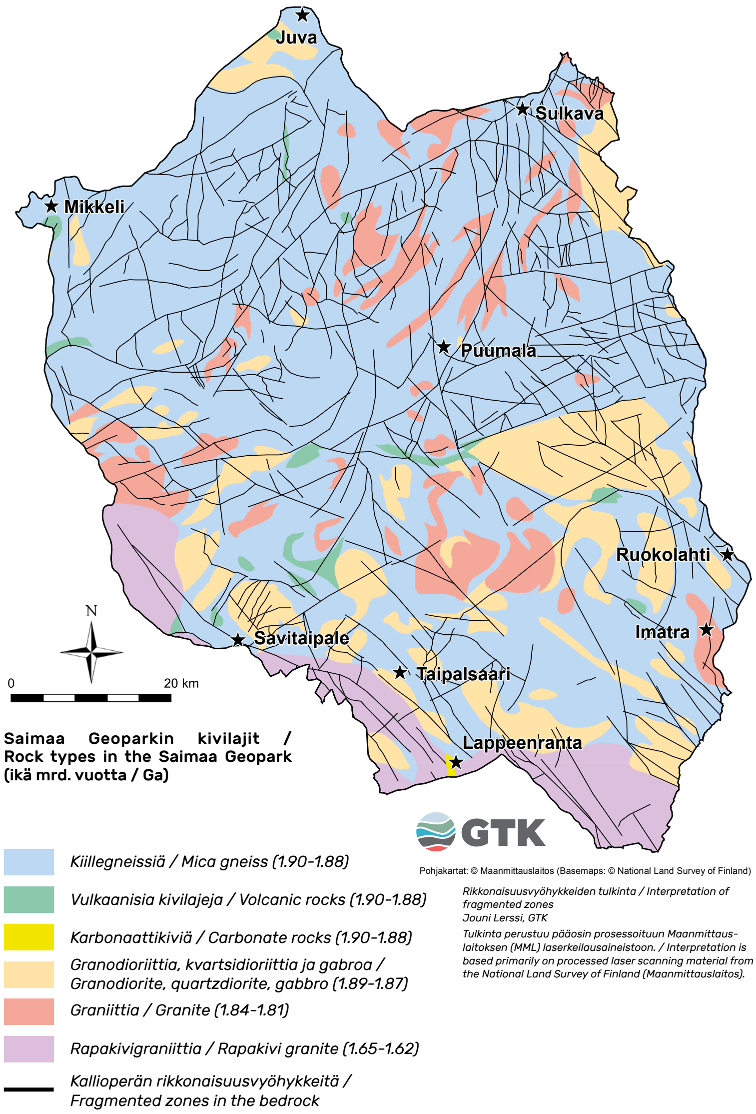
2 BEDROCK AND QUATERNARY DEPOSITS IN THE AREA

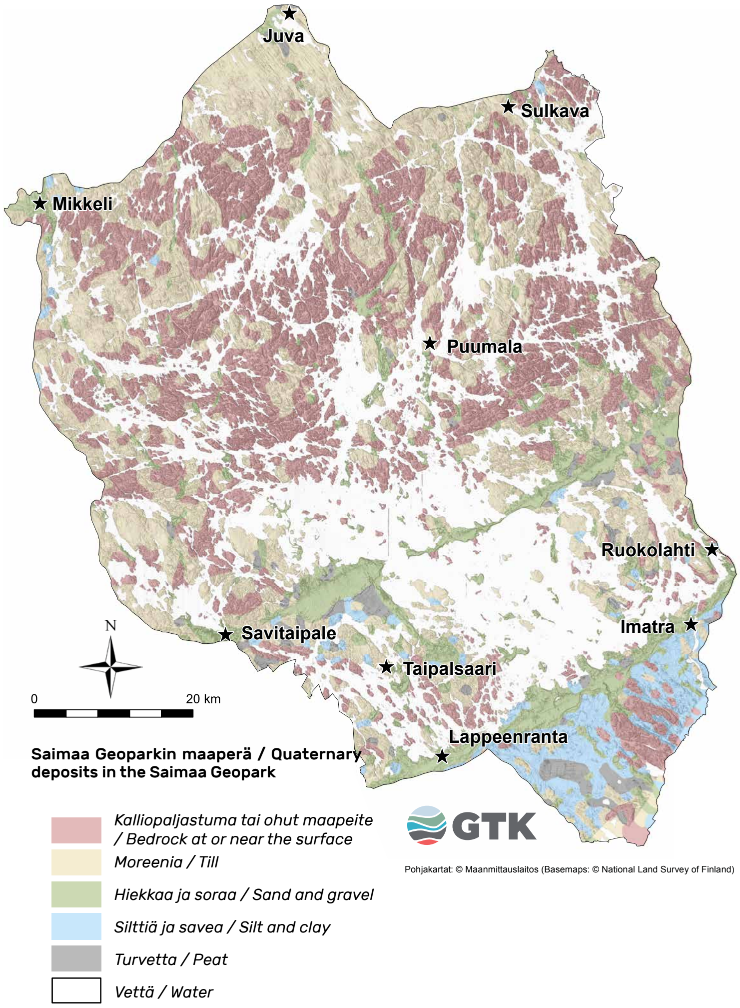
The bedrock in the Saimaa Geopark area consists of types of rock that were formed approximately 1.9–1.6 billion years ago. This means that the bedrock was formed during the Paleoproterozoic Era. The bedrock is covered by loose Quaternary sediments deposited during the last 20,000 years (Image 2). The section describing the area's bedrock and Quaternary deposits has been compiled from the application materials submitted to UNESCO (UGG application material), and it includes an extensive bibliography of geological publications.

