LIMESTONE – A NATIONAL STONE OF ESTONIA
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Tallinn 2007
LIMESTONE – A NATIONAL STONE OF ESTONIA.

ISBN 978-9985-9867-2-1

Compiled: Helle Perens
Elmar Kala

Acknowledgements: Eesti Geoloogiakeskus OÜ
Eesti Vabaõhumuuseum

Layout: Helle Perens
Andres Abe

Figures & Photos: Helle Perens

Front cover: Lasnamägi limestone was mostly used in buildings of Rebala village, Harjumaa

Back cover: also pasture fences were often made using a Lasnamägi limestone

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Release of this booklet in English was co-financed by European Regional Development Fund ERDF, Environmental Investment Centre, Estonian Ministry of the Interior and it was accomplished within the framework of INTERREG IIIA Southern Finland and Estonia programme
LIMESTONE AS A SYMBOL

We need symbols to maintain our national consciousness. The cornflower, which commonly grows in rye fields, symbolizes our daily bread. The barn swallow is the symbol of the country home. The limestone is our foundation, the symbol of the existence and continuance of the Estonian nation.

In 1990, a scientific conference dedicated to limestone was held in Estonia. With this, the foundation was laid for discussions of the sustainable use of limestone as a natural resource. On April 23, 1992, the Estonian Limestone Union was founded in the Kuressaare Castle. On May 4, 1992, limestone was declared the national stone of Estonia. The initiators of the idea were the geologists Rein Einasto and Anto Raukas, the historians Villem Raam and Vello Lõugas, the civil engineer Hubert Matve, and the naturalist Jaan Eilart.

Limestone Day is celebrated each May 4. On that day, the Estonian Limestone Union organizes limestone conferences and limestone trips and provides information on limestone. Limestone is a part of Estonia’s nature and cultural history. Deeper knowledge of limestone enables better perception of the aesthetic appeal of limestone landforms and better understanding of the architectural value of limestone buildings. A wall of an outcrop or a stone in a wall bears traces of ancient nature. It provides information on the sedimentation environment and biota of the past and shows how they have affected the properties of the rock. The knowledge of limestone is needed for students, teachers, architects, restorers, and all those who value limestone as a symbol of our continuance.

The present book was written at the time of the demolition of Sakala Centre in Tallinn, an outstanding representative of its era, built in 1985. This barbaric act became possible even though amid the decline in limestone production and processing, which had started in the 1960s, the limestone constructions of the 1980s and 1990s, designed by Raine Karp, were considered the renaissance of dolostone and limestone in Estonian architecture.
LIMESTONE: PART OF OUR PRIMEVAL NATURE

Inanimate nature is the memory of our planet. Traces in the rocks guide us to the secrets of the Earth’s life story. With this in view, the Book of Estonian Primeval Nature – a voluminous database of Estonian nature monuments – was compiled. The book records the most significant geological objects throughout Estonia, including bedrock exposures, erratic boulders, caves, karst areas, springs, waterfalls, and meteorite craters.

The compilation of the book was started in 1980 under the leadership of Herbert Viiding. The continuator of his work, Enn Pirrus, professor emeritus of the Mining Institute of the Tallinn University of Technology, has said that it is a unique phenomenon to have the entire inanimate nature of a country recorded in this way. Compiling the manuscript took 17 years. The most interesting parts of the book have to do with limestone beds.

Formation of limestone

Limestone is formed in shallow coastal marine environments, marl in the deeper parts of the sea. Clay accumulates at still greater depths in the open sea. Limestone belongs to sedimentary rocks in which formation the organism with the carbonate shells or skeletons have a crucial importance.

The sediments forming Estonian limestones accumulated 472 million to 416 million years ago in the flat-bottomed Paleobaltic Sea that covered the paleocontinent Baltica. Its formation is related mainly to the Ordovician and Silurian periods.

In Estonia, the formation of limestone began in the Middle Ordovician. At first, the glauconite and iron-rich lime sediments accumulated in northern Estonia. Thereafter, the pure building limestone of the Lasnamägi Stage began to form. The messages of primeval nature originating in a Silurian tropical lagoon. Selgase limestone quarry
deepening of the sea at the end of the Middle Ordovician resulted in the accumulation of clayey limestone.

