure 3, below, where the rocks are grouped by the associated [orogeny](#). The oldest rocks in the Baltic States, that form the [basement](#) and which outcrop in Sweden and Finland, are [Precambrian](#) rocks of the [Baltic Shield](#). These rocks are predominately crystalline metamorphic rocks and were formed during the [Svecofennian Orogeny](#) of the [Paleoproterozoic Era](#).

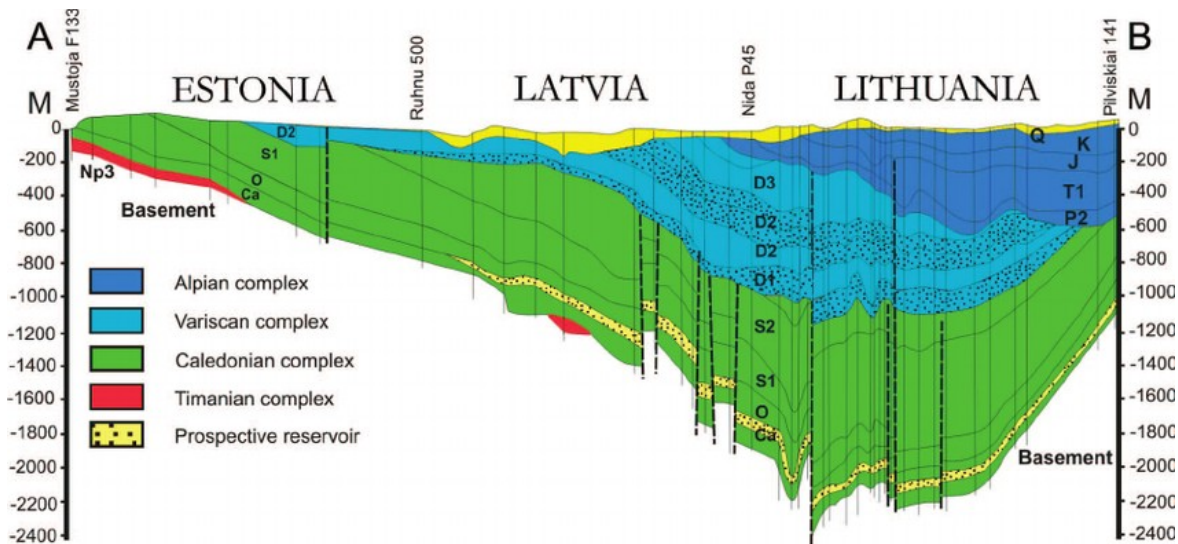
Immediately overlying the basement rocks in some places are [Neoproterozoic](#) deposits associated with erosion from the [Timanide Orogen](#). Some of these deposits, such as those in neighbouring Finland, contain [Ediacaran fossils](#).

Overlying the Precambrian rocks are early [Paleozoic](#) deposited associated with erosion from the [Caledonian Orogeny](#) during the [Ordovician](#) to Early [Devonian](#) periods. These include shallow marine deposits from the Ordovician and [Silurian](#) periods, and nearshore marine deposits as well as Devonian aged clastic deposits such as the [Old Red Sandstone](#). Also included in this Caledonian Complex are [carbonate](#) rocks such as limestone and [marl](#). An interesting feature from the early Paleozoic deposits of Estonia is the [Kärdla astrobleme](#) on Hiiumaa Island which formed from an asteroid impact 455 million years ago during the Ordovician Period.

Above the early Paleozoic rocks are late Paleozoic deposits associated with the [Variscan Orogeny](#). These [Carboniferous](#) and [Permian](#) aged rocks in the Baltic States are a mixture of clastic marine sediments and carbonate deposits. The Variscan Complex extends to [Mesozoic](#) deposits from the [Triassic](#), [Jurassic](#), and the [Cretaceous](#) periods. Triassic deposits are predominately clastic deposits, shale, silt and sandstone. The Jurassic deposits include marl, limestone, sandstone, sands, [siderite](#) and clay. A layer of [phosphorite](#) often separates the Jurassic from the overlying Cretaceous aged sand, silt, chalk, marl and limestone.