Image 2. Saimaa Geopark's bedrock and Quaternary deposits.

Yleistetty kallioperäkartta Saimaa Geopark alueesta
A simplified bedrock map of the Saimaa Geopark area



Yleistetty maaperäkartta Saimaa Geopark alueesta
A simplified map of quaternary deposits in the Saimaa Geopark area



2.1 BEDROCK FORMATION

The bedrock in the basin of Lake Saimaa was primarily formed through the deposition of sand and clay on the ancient seabed around 1,900 million years ago. During the mountain folding process following the sea stage, the deposits were compressed deep into the Earth's crust. In the prevailing high temperatures and pressure, they metamorphed into mica gneiss. Some of the rock material melted and crystallized into the mica gneiss as light granitic dikes and veins. They give the rock surfaces a stripey appearance. Mixed mica gneiss, or veined gneiss, formed in this way is the most common type of rock in the Geopark area (Image 3). Along with veined gneiss, volcanic rocks deposited in layers in the marine environment approximately 1,900 million years ago form narrow and dark stretches of rock. Limestone mud precipitated from sea water and accumulated on the seabed to form the current carbonate rock, or limestone.

Mountain folding was also associated with extensive melting deep in the Earth's crust. The slow crystallisation of this magma led to the formation of various plutonic rocks approximately 1,890–1,870 million years ago. The majority of these are light, granite-like rocks, such as granodiorite (Image 4). As a result of tectonic collisions 1,840–1,810 million years ago, the Earth's crust became thicker, and large quantities of magma formed once again. In the Saimaa area, this magma typically crystallised into pink and usually relatively small areas of granite, with coarse-grained pegmatite granites being the most common.

The youngest part of the bedrock in the general direction of Lappeenranta is formed from common and extensive rapakivi granites (Image 5). They crystallised approximately 1,650–1,620 million years ago from magma in the upper parts of the Earth's crust. The rapakivi rocks in the Lappeenranta region are part of the extensive Vyborg rapakivi massif, which extends from South Karelia into Russia, and is globally considered to be the type area for this type of rock. The rapakivi deposits in the Saimaa Geopark area hold significant international value.

