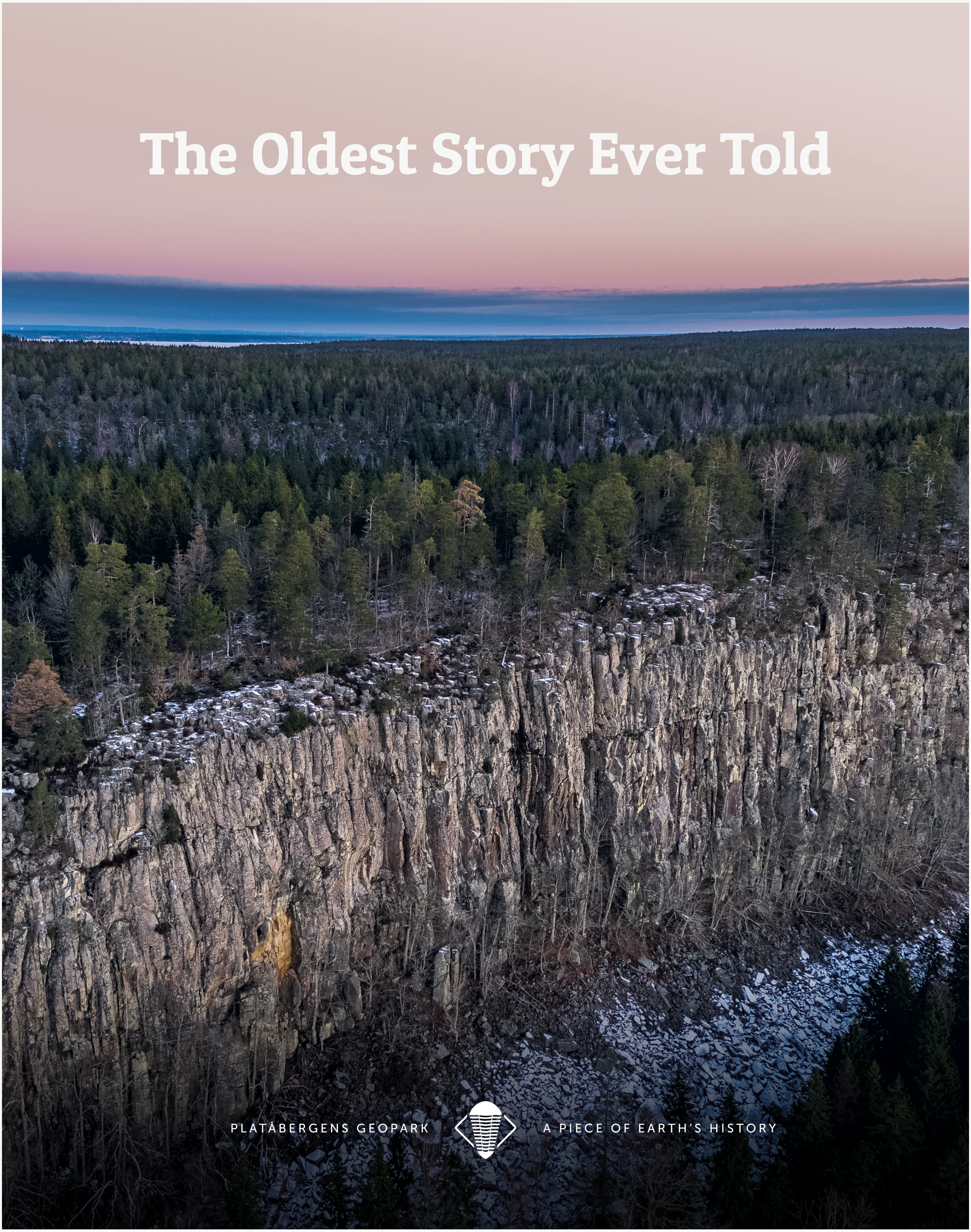
The Oldest Story Ever Told



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Contents

Glossary

BENTONITE | Soft, pliable and lightly coloured clay that is essentially made up of clay minerals from the smectite group (e.g. montmorillonite). Bentonite is formed through metamorphosis or chemical erosion of glassy, volcanic material. Bentonite is capable of absorbing large quantities of water, which significantly increases its volume. In Sweden, bentonite can be found in the form of metre-thick layers in some of the table mountains.

CONGLOMERATE | Sedimentary rock mainly composed of rounded pebbles 2 mm or larger and with a finer matrix. The pebbles, which can be of different rocks (polymict conglomerate) or of a single rock (monomict conglomerate), are cemented by a matrix rich in clay, limestone or quartz.

CONTINENTAL COLLISION | When two lithospheric plates meet and their continents collide.

CONTINENTAL CRUST | The part of Earth's crust that forms the continents. It is thickest under the mountain ranges, where it can be as thick as 70 km.

CRUST | Earth's outer layer, approx. 10–50 km thick, mainly composed of silica-rich minerals.

CRYSTALLINE BEDROCK | Rocks formed when magma cools and then crystallizes.

FAULT | Occurs when two adjacent blocks of rock are displaced relative to each other. Faults can occur in any direction.

FELDSPAR | An aluminium silicate mineral with two variants; one grey which is rich in sodium and/or calcium (plagioclase) and one reddish which is rich in potassium (K-feldspar).

FOLIATION | A parallel stucture of minerals making the rock look striped.

FOSSIL | Preserved remains of an organism in sediment. Casts, imprints, and traces of organisms are also defined as fossils.

GEOLOGICAL TIME | Earth's history is divided into eons (e.g. the Proterozoic and Phanerozoic), which in turn are divided into eras (e.g. the Palaeozoic and Mesozoic), which in turn are divided into periods (e.g the Cambrian, Ordovician and Silurian), which can be divided into epochs (e.g. the Lower, Middle and Upper Cambrian) and further into ages.

GNEISS | Metamorphic rock with clearly visible foliation; often veined.

GRANITE | An igneous plutonic rock composed mainly of quartz and feldspars, as well as a smaller portion of dark minerals. The feldspars can be either potassium feldspars or sodium-rich plagioclases of varying proportions. The dark minerals are mainly biotite or hornblende.

IAPETUS OCEAN | The ocean that formed between North America/Greenland (Laurentia) and Northern Europe (Baltica) when the supercontinent Rodinia broke apart. A basin of the ocean surrounded Scandinavia, and the sedimentary rocks found in Platåbergens Geopark were deposited in this basin. The Iapetus Ocean existed for roughly 150 million years until Northern Europe was once again joined to Laurentia.

ICE AGE | A long period of time in which a larger continental ice sheet exists.

IGNEOUS ROCKS | Rocks formed from molten material (magma or lava).

INTERGLACIAL | A long interval of warmer temperatures between two glacial periods.

INTERSTADIAL | A short interval of warmer temperatures between two glacial periods.

KAME | Hill or mound mainly composed of ice river sediments, mostly gravel and sand deposited in fissures in and between large blocks of ice outside of the actual terminus. Rather common above the highest coastline.

KETTLE HOLE | Pits formed when blocks of ice that were embedded in moraines or ice river material melted. The result is a landscape characterised by small hills. The last and largest ice blocks to melt could leave kettle holes, which today can be lakes or peatlands.

LITHOSPHERE | The upper, rigid part of Earth that includes the crust and the uppermost part of the mantle.

LITHOSPHERIC PLATE | One of the large moving segments (crust + the uppermost part of the mantle) that Earth is composed of.