In the Late Ordovician, layers of oil shale layers (kukersite) appeared in the limestone. The period of formation of kukersites was followed by a period of intense volcanic activity in the areas adjacent to Baltica. Part of the ash emitted by volcanoes settled on the bottom of the sea covering Estonia’s territory. Interlayers of volcanic ash formed in the limestone.

The Paleobaltic Sea became shallower and deeper periodically. During the course of one shallowing period, Estonia’s oldest reefs developed in the Vasalemma area; this was followed by the deposition of carbonate muds which were transformed later on into pure aphanitic limestones.

The Ordovician limestone contains rich and diverse association of fossils such as bryozoans, corals, and stromatoporoids, which played a significant role in reef formations. Brachiopods, trilobites, echinoderms and sea lilies were also abundant.

In the Ordovician, Baltica was in the Southern Hemisphere, where the climate was warm and maritime. At the end of the period, there was an abrupt cooling, which culminated with the glaciation of the Southern Hemisphere. As a result, the global sea level dropped 50 to 100 meters. At that time, the sediments which are now know as the Röa dolostones formed in the shallow sea of northern Estonia.

In southern Estonia, where the sea was deeper, sediments with a much higher clay content and reddish intervals accumulated during the Ordovician.
In the Silurian, Baltica shifted from the Southern Hemisphere to the equator, and the diversity of corals and stromatoporoids increased. Sea lilies formed big thickets, their skeletal particles in turn forming thick limestone beds. Sea scorpions (eurypterids), appeared in the brackish water environments. Sparse land vegetation was developing. The Paleobaltic Sea began to retreat slowly.

At the beginning of the Silurian, a huge coquina bed was formed consisting of shells of the brachiopod *Borealis*. The bed extended from Hiiumaa Island to Lake Peipsi. The thickness of this bed reaches 13 meters on the Pandivere upland. This mineral resource, locally termed "ring limestone", is one of the best technological raw materials in Estonia and also an excellent building stone.

The sea turned periodically deeper. The deepest water developed during the Early Silurian Adavere and Jaani stages. A marl complex formed, about a hundred meters in thickness. In the succeeding Jaagarahu stage the sea turned abruptly shallower, which caused the accumulation of a reef complex about 30 m thick in Estonia’s territory. The main and largest reef belt was situated to the west of Estonia, near Gotland Island.
The rocks of the Silurian period are characterized by a frequent rhythmic alternation of different types of rock. As a rule, these are muddy and granular limestones and primary lagoonal dolostones. The latter are represented by Orgita and Kaarma dolostones. At the end of the Silurian period, the sea retreated from Estonia’s territory to the southwest.

A slight revival of limestone formation occurred in the Late Devonian, some 385 million to 359 million years ago. The marine basin advancing from the east covered the southeastern part of Estonia. There, a complex of lime sediment was deposited, rich in fossils and about a meter thick.

**Limestone landforms**

The limestone bedrock crops out north of the Pärnu-Mustvee line. Many picturesque and magnificent landforms are related to the bedrock. Among them are the North Estonian Klint, the Saaremaa coastal cliffs, the coastal areas, alvars on limestone, waterfalls spilling over the coastal bluffs, and different karst forms.

The North Estonian Klint is the most magnificent nature monument in Estonia. The klint is impressive both from the land and from the sea. The length of the klint is 300 km and it extends from Osmussaar Island to the city of Narva. The escarpments expose gray limestone, green glauconitic sandstones, brown shale, and, at the bottom, yellowish sandstone.

The North Estonian Klint is at its highest (56 m) on the Saka-Ontika-Toila klint plateau. The height of the upright wall is 25 to 30 m.

The Silurian Klint is smaller and lower. It runs along the northern coast of Saaremaa and Muhu islands and continues in the form of single cliff on the west Estonian mainland. The highest klint is on Gotland Island in Sweden.

On the West Estonian islands, the length of the coastal cliffs and scarps of the Silurian Klint is 90 km. Mustjala or Panga Cliff is the highest: 21.3 m.