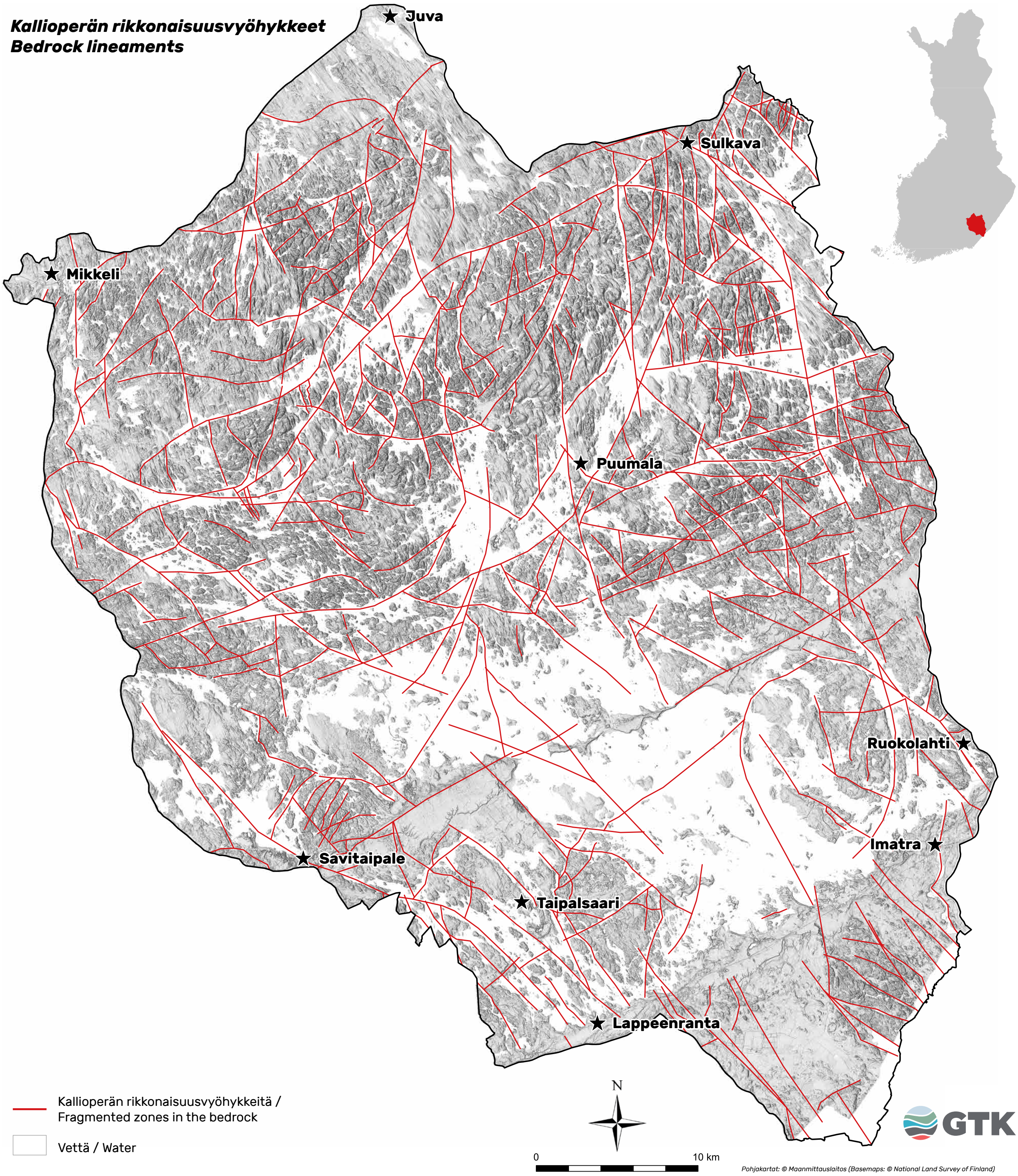
The Saimaa area rock types, which formed 1.9 billion years ago at the base of the folded mountains deep in the Earth's crust, are visible today because the highest parts of the folded mountains have been worn away due to surface erosion. As the rapakivi granite crystallised approximately 1.6 billion years ago, the ancient mountain range had largely levelled out. The fractured nature of the bedrock in the Saimaa lake area is the result of tectonic shear zones of various ages which run through the area (Image 6). They are seen particularly in the mesh-like structure of the water areas in the northern area of the Geopark, and often as rugged scarps rising from the water's surface.

Image 3. The image depicts the shoreline rocks of Huuhanranta, which consist of veined gneiss, or dark mica gneiss, and lighter granite dikes and veins running through it. Image: K-M Remes / Saimaa Geopark

Image 4. The image depicts Luotolahdenvuori rock consisting of granodiorite. The granodiorite crystallised in the magma formed deep in the Earth's crust during the mountain folding process. Types of rock created deep in the Earth's crust are visible today because the highest parts of the folded mountains have been worn away due to surface erosion. This means that the rocks in Luotolahdenvuori and in nearby areas are part of the foot of an ancient mountain range. Image: K-M Remes / Saimaa Geopark

Image 5. The image depicts rapakivi at the Kuivaketvele hill fort. The type of rapakivi at the hill fort is porphyritic granite rapakivi, in which the pink K-feldspar is visible as dispersed granules. Image: K-M Remes / Saimaa Geopark