MANTLE | The mantle stretches from a depth of about 10–70 kilometres down to 2,900 kilometres. The mantle consists of molten rocks (magma) that can penetrate to the surface in the form of lava during volcanic eruptions.

METAMORPHIC ROCKS | Metamorphosed rocks where the minerals in the original rocks have been transformed and new minerals have been formed.

MYLONITE | A strongly deformed, often banded rock where the minerals have metamorphosed and become fine-grained, sometimes glassy, because of movements in the bedrock.

PRECAMBRIAN BASEMENT | Bedrock formed before the Cambrian period, i.e. more than 542 million years ago.

RODINIA | Large coherent landmass (supercontinent) composed of North America and surrounding adjacent continents. Formed approximately 1 billion years ago.

SEAFLOOR SPREADING | A process in which the ocean seafloors grow horizontally as magma advances up through the mid-ocean ridges and the lithospheric plates move away from each other with a speed of approx. 1–15 cm/year.

SEDIMENTARY ROCKS | Rocks formed from sediment.

STINKSTONE (ANTRACONITE) | Dark-coloured limestone, often giving off a characteristic kerosene smell when broken apart. Usually found in layers of lens-shaped accumulations (concretions) of bituminous shale (oil-rich alum shale).

SUPERCONTINENT | Large accumulation of lithospheric plates that together form a continent.

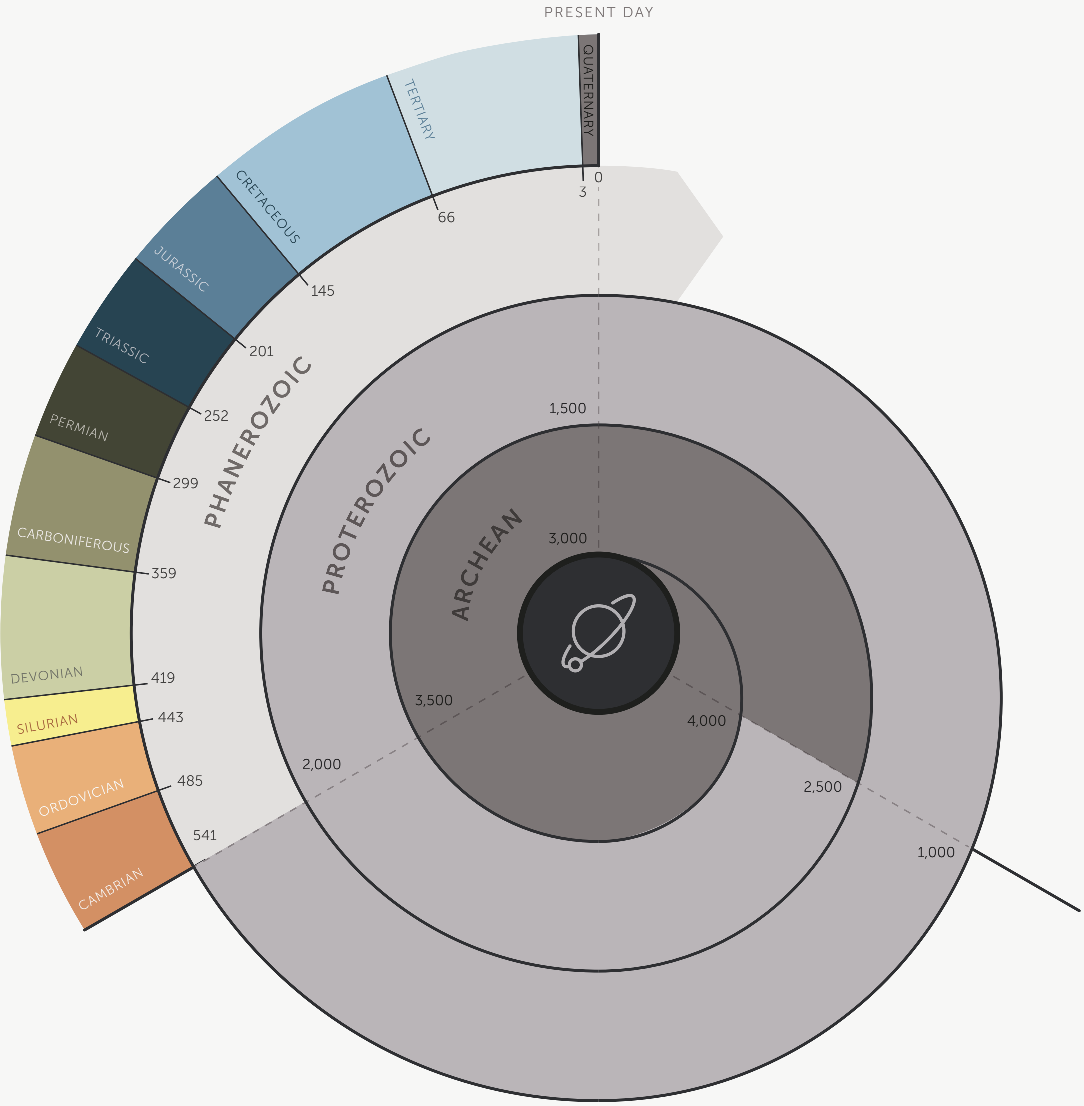
TILL | A glacially formed accumulation of unconsolidated debris composed of particles of all sizes, from large blocks to minute clay particles.

VEINS | Molten parts of a rock causing streaks (veins), mainly of quartz and feldspars, often parallel to the foliation.

The geological time scale

The figures indicate million years (Ma),

= Formation of Earth and the solar system



KRONOGÅRDEN, TROLLHÄTTAN
58°16′22.27″N 12°17′55.05″E

In Trollhättan, you can get a good look at these approximately 1.7 billion-year-old rocks. The light coarse-grained veins are made up of feldspars and quartz and formed when the rock partly melted deep down within Earth and folded into a gneiss in connection with a collision between two plates long after the rock had formed.

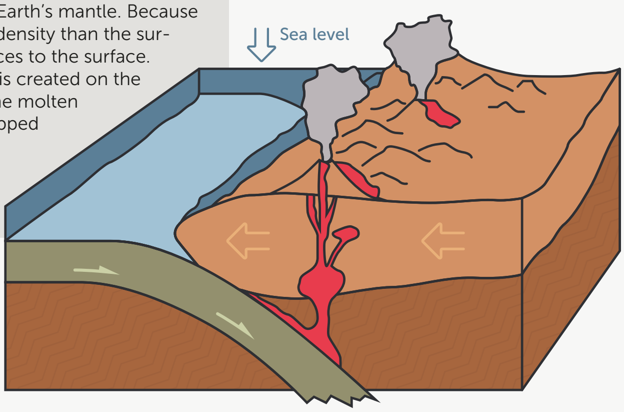
A piece of Earth's history

Earth's continents are in a state of constant movement around the globe. Our planet's surface is made up of tectonic plates that move and may collide or slide underneath each other, resulting in volcanic eruptions. This is how oceans are born and die, how mountain ranges form and ultimately erode. Of course, it's all happening over very long periods of time—millions of years.

The bedrock that the table mountains rest on formed approximately 1.7–1.65 billion years ago as a result of colliding tectonic plates. Hot, molten rock advanced from deep within Earth and the first bedrock in Platåbergens Geopark was created. But the long and violent history that this oldest bedrock has seen since then has caused the rocks to metamorphose into foliated and veined gneisses. They can now be seen in the form of rocks rich in quartz and feldspar, that formed deep down.