Besides powerful limestone escarpments, there are numerous limestone outcrops in Estonia; of those, most significant are stratotypes, which locations gave the names for stratigraphic units of the
Ordovician and Silurina strata. Limestone quarries serve simultaneously as outcrops of mineral resources and are part of our national heritage. On the initiative of the Estonian Limestone Union, much has been done to put old limestone quarries in order and exhibit them at Porkuni, Keila, Paka, Mälivere, and Tamsalu.

Karst is an enchanting phenomenon of nature. It embraces almost the whole area of limestone distribution. This has to be considered when solving various practical problems related, for instance, to water supply and the mining of mineral resources. Karstification is caused by the dissolution of limestone and dolostones in water. Intense karst phenomena reach to a depth of 5 to 10 m. The most widespread karst form is the sinkhole, an oval, irregular, or dish-shaped opening in the ground. The landforms related to sinkholes include subsurface karst cavities but occasionally also subsurface creeks or rivers, with the fields of different-sized surface karst forms above them. Kostivere, Kuimetsa, Kata, Uhaku, and Pae are the largest karst fields in Estonia. The most picturesque karst forms are relict banks of limestone in the shapes of tables, mushrooms, and bridges.

**CHARACTERISTICS OF LIMESTONE**

**Composition, structure, texture**

Limestone, dolostone, and marl are the varieties of carbonate rocks; of those, the most widespread is limestone. Limestone is a rock formed mostly of calcium carbonate (CaCO₃). Pure limestone comprises
56% CaO and 44% CO₂, but this kind of rock is very rare in nature. Usually, dolomite, clay, glauconite, and iron hydroxide occur as impurities in limestone. Limestones vary in color from white, yellowish, pinkish, or gray, according to the impurities they contain. According to the type and quantity of impurity, limestones are divided into clayey, sandy or dolomitic limestone (impurity 10% to 25%). Organic-rich limestone is termed kerogenous. Oolitic limestone consists of rounded ooids having a diameter about 1 mm and are composed of calcium carbonate or iron oxides.

The inner texture of the limestone ranges from cryptocrystalline to coarse-grained. According to the size of the constituents, limestones are divided into several varieties: aphanitic or cryptocrystalline (less than 0.01 mm), microcrystalline (0.01 to 0.10 mm), fine-grained (0.1 to 1.0 mm), and coarse-grained (more than 1 mm). The crystals consist of calcite, but the grain material is most often detritus formed of crushed fossil shells and nodules of chemical origin. More frequently, the matrix of the limestone is microcrystalline, while cryptocrystalline aphanitic limestone is less distributed.

Besides the size of constituents, their origin and peculiarities are also of importance. Limestone comprising 25% uncrushed skeletal parts is termed biomorphic, while limestone with a high content of detritus is classified as detritic. According to the group of fossils, forming the limestones the rock is considered to be coquinoid, coral, or oncolitic limestone.
Unlike limestone, dolostone or dolomite $\text{CaMg(CO}_3\text{)}_2$ comprises up to 21.7% MgO, 30% CaO and 48% CO$_2$. Dolostone is more yellow and grayer than limestone. Most dolostone was formed as a result of the dolomitization of limestone. During this process, pores and cavities form in the rock, because the substitution of calcium by magnesium causes the volume of the rock to decrease. Cavities are prevalingly caused by the leaching out of fossils.

Marl is a link between limestone and clay. It comprises 25% to 50% clayey matter and is greenish or variegated in color. Dolomitized marl is called domerite.

The texture of the rock is caused by the arrangement and orientation of its constituents. The generally acknowledged textural characteristics of limestone are its lamination, which is revealed in changes of composition and grain size or some other lithological property. Horizontally laminated (tabular), wavy, and nodular textures are the most widespread ones.

**Physical and mechanical properties**

Building limestone must be resistant to weather, strong pressure, blows, and wear. The chemical composition and structural and textural peculiarities affect the physical and chemical indices of limestone. The compressive strength of Estonian building limestone is prevalingly 600 to 800 kg/cm$^2$, rarely as low as 400 kg/cm$^2$ and as high 1200 kg/cm$^2$; wear resistance is 1 to 3, most frequently 2. The frost resistance is usually 25 cycles,
rarely as low as 15 and as high as 35. The water-absorption capacity is usually 1% to 2%. In general, the properties of building dolostones are similar to those of limestones. However, their water-absorption capacity is slightly higher due to porosity and their compressive strength sometimes may reach 1200 kg/cm².