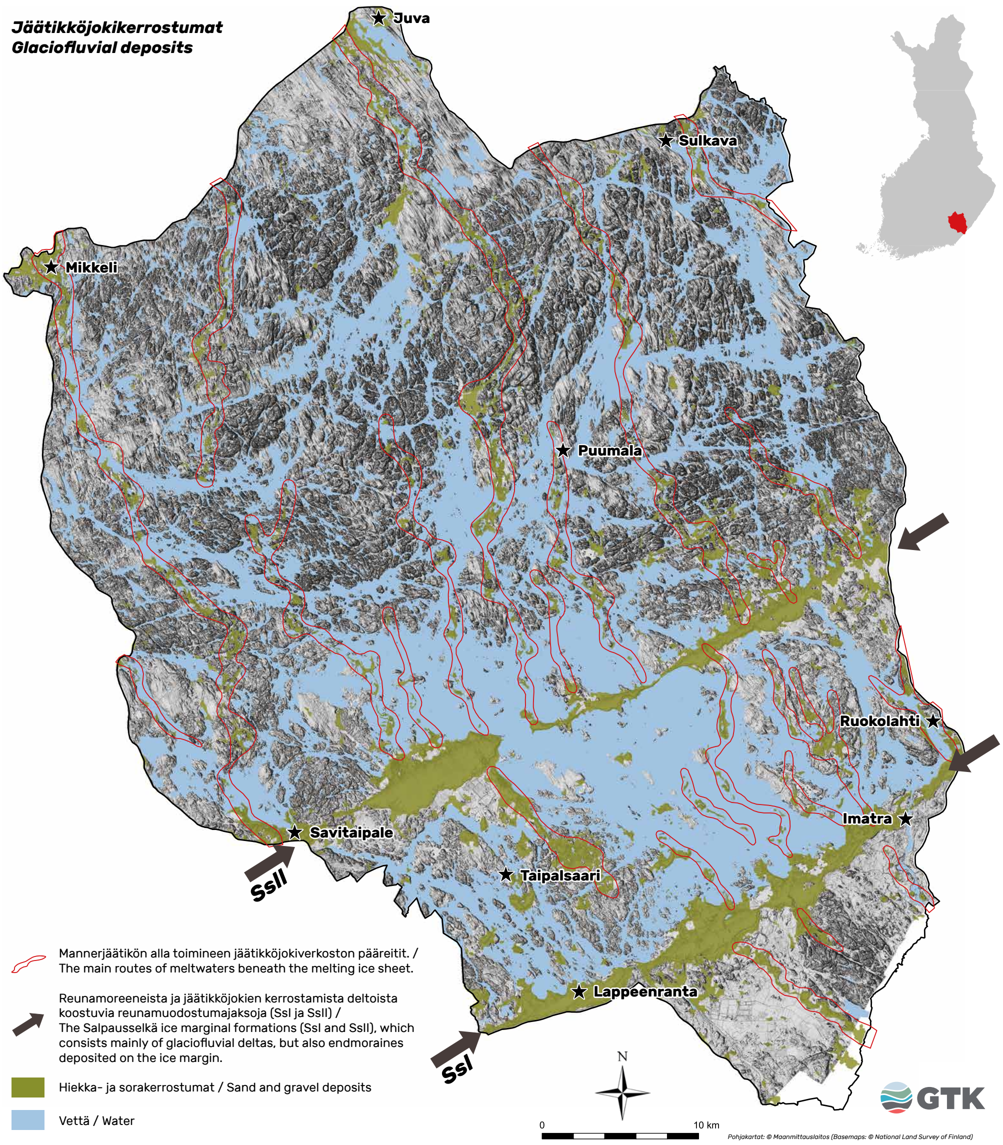
Image 6. The map shows the fracture zones of the bedrock in the Saimaa Geopark area as red lines.