In west Sweden, tectonic plates have collided many times and joined an older continental plate in the east. Therefore, the bedrock in west Sweden is younger the farther west you go. ◆

WHEN TWO LITHOSPHERIC plates collide, the heavier of the two will be forced to sink below the lighter one and melt in Earth's mantle. Because the molten rock has lower density than the surrounding bedrock, it advances to the surface. Thus, a volcanic landscape is created on the planet's surface. Some of the molten rock (magma) becomes trapped in magma chambers within the crust where they form so-called plutonic rocks.



EARTH IS APPROXIMATELY 4.6 billion years old. The oldest rocks in Sweden can be found in the northernmost parts of the country and are a little older than 2.5 billion years. The youngest part of the crust can be found in west Sweden, where the rocks are between 1.7 and 1.5 billion years old. Thus, we can say that the crust in Sweden was formed over a period of 1 billion years, beginning around 2 billion years after Earth was formed. There are rocks younger than 1.5 billion years in Sweden, but these were formed on top of and inside an already established crust.

AUGEN GRANITE AT NORDKROKEN, VARGÖN

58°23′15.3″N 12°24′09.0″E

One example of the area's younger igneous rocks is the type called Ursand granite, which is exposed at Nordkroken. The rock is a reddish grey granite with accumulations of potassium feldspar, often called augen ("eyes"). The many feldspar augen make the rock surface look rough.

Why are there sometimes granites and sometimes gneisses?

Some granites in the geopark are different from the 1.7 billion-year-old foliated and veined gneisses that make up the oldest bedrock.

These granites have not been subjected to all the events that have affected the oldest bedrock. Therefore, they look less deformed; i.e. they are less metamorphosed since they didn't exist when the older bedrock metamorphosed into the veined gneisses that are visible today.

These younger rocks formed approximately 1.3 billion years ago when magma advanced through the older bedrock and solidified at great depths. The foliation that is visible in the rocks formed in connection with a continental collision with the North American plate approximately 1 billion years ago. ◆

THE OLDER WEST Swedish bedrock has been subjected to heating and deformation several times. One effect of this is that rocks have metamorphosed into gneisses and become folded and veined. This happened when our own tectonic plate collided with adjacent plates—something that has happened many times; the last in west Sweden was roughly 1 billion years ago. It is therefore no wonder that west Sweden is made up of strongly metamorphosed, gneissed, folded and veined rocks.

MILLSTONE SQUARE IN LUGNÅS | 58°37′ 32.14″N 13°42′ 52.28″E

Depending on its prehistory, the older rocks may be more or less metamorphosed. Here is a millstone from Lugnås which has no veins or bands but clearly visible folding.

4.54 – HADEAN – 4.0 – ARCHEAN – 3.0 – 2.0 – PROTEROZOIC – 1.0 – PHANEROZOIC – 0 billion years

The collision with North America

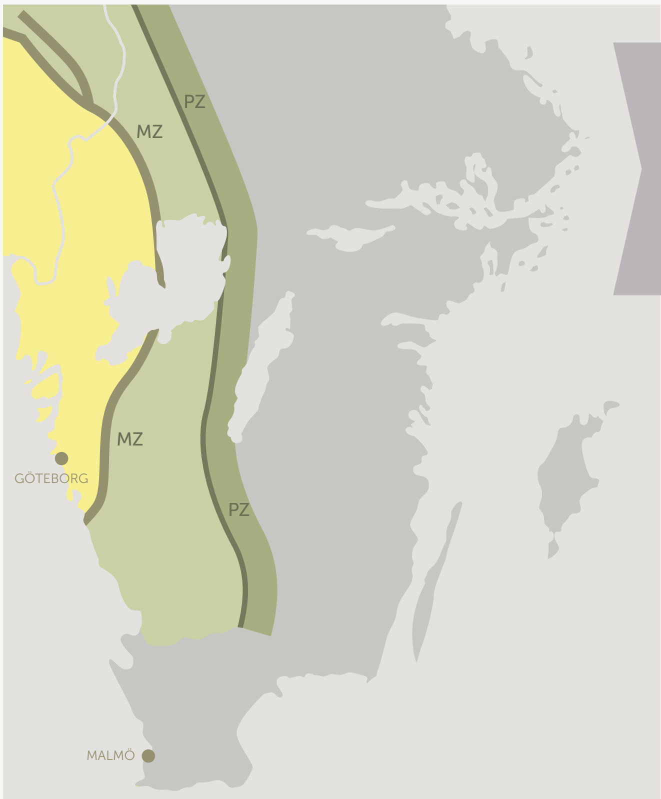
Because of the movement of the crust, continents have collided and drifted apart several times, affecting the bedrock in the area that is now Västergötland.

The event that had the greatest effect on the geopark's oldest bedrock was the collision with the North American-Greenland tectonic plate, which occurred roughly 1 billion years ago. The bedrock was thrusted from west to east, causing the crust in the east to almost double in thickness.

Because of the weight of the overthrust, the underlying parts of the crust were pressed down to great depths, where they heated up and metamorphosed.

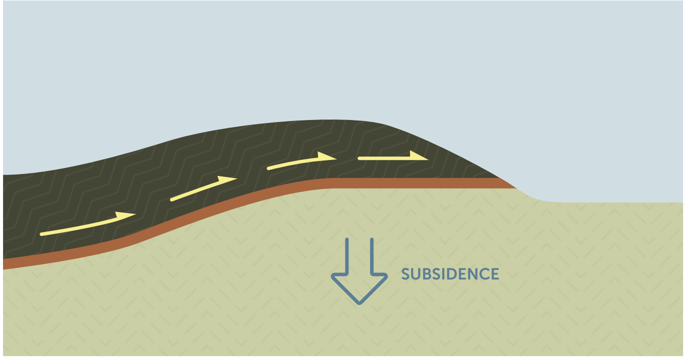
The overthrust happened predominantly along the so-called mylonite zone, a shear zone that can be traced in a north-south direction through the geopark.

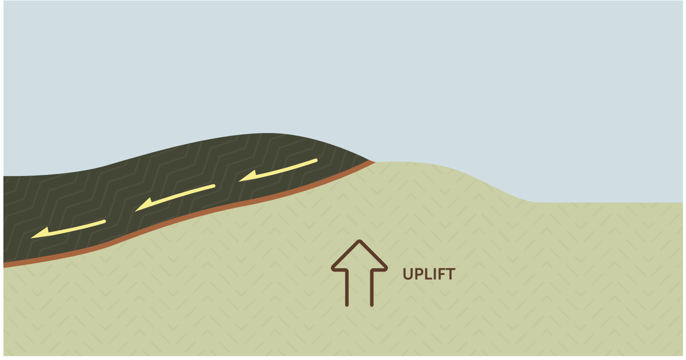
LÄCKÖ CASTLE, LIDKÖPING
58°40'29.2"N 13°13'07.9"E



THE MYLONITE ZONE is a zone with strongly metamorphosed, foliated rocks. In this exact place, the western bedrock was thrusted up over the eastern bedrock. The mylonite zone (MZ) can be traced from the northern parts of the province of Halland to Lake Mjösa in Norway. In Platåbergens Geopark, it can be traced from Järpås in the south to Kållandsö in the north where it disappears into Lake Vänern. In the rocks along the beaches south of Läckö Castle, there is visible granite metamorphosed into mylonite. At Svalnäs, the mylonite is banded with darker and lighter rocks.