Over the Variscan complex are deposits from the [Alpine Orogeny](#) from the [Cenozoic Era](#). The deposits of the Alpien Complex include [Paleocene](#) marl and [glauconite](#) silt, [Eocene](#) glauconite sands, silts and phosphorite that contain [amber](#); [Miocene](#) aged [carbonaceous](#) sands with layers of silt and clay; and [Pliocene](#) sand, silt and clay.

Near and at the surface are [glacial till](#), [glaciolacustrine](#), and [glaciofluvial](#) deposits from the [Quaternary](#) glaciation.



**Figure 3 – Geological Cross-section Across Estonia, Latvia and Lithuania**  
**Credit: Figure 1 in [Shogenov et al, 2013](#)**

The cross-section in Figure 3 was from a [paper](#) discussing possible subsurface reservoirs for carbon dioxide storage.

## Resources

### *Agricultural Resources*

Presently, the Baltic States are part of the [European Union](#) and follow the [Common Agricultural Policy](#). This has been an improvement over previous management of agriculture when the states were part of the [Soviet Union](#). Under Soviet rule, most farm land was organized into [collective farms](#). After the collapse of the Soviet Union, the collective farms in the baltic States were reorganized, often on an ad hoc or questionably legal basis. The three states are still in the process of sorting out the mess.

The [Food and Agriculture Organization](#) notes the following agricultural production for the Baltic States for 2018:

- Estonia produced 450 thousand tons of wheat; 347 thousand tons of barley; 113 thousand tons of rapeseed; 88 thousand tons of potatoes; 78 thousand tons of oats; 53 thousand tons of peas; 29 thousand tons of rye; and smaller quantities of other agricultural products.
- Latvia produced 1.4 million tons of wheat; 426 thousand tons of potatoes; 306 thousand tons of barley; 229 thousand tons of rapeseed; 188 thousand tons of oat; 81 thousand tons of rye; 80 thousand tons of beans; and smaller quantities of other agricultural products.
- Lithuania produced 2.8 million tons of wheat; 888 thousand tons of sugar beet; 619 thousand tons of barley; 433 thousand tons of rapeseed; 296 thousand tons of potatoes; 213 thousand tons of peas; 182 thousand tons of oats; 153 thousand tons of [triticale](#); 149 thousand tons of beans; together with smaller productions of other agricultural products such as apples (92 thousand tons), maize (87 thousand tons) and rye (44 thousand tons).

Livestock production is extensive in all three of the Baltic States and all three have been exporters of meat and meat products. [Fishing](#) is also an important source of food in the Baltic States; one notable [seafood product from Latvia](#) are the [Riga Smoked Sardines](#).

### *Forestry*

[Estonia](#) has an important forestry industry, with 1.8 million hectares of forest containing approximately 274 million cubic meters of timber. About [half of Latvia](#) is covered in forest containing 682 million cubic metres of wood. About 1/3 of [Lithuania is covered in forest](#), containing about 521 million cubic meters of wood.

### *Mineral Resources*

[Estonia's mineral industry](#) includes oil shale production, peat mining and extraction of aggregate for construction. The USGS summary is [here](#).

[Latvia has a small mineral industry](#). Local mining consists mostly of peat and industrial minerals such as clay, dolomite, gypsum, limestone, sand for glass and brick. The USGS summary is [here](#).

The [mining sector in Lithuania](#) is relatively small, there are no ore mining or metallurgical industries, and extraction is concentrated in peat, aggregates and industrial minerals (dolomite, limestone). The USGS summary is [here](#).

The USGS also published a report on the [Mineral Industries of Estonia, Latvia, and Lithuania](#), the latest edition was in 2007.

## Climate

The climate of the Baltic States is cool and damp, with greater rainfall in the interior uplands than along the coast. Temperatures are moderate in comparison with neighbouring states to the east such as Russia. If you plan to travel to the Baltic States, you can find summaries of the climate for [Estonia](#), [Latvia](#) and [Lithuania](#).