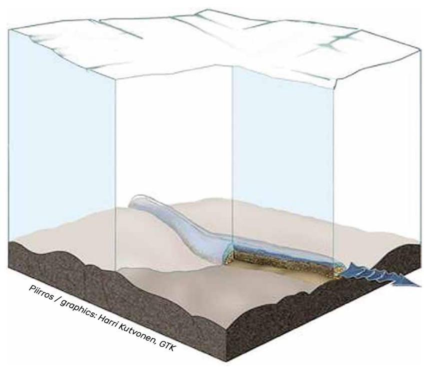
2.2 QUATERNARY DEPOSIT FORMATION

The Geopark area's fractured bedrock and its varied topography is covered by a layer of Quaternary deposits. The layer is of varying thickness and consists of different kinds of Quaternary deposits. The layer formed over the last 20,000 years as a result of ice sheet erosion and deposition processes, and shore displacement, river erosion and paludification following the melting of the ice sheet. The till that is common in the Saimaa Geopark area was created by glaciers. The sand and gravel deposits in the Geopark area were primarily formed in glacial rivers, while silt and clay deposits were deposited in deep water at the edge of the ice sheet. The most significant glacial river deposits relate to the Salpausselkä ridge system and its feeder eskers, which transported material to the ice-marginal formations (Image 7). The Salpausselkä ridge system is of great scientific significance. It is globally unique.

Image 7. Saimaa Geopark map, where the First Salpausselkä (SS I) and the Second Salpausselkä (SS II), which formed at the edge of the ice sheet, are marked in green. Green areas with red borders are intermittent stretches of eskers that end in the ice-marginal formations. When the Salpausselkä ridge system formed, the edge of the ice sheet was at the level of the Baltic Ice Lake, the predecessor of the Baltic Sea.



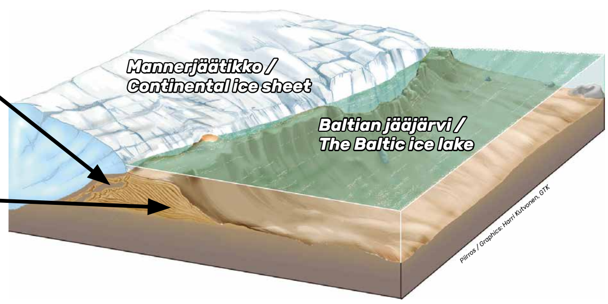
Harjut ovat kerrostuneet muinaisen jäätikön virtaussuunnan mukaisesti / Eskers are deposited in the same direction as the glacial flow of the ice sheet



Hiekasta ja sorasta koostuva harju kerrostuu sulavan mannerjäätikön alla tunneliin tai railoon.
An esker that consists of sand and gravel is deposited in a tunnel or crack underneath a melting glacier.

Hiekka- ja sorakerrostumiin työntynyttä moreenia ja moreenivalleja
Till pushed into sand and gravel deposits and end moraine ridges

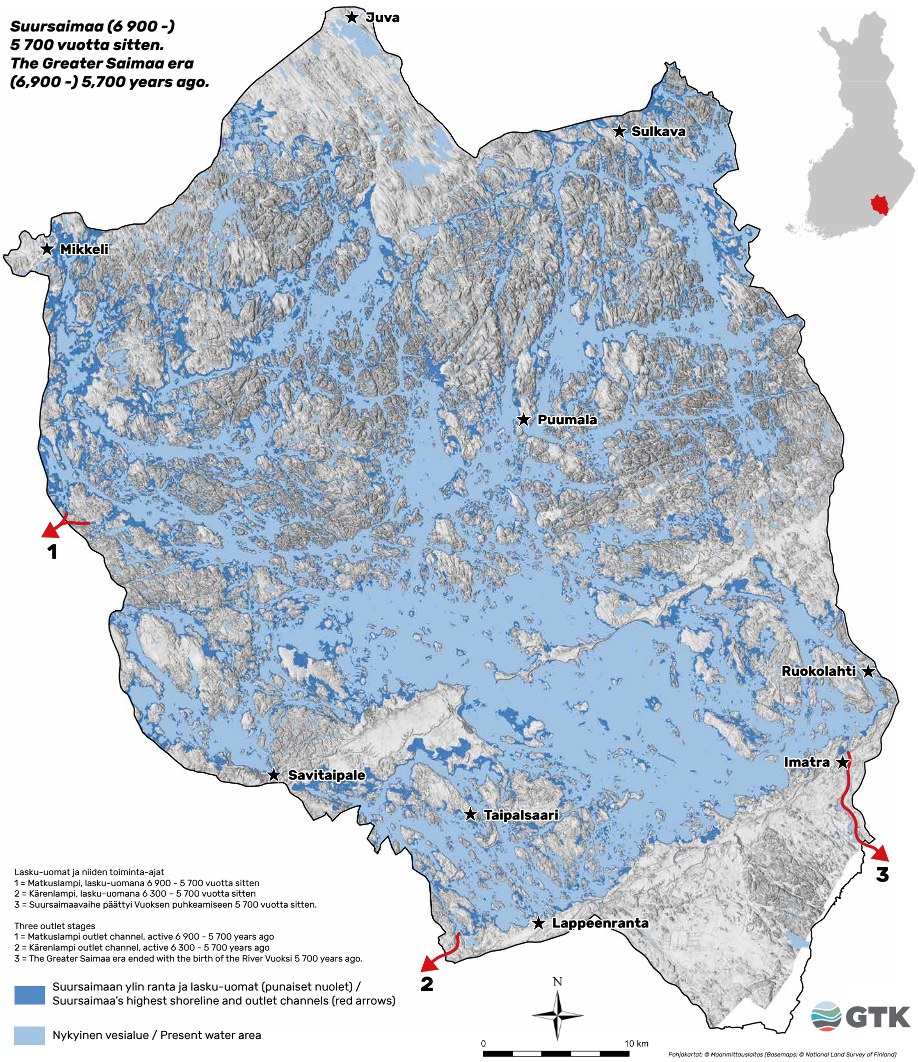
Reunadeltan hiekka- ja sorakerrostumia
Sand and gravel deposits in the ice-marginal delta