When the bedrock was thrusted, a tall mountain range was created. After this thrusting at around 970 million years ago, the mountain range collapsed. The thrusted bedrock then slid back west along the mylonite zone, and the pushed-down crust was uplifted, eroded and eventually regained its normal thickness. When the crust rose, a new zone was formed, along which movements occurred—the so-called protogine zone (PZ). Thus, the surface we walk on in the geopark today was once located at a depth of several kilometres. The sediments created by the eroded mountain range can today only be found as scattered deposits outside the geopark area. ◆





THERE'S A DIFFERENCE between so-called thrust faults and normal faults in the bedrock. An overthrust is when the bedrock is thrusted up onto adjacent bedrock. A normal fault is when parts of the bedrock slide off. The mylonite zone has seen both thrust faulting and normal faulting. In shallow parts of the crust the bedrock is cold and fragile, and thus it breaks from fault movements. At greater depths the bedrock is so hot that it becomes plastic. Therefore, it doesn't break but instead the minerals metamorphose when the crust moves, and certain new minerals can then be created. This is how mylonite forms; the mineral grains are completely reshaped and can even melt into streaks of a dense, fine-grained rock.

SVALNÄS, ÖRSLÖSA
58°33'24.5"N 12°56'30.0"E

SEVERAL TIMES IN Earth's history, landmasses have joined together into supercontinents, such as Gondwana and Pangea. Such a supercontinent existed more than 1.3 billion years ago, when Northern Europe was joined to North America and Greenland. But the supercontinent broke apart and Northern Europe drifted away from other landmasses. However, it took "only" 300 million years until Northern Europe again joined with North America through a continental collision. This event created the supercontinent known as Rodinia, shown on the left. This supercontinent broke apart after approximately 400 million years.

SLÄTTBERGEN, TROLLHÄTTAN | 58°17′04.5″N 12°20′35.0″E

The sub-Cambrian peneplain is clearly visible, for example at Slättbergen, Trollhättan. The rock surface here is flat and only broken by later fractures. In some of these, one can see that sand has penetrated to fill the fractures. This sand comes from the sedimentary layer that was once directly on top of the basement rock.

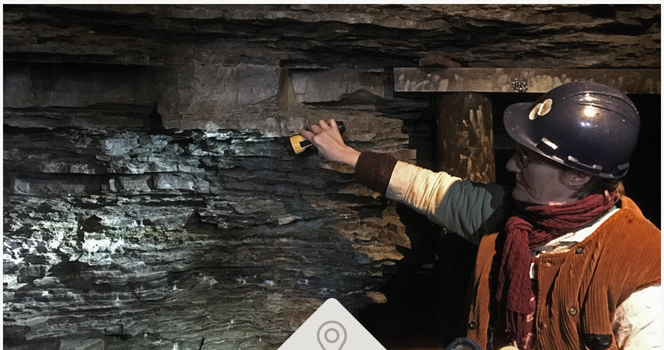
The geopark becomes flat!

Around 600 million years ago, a global cooldown of Earth's surface occurred, causing major glaciations. It was followed by a climate that promoted heavy erosion and weathering of the bedrock.

The landscape eroded down to an even surface and large flat areas formed—something that we now call a peneplain. The peneplain in the geopark is known as the "sub-Cambrian peneplain" since it formed before the Cambrian period and is therefore positioned beneath the Cambrian sedimentary rocks in the table mountains.

The peneplain formed over large parts of Sweden, and this old basement rock surface is visible at several locations in the geopark. The large plain known today as Västgötaslätten is actually composed of this eroded basement rock. ◆

NATURE ALWAYS STRIVES to even out the topography of Earth's surface. Therefore, heights are weathered and eroded down to sediment which is then deposited at lower levels. The sediment is cemented together by evaporated aqueous solutions and becomes solid sedimentary rocks. Rocks may in turn melt when the crust is pushed down into the earth and form magma which can then form new igneous rocks. Both sedimentary and igneous rocks can be subjected to high pressures and high temperatures and be metamorphosed. Such "transformed" rocks are called metamorphic rocks.



THE MILLSTONE QUARRY AT LUGNÅS

58°37′30.9″N 13°43′57.0″E

The sub-Cambrian peneplain has been preserved beneath Lugnåsberget. Down in the mines at Lugnås it is therefore possible to see the boundary between the eroded basement rock surface and the sandstone layered on top of it.

THE PENEPLAIN, NORDKROKEN

58°23′15.3″N 12°24′09.0″E

At Nordkroken, one can clearly see that the peneplain continues beneath the younger sedimentary rocks of Halleberg.

SANDSTONE FISSURES AT SLÄTTBERGEN

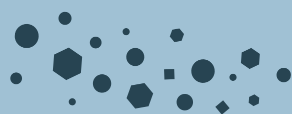
58°17′04.5″N 12°20′35.0″E

In fissures in the sub-Cambrian peneplain in Slättberg, you can see traces of the 540 million-year-old sandstone, i.e. the earliest deposits in the Iapetus Ocean. This shallow sea was located between the continents of North America and Northern Europe. This is the same sandstone that you can see in other places in the geopark, e.g. in Lugnåsberget. At this time, Sweden was located far to the south in the southern hemisphere.

An ocean is born, then grows and shrinks

The supercontinent that formed around 1 billion years ago, Rodinia, broke apart again roughly 600 million years ago. An ocean known as the Iapetus Ocean formed between the continents of North America and Northern Europe. In this ocean, sand and clay particles were deposited along with calcareous sediments. The ocean was rich with aquatic organisms, something that we can now see traces of as fossils in the layers of the table mountains. »

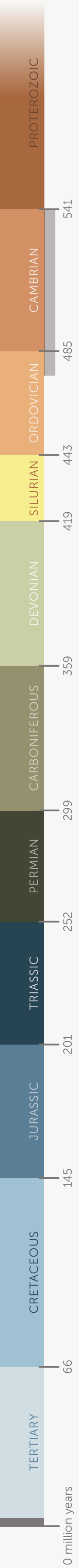
SEDIMENTARY ROCKS CAN be composed of granules of different sizes. If the sediment is composed of rounded pebbles (several millimeters or more in size), the rock is called a conglomerate. If the sediment is composed of sand particles, the rock is called sandstone and when it is composed of clay particles, it is called claystone. The different sizes of the grains reflect the environment in which they were deposited: large particles were deposited close to the shore while finer particles represent deeper environments.