**Decorativeness**

Limestone is usually gray with different shades of color. Less frequent are green, brown, red, black, and white shades due to impurities. The pattern of the rock depends on its structure, texture, and its fossils. One of the most frequent textural effect is the discontinuity surface, the surface formed during a break in sedimentation. This surface is burrowed by different organisms and the burrows are afterward filled with material other than the main rock. Often, the discontinuity surface is black, brown, or red due to the impregnation by the iron or phosphate compounds.

**FIELDS OF APPLICATION**

Limestone is a valuable resource. Studies carried out in the Geological Survey of Estonia have shown that there are some hundred limestone quarries in the republic that can be worked for various purposes.

The fields of limestone use are determined by its chemical, physical and mechanical properties. Limestone and dolostone are used as a building material and technological stone and for lime burning and cement production. Souvenirs and adornments are also made of limestone.
Limestone as a building material

Both limestones and dolostones are used as a building material. In good building stones, the thickness of the layer is 10 to 20 cm. In the Lasnamäe building limestone, coquinoid limestone, Ungru limestone, and "marble" of Vasalemma, the layers are occasionally 30 cm thick, sometimes even more.

Building dolostones that formed as a result of the dolomitization of limestones are more monolithic than the primary rock, because the marl layers weakening the limestone usually disappear during the course of dolomitization. Microcrystalline and fine-porous dolomites make good building stones if the porosity does not exceed 10%. Primary dolostones are important building stones. Estonia’s best massive dolostones quarried at Kaarma, Orgita, Selgase and Mündi belong to primary dolostones.

History of use

Limestone constructions play a big and significant role in introducing our national stone. At the end of the younger Bronze Age, the stones removed from fields were dumped in piles. Over time, a low stone wall formed around the fields. In northern and western Estonia, people were buried in stone cist barrows, which were usually made of limestone.

Several hundred years before our era, a limestone wall was erected on Saaremaa Island to protect the fortified settlement of Asva, where limestone floor slabs were already being used. In the ninth and tenth centuries, limestone was used more and more in strongholds. At that
time, defense mounds with dry walls were erected on natural elevations. The mounds were 7 to 10 m high and were made of local limestone. The limestone-mantled wells of Varbola and Valjala strongholds have been preserved to this day. In all likelihood, the stronghold 25 m high of the ancient Estonians on Toompea hill was also surrounded with such a dry wall. It was either destroyed by later building activities or buried under a cultural layer 4 to 5 m thick.

Local rock supplies were an important prerequisite for the development of architecture and stone carving in Estonia. The traditions of stonemasonry in Estonia go back to times prior to foreign invasions. Evidence is derived from the trapezoidal grave-marking tablets, which are found mostly on the island of Saaremaa. These are traces from the time in which heathenism and Christianity met in these places. They were massively used in the eleventh through the thirteenth centuries. More than 90 grave tablets of this kind are known in Estonia. In the late Middle Ages grave tablets were used as a building material.

Old, trapeze-shaped grave tablet in the outer wall of Kaarma Church.

Limestone grave at the site of Jõelähtme stone-cist barrows

The triumph of Christianity was followed by the large-scale and rapid construction of chapels, churches, monasteries, and new fortifications. This required elucidation and application of the most significant types of building rocks in Estonia.

The oldest limestone churches originating from the thirteenth century were built on western Saaremaa, on Toompea hill in Tallinn, and in Järvamaa. As a rule, the primary churches were made of local stone, which whenever possible was also used for carving.
Saaremaa is one of the richest regions for limestone reserves in Estonia. There has never been a need to transport it from elsewhere. However, some end products have been brought to Saaremaa. These include medieval baptismal fonts (the churches of Kaarma, Pöide, Muhu, and Anseküla) from Gotland and floor tiles (Pühala Church) from Öland.