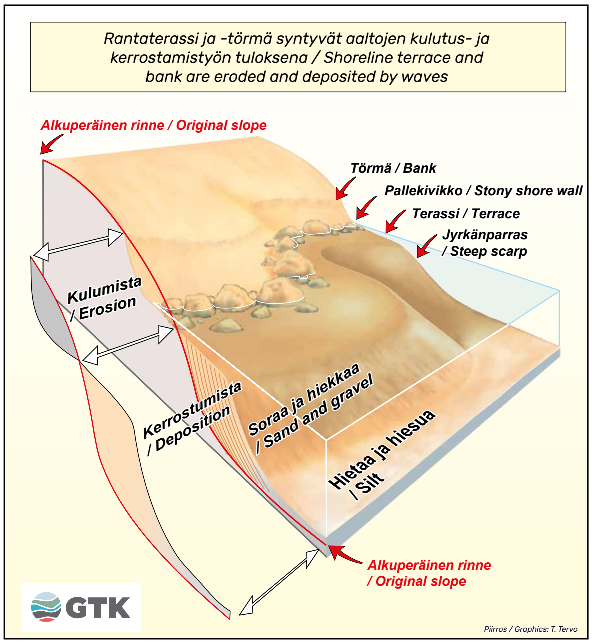


Reunamuodostumat ovat muinaisen jäätikön reunan suuntaisia / Marginal moraine formations are in the same direction as the edge of the ancient ice sheet

Fine material deposits are concentrated on the southeastern side of the Salpausselkä zone. After the ice had melted, water stages turned older Quaternary deposits into shore and river deposits. In this way, Saimaa's rich history has been recorded in these ancient shores (Image 8). Peat is the youngest type of Quaternary deposit in the Geopark area.

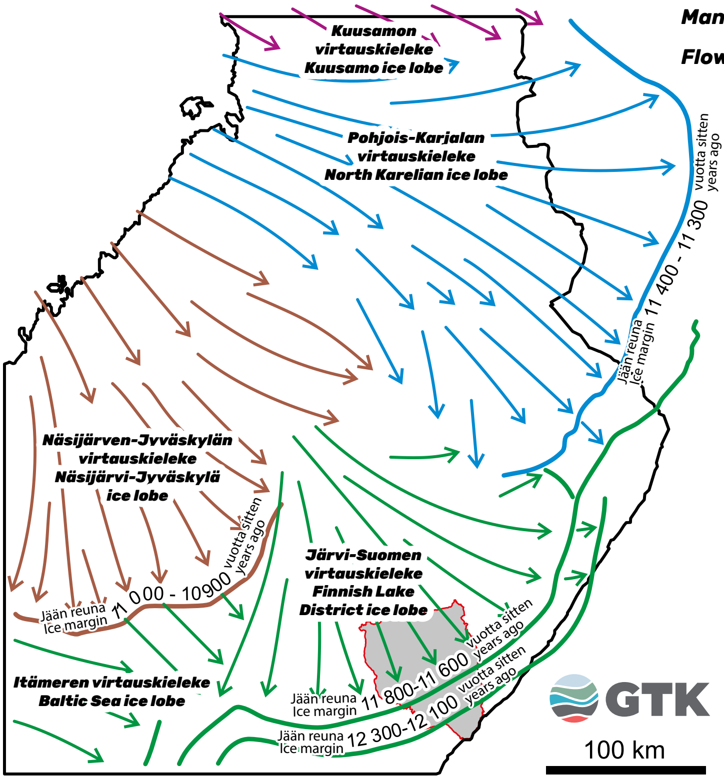
Image 8. Saimaa Geopark map where the surface level of the Greater Saimaa stage has been marked in dark blue and the current water areas in light blue. During the Greater Saimaa stage, the water surface began to rise slowly in the southern and southeastern parts of the Saimaa lake group, as the first outlet channel of the lake group in North Savo (not visible on map) was in an area where land uplift was occurring quickly. The Greater Saimaa stage ended when Vuoksi broke through approximately 5,700 years ago. Due to uneven land uplift, the ancient shores of the Greater Saimaa can be found at different elevations around the Geopark. At the First Salpausselkä, the Greater Saimaa level is around 80 m above sea level (m above msl), and at the northern part of the Geopark in Mikkeli, the elevation is around 90 m above msl. The current surface level of Lake Saimaa is around 76 m above msl.