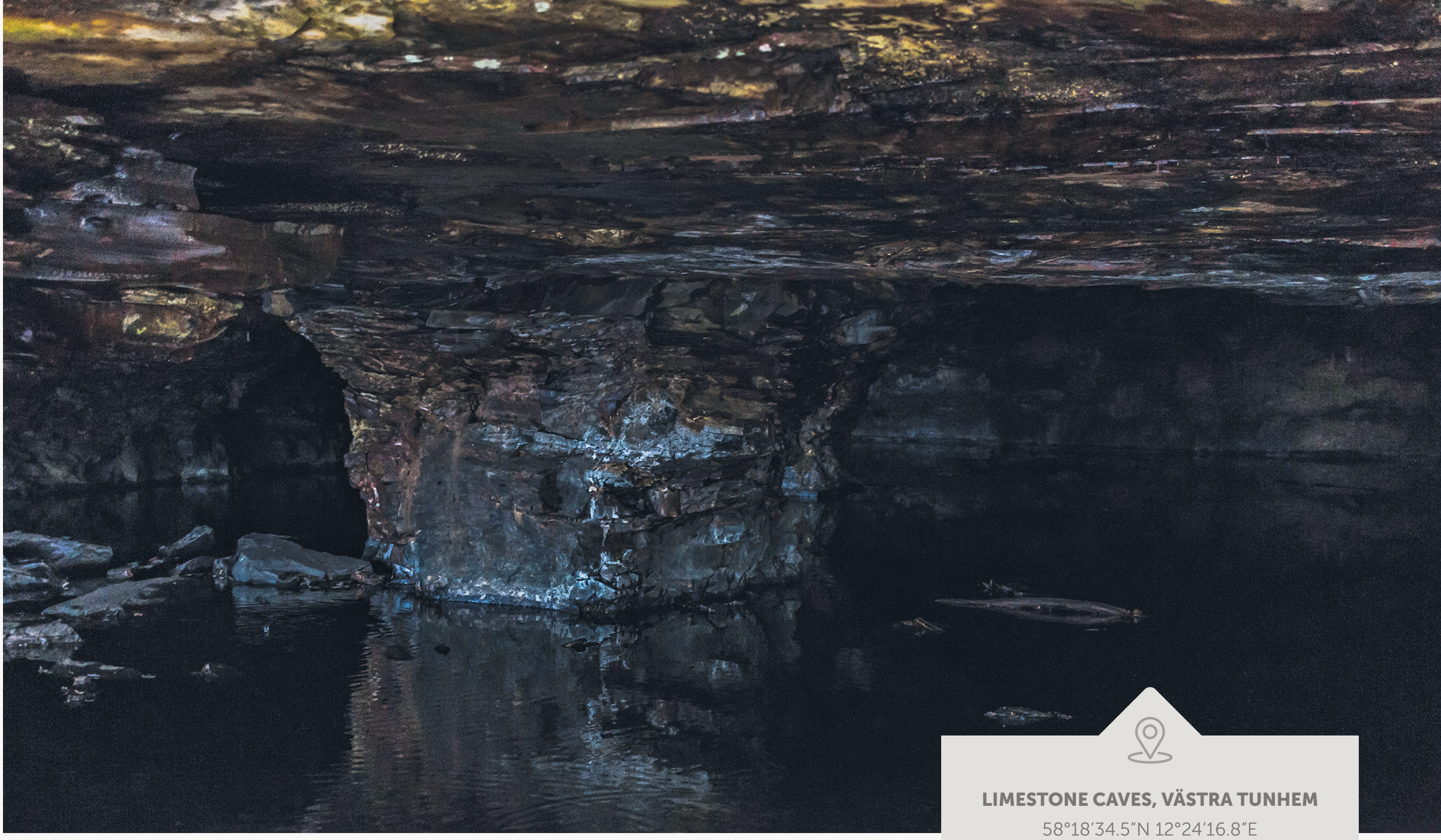


TROLMEN HARBOUR, KINNEKULLE

58°35′44.5″N 13°20′16.2″E

At Trolmen Harbour, you can see the first sediments that were deposited onto the peneplain surface when the Iapetus Ocean flooded the land 540 million years ago. The sediments are composed of rounded blocks, pebbles, and gravel in a finer matrix—a rock we call a conglomerate. Sand was deposited on top of the conglomerate, creating the sandstones that are visible along the road on the hill down towards the harbour.





LIMESTONE CAVES, VÄSTRA TUNHEM

58°18′34.5″N 12°24′16.8″E

At Västra Tunhem, the Cambrian/Ordovician alum shale is visible. It was mined here to fuel limestone kilns—the remains of the kilns can be seen along the side of the mountain. There are limestone deposits in the alum shale, which constituted the raw material in the lime burning. These deposits are known as stinkstone since they are rich in hydrocarbons and smell of kerosene when you break them.

When the gap between North America and Northern Europe widened, so did the ocean. Clay particles were then deposited on top of the sand along with the remains of dead organisms. These sediments were the basis for the rock we call alum shale. »

KAKELED, KINNEKULLE

58°33′31.6″N 13°19′59.8″E

At Kakeled on Kinnekulle, one can study the Cambrian shale which in certain places contains large quantities of fossils. The small picture above shows trilobite fossils about a centimetre in size. These are quite common in the alum shale. There are also stinkstones here—lens-shaped accumulations rich in organic material.

During the geological period known as the Ordovician, the seafloor spreading stopped and the continents of North America and Northern Europe once again began to close the gap. Large quantities of calcareous sediment were deposited in the Iapetus Ocean, eventually becoming limestone. It is this limestone, known as Orthoceratite limestone, that has been quarried at Hällekis and other locations. »

THE LARGE QUARRY, KINNEKULLE

59°17′37″N 18°4′59″E

In Hällekis Quarry (also known as the Large Quarry on Kinnekulle), as well as in Cementa's quarry in Skövde, limestone has been quarried for a long time. In the 50-metre-thick limestone in Cementa's quarry, fossils of cephalopods, trilobites and echinoderms have been found.

AT ONE TIME during the Ordovician, a bombardment of meteorites reached our planet's surface and struck the calcareous sediment. Fossil meteorites can be found today in the Österplana quarry. They have metamorphosed and are now mostly composed of clay minerals. The Ordovician deposits at Kinnekulle are the oldest deposits in which meteorites have been found Sweden. They come from the asteroid belt between Mars and Jupiter and are the result of a collision between two asteroids.

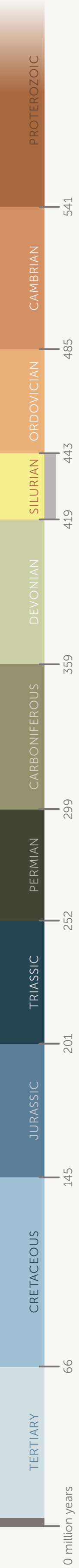
METEORITE, KINNEKULLE

58°35′51.1″N 13°26′19.9″E

The fossil meteorites found in the Thorsberg quarry at Österplana, Kinnekulle, are remains from a collision between two asteroids that occurred roughly 470 million years ago.

THE VOLCANIC ASH found at Kinnekulle and Billingen has metamorphosed and is today composed of clay minerals called bentonite. The bentonite's clay minerals have the ability to expand when water is added to them. This ability makes bentonite useful for sealing landfills, and it has been suggested as a sealing material around canisters for final disposal of spent nuclear fuel. Since bentonite can absorb liquid, it is also used as cat litter.

In the south, a part of the supercontinent known as Gondwana broke free. This part, known as Avalonia, began drifting north and eventually collided with Europe. When the lithospheric plates collided, about 455 million years ago, volcanoes spewed out large quantities of ash, which can be seen today in the form of metamorphosed layers of clay, about a metre thick, at Kinnekulle, Billingen, and other places. ◆



SILURIAN SHALE, KINNEKULLE

58°33′31.6″N 13°19′59.8″E

The grey to black clay-rich shales which formed during the Silurian period, approximately 400 million years ago, are visible as the second topmost layer in the table mountains, just below the dolerite cap. These sediments were home to small, colony forming animals called graptolites, which can be found in the shale today in the form of fossils.