## History and Geopolitics



**Figure 4 – The Polish-Lithuanian Commonwealth in 1672**

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

[Finnic](#) and [Baltic](#) tribes lived in the area of the modern Baltic States during [antiquity](#). Their main interaction with the outside world was through the trade in [Baltic Amber](#). Their main interaction with one another was endemic intertribal warfare. During the early [Middle Ages](#), Swedish and Danish [Vikings](#) conquered Estonia and parts of modern Latvia, the Swedes having been previously taken parts of Finland and the Danes wanting to get in on the fun. Also, during the Middle Ages, German knights of the [Order of the Brothers of the Sword](#) and the [Knights of the Teutonic Order](#) began forcibly converting the Baltic tribes to Christianity, beginning with the conquest and eventual assimilation of the [Old Prussians](#). Another important actor during the Middle Ages were the German speaking merchants of the [Hanseatic League](#) who dominated trade in the Baltic Sea throughout the until the League fell apart in the 16<sup>th</sup> Century and established [German speaking merchant communities](#) throughout the Baltic region.

The Lithuanians, meanwhile, saw what was happening and made common cause with Poles, creating the Polish–Lithuanian Commonwealth with agreements first made in 1386. Formal union was established in 1569 and the Commonwealth continued until 1795, when it was [partitioned](#) between [Russia](#), [Austria](#) and [Prussia](#) after a series of wars.

In 1592 Estonia and the bulk of Latvia came under the Swedish rule. However, during the [Great Northern War](#) (1700 – 1721), the area of modern Estonia and Latvia was conquered by Russia. Later, in

1795, Russia swallowed up Lithuania. The three Baltic States remained part of the Russian Empire until the end of the [First World War](#). Following the collapse of the Russian Empire, Estonia, Latvia and Lithuania [declared independence](#), concluding treaties with the new Soviet Union recognizing their independence.

It was not to last. In 1939, as part of the [Molotov–Ribbentrop Pact](#), the Baltic States became part of the Soviet “sphere of influence”; which meant that [Germany](#) would not prevent the Soviet Union from taking over the Baltic States – and the Soviets proceed to do [exactly that in 1940](#).

The [war between Germany and the Soviet Union](#) began in 1941, with German [Army Group North](#) invading the Baltic States on their way to [Leningrad](#). Wartime population losses in the Baltic States were among the highest of any of the countries involved with the [Second World War](#) with approximately 25 percent for Estonia, 30 percent for Latvia, and 15 percent for Lithuania. These include losses in battle and atrocities committed against civilians by all sides during the war.

The 1945 peace [brought some relief](#), unless you were targeted by the [Soviet secret police](#). Under Soviet rule, about [20,600 to 20,700](#) people from Estonia, around [60,000 inhabitants](#) of Latvia, and at least [130,000 people](#) from Lithuania were deported to various parts of the Soviet Union, often [Siberia](#) or [Soviet Central Asia](#). The reasons for these deportations varied but were part of a concerted effort to assimilate the Baltic peoples into a [greater Soviet people](#).

Another example of [mass deportations](#) took place in the Russian enclave of Kaliningrad, formerly known as East Prussia. Prior to 1945, most of the population of East Prussia, and its capital [Königsberg](#), was [ethnic German](#). After the end of World War 2 in 1945, the Soviets expelled all the ethnic Germans in East Prussia, mostly to Germany, renamed the territory and its capital Kaliningrad, and relocated ethnic Russians in the parts of the [oblast](#) not handed over to Poland.



**Figure 5 – Latvian Winter Landscape**

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

The end of Soviet rule in 1991 was welcomed by the peoples of the Baltic States, although renewed independence brought its [own problems](#). Their main geopolitical problem is how to keep Russian out. The long occupation of the Baltic States by the Russian Empire and their horrific experience with the Soviet Union (a.k.a. [the workers paradise](#)) has taught them to fear their Russian neighbours. The example of neighbouring East Prussia / Kaliningrad was not re-assuring. In order to help preserve their independence, the Baltic States have joined the [North Atlantic Treaty Organization](#) and are [enjoying its protection](#).

However, it's a delicate balance. [Russia has its own fears](#) about the encroachment of Western powers, lead by the [United States](#), [Germany](#) and [Britain](#), all of whom had had antagonistic relations with Russia in the past. Meanwhile the Baltic States, and all Europe, [are keeping a watchful eye](#) on events in the Ukraine war.

It's hard not to sympathize with the situation of small states like Estonia, Latvia and Lithuania. It is also hard not to see the potential for further suffering. We can hope and pray otherwise, but international affairs are often cruel, as is shown by the fate of the former German inhabitants of East Prussia.

### **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.