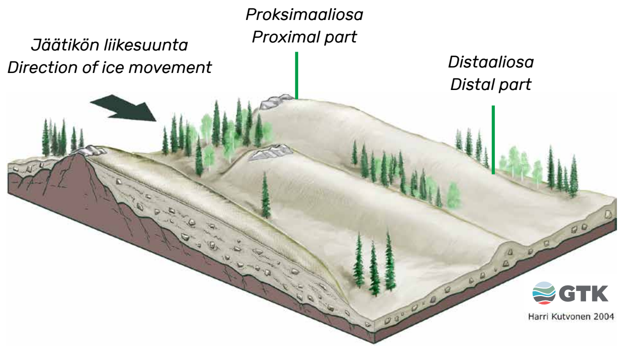


Suursaimaa-vaihe käynnistyi vähitellen, kun kaikki Saimaan järviryhmän altaat olivat kuroutuneet Itämerestä noin 9000 vuotta sitten / The Greater Saimaa phase was gradually started when all the basins of the Lake Saimaa group had isolated from the Baltic Sea about 9000 years ago.

In the Saimaa region, the Salpausselkä ice-marginal formations indicates the extreme positions of the Finnish Lake District ice lobe, at the edge of the ice sheet (Image 9). As ice-marginal formations formed on the outer parts of the lobe, actively flowing ice formed the scenery near the northern border of the Geopark. The thick, slow-flowing ice mass detached boulder and rock material from the bedrock underneath and crushed, ground, and layered it over the bedrock as basal till. Basal till also formed into fusiform ridges or drumlins, indicating the direction of glacial movement. The northern border area of the Geopark contains a representative sample of the Pieksämäki drumlin field. The field, which contains tens of thousands of drumlins and other terrain formations of glacial origin, is Finland's largest and also holds international significance. The fan shape formed by the direction of the field's drumlins and other formations accurately depicts ice movement in the Finnish Lake District ice lobe at the time of the formation of the Salpausselkä ridge system.



Mannerjäätikön virtaussuunnat ja jään reuna-asemat / Flow directions and marginal stages of the continental ice sheet



Drumliinit syntyivät Järvi-Suomen virtauskielekkeen sisemmissä osissa. Drumliinin proksimaaliosassa eli jäätikön puoleisella sivulla on usein kallioydin. Moreeni on kerrostunut kallion taakse muodostaen pitkän selänteen (distaaliosa).

The drumlins were formed in the innermost parts of the Finnish Lake District ice lobe. The proximal part of the drumlin, or the side facing the ice sheet, is usually a rock core. Till builds up behind this rocky part, forming a long ridge (the distal part).

Image 9. The map shows the fan-like ice lobes in Southern Finland at the end of the Ice Age. The Finnish Lake District ice lobe was active in the Saimaa Geopark area. The First and Second Salpausselkä accumulated at the edge of the Finnish Lake District ice lobe approximately 12,300–11,600 years ago. Around the same time, drumlins formed under the ice sheet at the middle of the ice lobe.