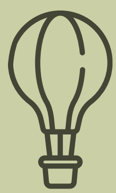
The ocean disappears and we collide with North America—again!

As the Northern European plate moved closer to the equator the Iapetus Ocean continued to shrink, and by the end of the Silurian—around 400 million years ago—Northern Europe and North America collided once again.

This collision resulted in the creation of our mountain range, the Caledonides. Sedimentary remains from this shrinking ocean have been preserved in the form of dark-coloured top layers of shale, for example at Kinnekulle.

Originally, our fells were quite high—probably comparable to the Himalayas—but they quickly eroded. Pebbles, gravel and sand were then deposited to the east of the mountain range during the Devonian, Carboniferous and Permian periods. The sediment layer grew up to four kilometres thick in some places! The geopark was also covered by these younger sediments which were deposited on top of the older "Cambro-Silurian" sediments. This massive sediment cover caused the temperature below it to rise to around 100 degrees Celsius, so that the basement rock surface we walk on today became boiling hot! ◆

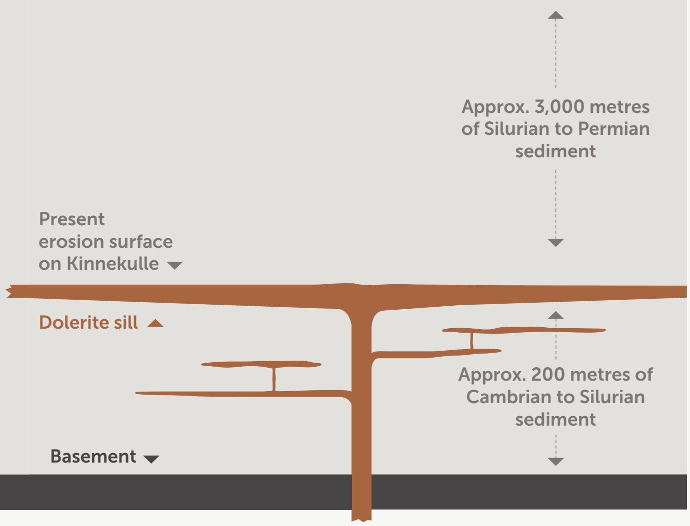
THE POLAR EXPLORER Andrée, known as the daredevil who died while attempting to reach the north pole by hydrogen balloon, was also interested in geology. He made excavations at Kinnekulle with the purpose of uncovering the contact between the dolerite and the underlying shale. His aim was to determine whether Kinnekulle was a volcano, and they searched for the dolerite's magma conduit—without results. What they didn't know at the time was that the dolerite had advanced into a kilometre-thick sediment cover.



The crust cracks open

During the late Carboniferous, more than 300 million years ago, Earth's crust rifted in the Oslo area, resulting in violent volcanic activity that lasted for tens of millions of years. This volcanic activity would have been felt as far as west Sweden. Dark magma, rich in iron and magnesium, advanced through the thick sedimentary layers that covered the geopark at the time.

When the magma reached the uppermost part of the crust, it intruded the horizontal sedimentary layers and was cooled and crystallized to dolerite sills. The relatively soft sedimentary rocks that covered the dolerite quickly eroded away and can today be found in the Baltic Sea and other places. Thus, the hard dolerite caps that are now visible at the top of the table mountains were exposed. ◆



RYD CAVES, BILLINGEN
58°25'51.7"N 13°49'20.6"E

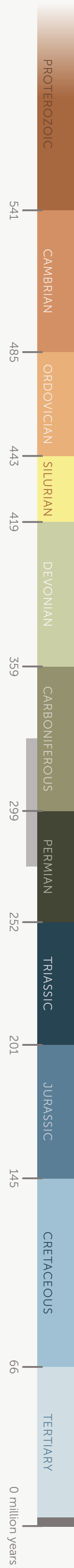
Ryd Caves offer not only a spectacular view of the surrounding plains but also a good view of the 40-metre-thick dolerite layer on Billingen. The dolerite has fractured into what looks like pillars. The fractures that once ran through the dolerite have been widened by erosion, leaving the less damaged parts standing like pillars.

It is also clear just how different fracture patterns can look in different rocks. For example, the older, underlying limestone in Billingen shows fractures that are mostly horizontal and parallel to the layering, while the more brittle dolerite shows a pattern of vertical fractures—resulting in the pillars we see today. The view from Ryd Caves shows the peneplain that formed more than 550 million years ago, onto which the sediments that still rest under the dolerite cap on Billingen were deposited, a process that started around 540 million years ago.

THE VIOLENT VOLCANIC activity in the Oslo area that could also be felt in the geopark started a rifting of the crust that could have separated parts of Norway from Sweden. Luckily, the process came to a halt and we can still visit Oslo by land. The same thing is currently happening in East Africa, where a rift valley with many volcanoes has formed. In all likelihood, the African continent will split apart along this zone—many million years from now.

DOLERITE ON HALLEBERG AND HUNNEBERG
58°21'38.2"N 12°30'07.6"E

The dolerite cap is at its thickest on Halleberg and Hunneberg, measuring up to 60 metres. Because dolerite is a hard rock, water, wind, and temperature changes have not weathered it down, allowing us to admire the beautiful waterfalls cascading down the dolerite escarpments. At Hunneberg, you can take a stroll through geological time from the approximately 550 million-year-old peneplain to the 300 million-year-old dolerite by following the geotrail from the mountain's north-west approach.



VALLEBYGDEN, BILLINGEN | 58°26′53.1″N 13°42′39.4″E

Valle Härad is a famous example of a kame landscape—a hilly region with many kettle holes and mounds. Valle Härad was created when the ice moved back and forth, and the area was located above sea level at the time. Big meltwater rivers transported large quantities of gravel and sediment—even some large and small icebergs were buried in gravel. When they melted, they formed pits in the landscape known as kettles. Pebbles and gravel accumulated on top of the ice, filling out fissures. As the ice melted, the deposited materials created a more or less unstructured system of hills. Beneath the ice, running water created ridges of stone and gravel known as eskers. All of these landforms—and several others—form the basis for the the hilly landscape and the diversity that is still visible in Vallebygden. The landforms have also created a special flora and fauna, as well as fertile agricultural soils with meadows and pastures.

Ice Ages come and go

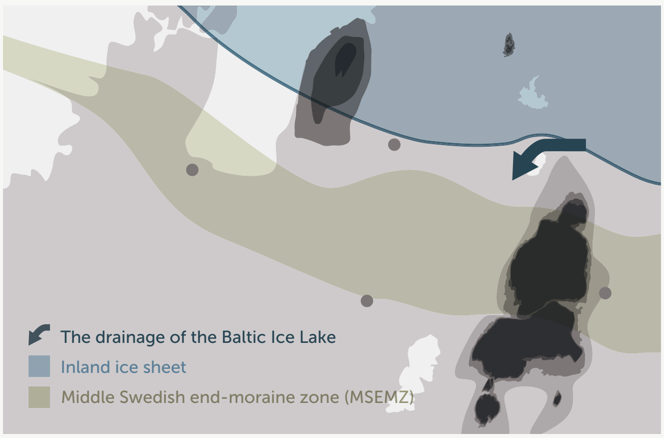
The table mountains in Västergötland have eroded down to their present shape partly during several glaciations that have occurred since the mountains formed. The landscape that we see today is in large part characterised by deposits and landforms created during the last Ice Age, which began 115,000 years ago.

When the ice was at its thickest, the geopark was covered by an ice sheet roughly 3.5 kilometres thick. When the climate grew warmer around 20,000 years ago, the ice started to retreat north (after having reached as far south as the area around Berlin, Germany) and Sweden gradually became ice free. During the deglaciation, several relatively dramatic events took place in the geopark area. A huge meltwater lake—the Baltic Ice Lake—was drained twice into the Western Sea through a passage just north of Billingen.

The first drainage happened as the ice retreated until a passage formed just north of Billingen where the Baltic Ice Lake, a dammed-up lake located roughly where the Baltic Sea is today, was drained in a cataclysmic event.

EVIDENCE OF THE cataclysmic drainage of the Baltic Ice Lake can be found in several places in the geopark. In the Klyftamon nature reserve, there are large areas where the bedrock has been washed clean, as well as sorted boulders and stones that were deposited during the drainage. Along the left edge of Klyftamon, the water entered the sea which covered the area at this time. Samples taken from drill cores from the area have shown traces of the drainage beneath clay that was deposited on the ancient seafloor. The drainage of the Baltic Ice Lake is an important event—not only does it give us information about the geological development of the Baltic region, it also helps us understand the development of ecosystems, and human settlement patterns after the Ice Age.

Shortly after the first drainage, the climate once again became colder—in fact returning to the glacial conditions of the Ice Age. The change took only a few years. This period is known as the Younger Dryas (approx. 12,800–11,600 years ago). The colder conditions caused renewed glaciation, and the glacial terminus again moved south into the geopark area. Large quantities of moraine, in the form of boulders and cobbles, were deposited ahead of the terminus, creating the peninsula called Hindens rev and the ness called Hjortens udde. Both are part of an area known as the Fennoscandian Ice-Marginal Zone. Råda ås, Skararyggen that runs through Vallebygden, and several other ridges are also part of the Middle Swedish end-moraine zone. »



HINDENS REV, ÖRSLÖSA

58°34′24.6″N 12°54′46.0″E

The most spectacular terminal moraine in the geopark is Hindens rev, a narrow peninsula that stretches far out into Lake Vänern. It is part of the so-called Middle Swedish end moraine zone. Terminal moraines from the same time can be traced west into Norway, where they are called "ramoräner", and east into Finland, where they are called "salpausselkä". These terminal moraines are among the most explored quaternary landforms in Scandinavia, and they are important evidence of the cooling of the climate that occurred during the Younger Dryas.

The next major event was the second sudden drainage of the Baltic Ice Lake, which took place when the ice that had formed during the Younger Dryas began to melt away. The glacial terminus then retreated to the north end of Billingen. In a sudden, catastrophic event around 11,700 years ago, meltwater from the ice lake broke through the terminus and flooded the plains below. The Baltic Ice Lake contained huge amounts of water, having grown in size as the terminus retreated north. Because the lake was positioned 25 metres above sea level, the water drained west into the North Atlantic. Estimates show that 7,500 km^3 of water passed through the area! It took almost a full year for all the water to drain from the Baltic Ice Lake, until the water level was equal to the sea level and a coherent sea formed, known as the Yoldia Sea.

SEVERAL EARTHQUAKES OCCUR in Sweden every year. However, they are usually so weak that we cannot feel them. At rare occasions, we can feel the tremors and hear the rumble from the quakes. The reason for these earthquakes is mainly the relief that the crust experienced when the latest land ice melted away. In other words, the crust is recovering from having been pushed down, to a more "normal" condition. Several of the larger earthquakes have been registered in the area around Lake Vänern.

MUNKÄNGARNA, KINNEKULLE | 58°36′45.2″N 13°23′06.4″E

A precursor to the Baltic Sea known as the Yoldia Sea existed around 10,500 years ago. Kinnekulle became an island in that sea, and waves from the ancient sea polished and shaped the Ordovician sandstone. At Munkängarna, one can clearly see how the limestone has been hollowed out by the waves, creating sea-stacks like the Mörkeklev cave.

The geopark's geological history is also reflected in the composition of its soils. Areas to the north and north-west, which were under water for a long time, are dominated by clay and other fine-grained soils while areas to the south-east are dominated by till, where eroded shale from the table mountains have contributed to fertile soils. In some areas with limestone bedrock the soil cover is very thin. This has resulted in extreme agricultural conditions and alvar lands reminiscent of those on the island of Öland. ◆

CLIMATE CHANGE HAS been a common phenomenon throughout Earth's history. Ice Ages have been followed by interglacials, i.e. warmer periods mostly due to variations in Earth's orbit around the sun. Natural causes that can lead to rapid climate change include meteorite impacts and large volcanic eruptions with dust clouds that can disrupt the planet's heat balance. So, climate change is nothing new. What's new is the changes that we humans cause through our way of life. In order to predict the effects of current climate change on the Earth systems, it is important to have information about earlier changes in the planet's climate. Platåbergens Geopark is a key area when trying to understand the melting of the inland ice after the latest Ice Age, and it is very important that these vital sites are preserved if we are to prevent, predict, and adapt to future climate change.

Welcome to Platåbergens Geopark

A geopark is an area with a geology of international significance—something unique that you can't find anywhere else in the world. We think that's exactly what Platåbergen is. Both the table mountains themselves, the peneplain (i.e. the bedrock that the table mountains rest on), and the quaternary Ice Age deposits are special phenomena that deserve more attention.

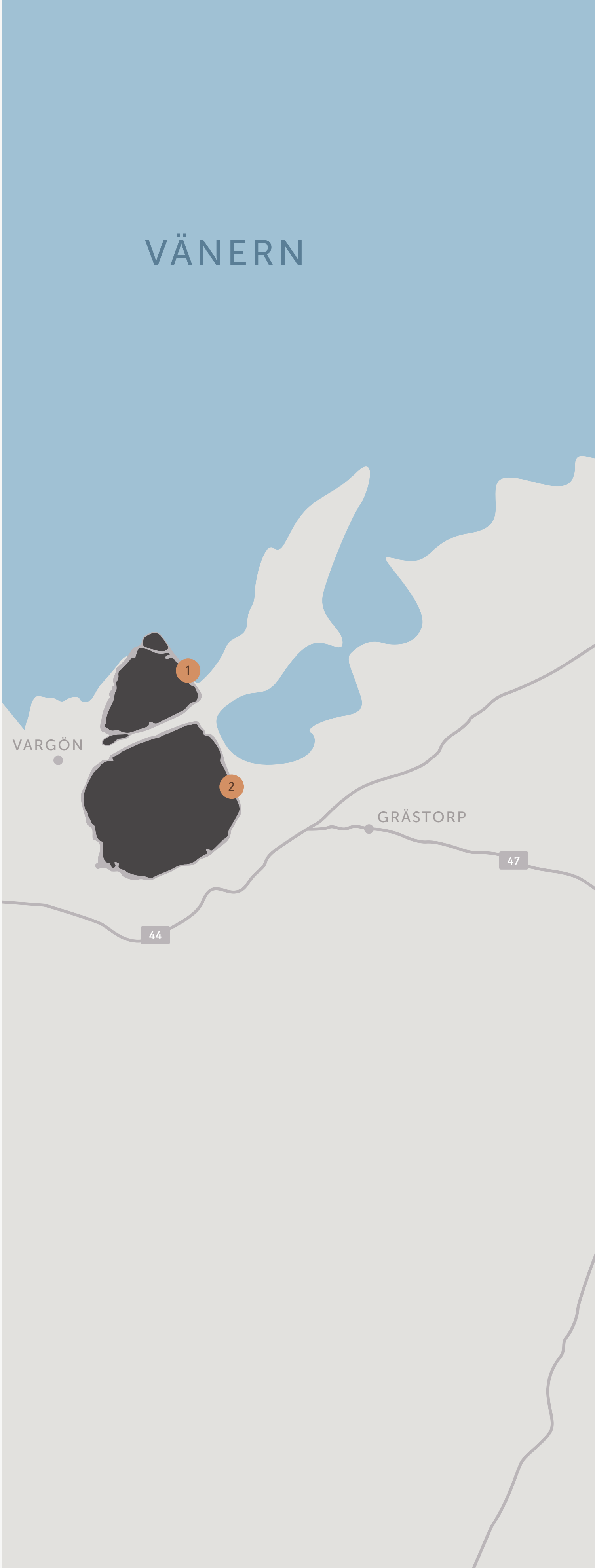
A geopark is the perfect place to inform about the links between geology, biology, people, and cultural history. A geopark brings increased understanding for how we best should manage our natural resources and our planet. But it also provides opportunities for positive development of rural areas, for example through increased tourism, and activities and educational programmes for children and young people. As a visitor or resident in Platåbergens Geopark, you will be able to learn more about the mountains and their surroundings, and experience historical stories and events through hiking trails, exhibitions, dramatizations, guided tours, animations, and exciting VR technology.