2.3 THE GEOLOGICAL VALUES OF SAIMAA GEOPARK

The geological values of the Saimaa Geopark area consist mainly of ancient and fractured bedrock and its most commonly known type of rock – rapakivi granite – and its massive ice-marginal formations known as the Salpausselkä ridge system, formed in front of the ice sheet at the end of the Ice Age. Additional geological value is provided by example sites in the north of the area, such as the formations and different drumlin variations in the Pieksämäki drumlin field. They supplement the glacial geological content to cover all key areas of the Finnish Lake District ice lobe. During the period following the Ice Age, the development of the Saimaa lake area, which was formed through the combined impact of the outlined geological factors, has been particularly affected by the southeastern tilting of the ground due to uneven uplift. This development and the story of Saimaa can be seen in the natural environment as ancient shorelines at various heights, rock paintings, and particularly Vuoksi and the Imatrankoski rapid potholes.

The geology is directly reflected in the shapes of the lakeland. In the deeply fractured bedrock areas in the north, Saimaa splinters into a labyrinthine network of watercourses. In southern Saimaa, where the Salpausselkä ridge system and related feeder eskers occur, the lakeland scenery is characterised by low sandy shores that span kilometres, and chains of esker islands which break the wide open waters. Saimaa offers the rare opportunity to learn about all of the key types of formations appearing on the ice lobe at the edge of the ice sheet, and the lake district's complex history. In addition, the geology has shaped intricate and interesting natural environments, which are linked to the significant number of natural and cultural values in the period following the melting of the ice sheet.

Image 10. Image depicts sand pinks growing on a sunny slope in Huuhanranta. Image: K-M Remes / Saimaa Geopark

2.4 SENSITIVITY OF QUATERNARY DEPOSITS AND BEDROCK TO EROSION

Ridge areas and sandy shores are sensitive to erosion, as the easily eroding sand is only covered by a thin layer of forest-floor shrubland. If the layer of shrubland is broken for example by off-road vehicles or bikes, the grooves may spread uncontrollably due to erosion. Heavy rainfall may also widen and deepen the grooves. Another combination that is sensitive to erosion is rocks covered with moss and lichen. In steep parts of rocky areas, paths easily become wider and new grooves form when the layer of moss and lichen protecting the rocks wears away.

The Saimaa Geopark bedrock is mostly durable, but in areas containing rapakivi, especially the easily weathering rapakivi granite, erosion can begin or be strengthened if the number of visitors increases uncontrollably. Saimaa Geopark also contains areas where the vegetation needs monitoring. There are some protected plants, such as spring pasqueflowers and sand pinks, growing in sunny environments on ice-marginal formations and esker ridges, and these should be protected from trampling (Image 10). The Salpausselkä ridge area also contains some small areas of lusher vegetation, or groves, that should be protected. For the preservation of the terrain and the environment, it would thus be of paramount importance that only marked paths and routes or structures are used for moving around in the Saimaa Geopark area.

2.5 GEOLOGICAL FORMATIONS, LANDSCAPES, AND ENVIRONMENTAL PROTECTION

Finnish legislation has several statutes governing land use planning, the utilisation of natural resources and other activities that may impact the natural environment or landscape. They are based on both national legislation and EU directives. A geologically significant piece of legislation is the Land Extraction Act (555/1981) and the accompanying Government Decree on land extraction. The general objective of these laws is to monitor the use of land material in such a way as to ensure the protection of nature, landscape and other environmental values in accordance with sustainable development. The regulation of land procurement is strongly linked with land use planning, earthwork and hydraulic construction, the protection of groundwater, and environmental and natural protection. Other key laws concern construction, transport, forests, and the use of surface water and groundwater.

Compliance with the Land Extraction Act has resulted in Finland having nationwide inventories of valuable rocky areas, moraine formations, and wind and shore deposits. Some of Saimaa Geopark's sites have been surveyed for this inventory, and they are listed in the UGG application materials. In connection to the national esker ridge protection programme, an inventory has also been made of valuable Finnish ridge areas. In addition, nationally and regionally valuable geological formations (ridges, moraine and rock formations, etc.) are indicated in regional plans. Markings in regional plans indicate that the area contains values listed in the Land Extraction Act, and that land extraction permits should not be issued for these areas.

Land Extraction Act Section 3:

The resources referred to in this Act shall not be extracted in such a way that:

1. beautiful scenery is disfigured;
2. natural sites of significant scenic value or distinctive features are destroyed;
3. substantial or extensive detrimental changes are caused to natural conditions; or
4. the water quality or yield of a major groundwater area or a site otherwise suitable for water supply is endangered, unless an exempting permit is granted under the Water Act.