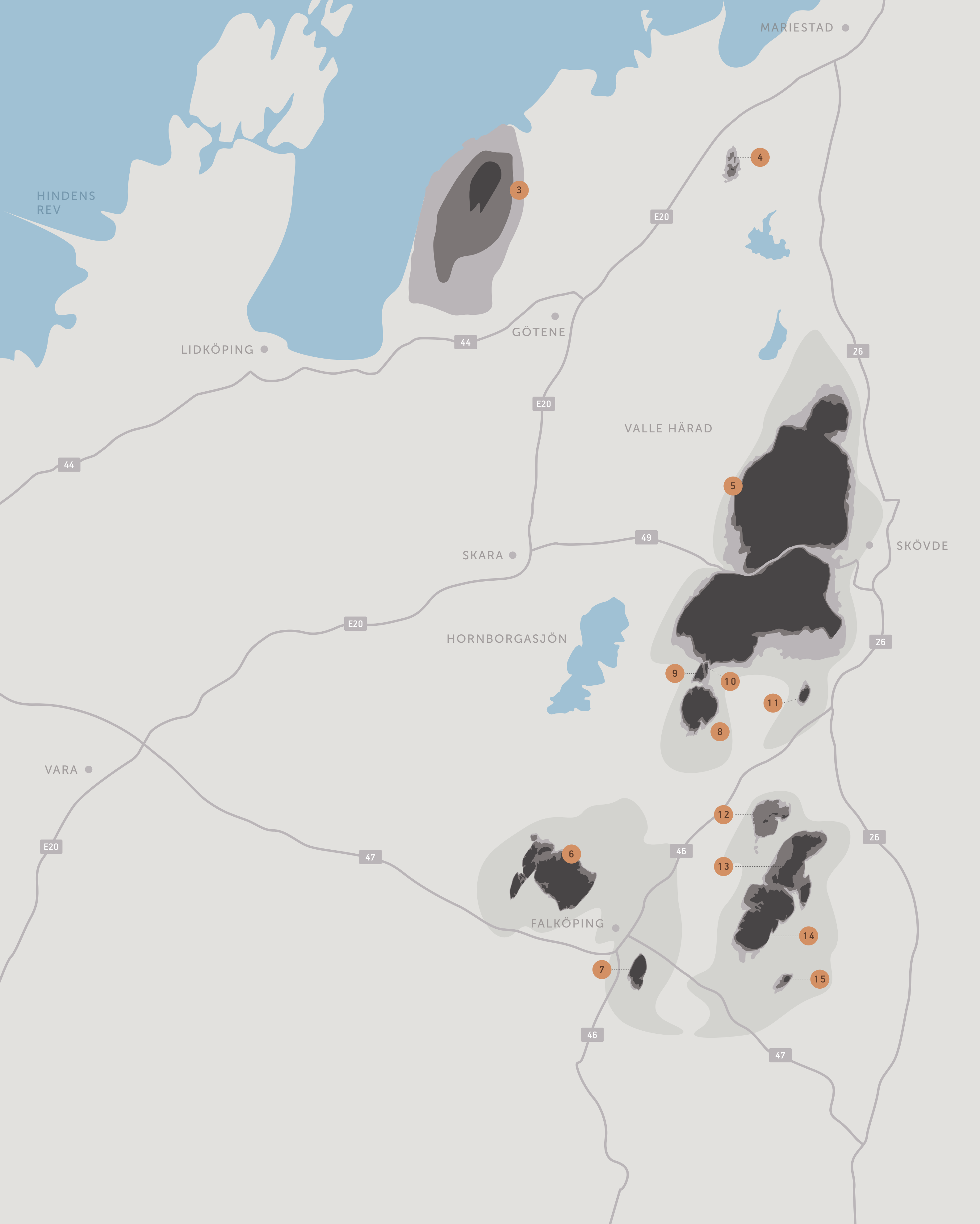
The project Platåbergens Geopark aims to establish a UNESCO Global Geopark in the table mountain landscape of Västergötland. The aspiring geopark stretches across nine municipalities: Trollhättan, Vänersborg, Grästorp, Lidköping, Götene, Skara, Mariestad, Skövde and Falköping. Grästorp municipality is the project owner.

The ambition is to become Sweden's first UNESCO Global Geopark. Such a status would be a mark of quality and proof that the region's environment is worthy of international attention.

We sincerely hope that the project will contribute to a sense of community and identity in the area, and make the locals even more proud of their region. ◆

1. Halleberg (Trollhättan, Vänersborg, Grästorp)
2. Hunneberg (Trollhättan, Vänersborg, Grästorp)
3. Kinnekulle (Götene)
4. Lugnåsberget (Mariestad)
5. Billingen (Skövde, Skara)
6. Mösseberg (Falköping)
7. Ålleberg (Falköping)
8. Brunnhemsberget (Falköping, Skövde)
9. Tovaberget (Falköping, Skövde)
10. Myggeberget (Falköping, Skövde)
11. Borgundaberget (Skövde, Falköping)
12. Plantaberget (Falköping, Tidaholm)
13. Varvsberget (Falköping, Tidaholm)
14. Gerumsberget (Falköping, Tidaholm)
15. Gisseberget (Tidaholm)





MARIESTAD
HINDENS
REV
LIDKÖPING
GÖTENE
44
E20
VALLE HÄRAD
26
SKÖVDE
SKARA
49
HORNBORGASJÖN
VARA
FALKÖPING
46
47
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Geology is history. Earth's history. By visiting geological sites throughout the table mountain region, you can experience a journey in time—trough several million years. Each site is a piece of the puzzle, and together they tell a story that began 1,700 million years ago.

A geopark is an area with a geology of international significance—something unique that you can't find anywhere else in the world. That's exactly what Platåbergen is!

PLEASE CONSIDER THE ENVIRONMENT

Don't throw me away! Pass me on to someone else.

PLATÅBERGENS GEOPARK
Layers of history