The construction of Kaarma Church in the second half of the thirteenth century marks the triumph of the massive Kaarma dolostone first in Saaremaa, then in Läänemaa and Pärnumaa. Since the seventeenth century it has been widely used in Tallinn and elsewhere in Estonia. The medieval stone carvings, with a richness of form and perfection of finish in the Karja church, are the most outstanding examples of the use of Kaarma dolostone.

Of the later buildings made of Kaarma dolostone, the following deserve attention: the baroque and classicist town buildings of Kuressaare, the porticus with pillars in the Niguliste Church in Tallinn (1676), the facade of the Gloria Cinema in Tallinn, and the sculptural decorations on the Võru Bank building.

Kaarma dolostone has been used to satisfy local needs for chimney stones, drinking and feeding troughs for animals, well curbs, grave markers, and magnificent monuments and memorials. The latter can be found all over Estonia and also in Latvia (the Võnnu Battle Monument).

Ridala Church, dating from the second half of the thirteenth century, is one of the oldest countryside church in Estonia. Its western portal and several other sculptured details are made of Unguru limestone, which is the best building carbonate rock in Läänemaa. This fine-grained limestone formed in a shallow wave zone; its bedding planes display ripple marks. The limestone comprises single corals, showing that the rock was formed close to the reef environment. This kind of limestone occurs in a limited area in the vicinity of Pusku, Sepaküla, and Pärnu.

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**AGE:**

- **SYSTEM:**
  - UPPER SILURIAN: age Ma 417
  - SILURIAN:
    - LOWER SILURIAN: age Ma 443
    - CARBONATE ROCKS AND USAGE IN ESTONIA

**AREAS OF USAGE:**

- building stone, finishing slabs
- construction aggregate
- industrial lime- and dolostone
- cement raw material
<table>
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 detritus cemented with calcite. "Marble" serves as a surrounding rock for bioherms. The rock is rich in jagged stylolitic surfaces coated with a very thin layer of marl. Along these surfaces the rock can be split into layers. In places, it is possible to break monoliths up to a meter in thickness. The distribution of the "marble" of Vasalemma is restricted to Harju-Risti, Vasalemma, Padise, Tuula, and Valingu. However, the area where it is used is much wider. Gravestones made of the
USAGE of CARBONATE ROCKS in MEDIEVAL BUILDINGS (after H. Perens, 2004, Fig 10)
Granular "marble" of Vasalemma

Orgita dolostone in pastel shades

Coat of arms on a grotto chapel in the Keila churchyard, Vasalemma "marble"

Gothic rose from Orgita dolostone. E. Kala, 2007

marble of Vasalemma in the nineteenth and twentieth centuries are found all over Estonia. The Vasalemma Castle (1890–93) is the most outstanding construction built of the marble of Vasalemma.

A century later, the Orgita dolostone was put to use. First it was used for the sculptures of Mārjamaa Church. In medieval times, it was used mainly in Tallinn, and later all over northern Estonia. In the seventeenth century it became particularly popular in Narva.

The Lasnamäe building limestone was first quarried on Toompea in Tallinn. Since the limestone reserves there were limited and the insular height itself was soon full of buildings, the production of limestone was transferred to the Lasnamäe area. Compared to Lasnamägi, the topmost 30 to 40 layers are absent in the Toompea section. The demand for the stone was particularly great at the end of the thirteenth century, when construction of the town wall began.
Art historians have always been interested in the role of Estonians in medieval stone architecture. Most of the materials related to limestone production and processing are stored in the archives of Tallinn, which offer good possibilities for studying the related problems.

The stonemasons’ guild was a professional union that emerged in the fourteenth century. To become a master of the guild, one had to cut out a window pillar, lavatory, or door arch and put it in place. The first masons were foreigners; however, beginning in the fourteenth century these works came to be done mainly by Estonians. Out of 36 masons listed by name in a count book of the Tallinn Town Council, 25 were Estonians. They came from Harjumaa, Virumaa, Järvamaa, and Läänemaa.

Typical medieval dwelling with its porch made of Lasnamäe limestone

The town wall in Tallinn is made entirely of Lasnamäe building limestone
Native men were working in limestone quarries. Their main tools were bombs with attached handles, iron crowbars, and rock drills. Limestone layers were broken loose along natural fissures. The broken lumps were cut into smaller pieces of a suitable size using the blunt end of the crowbar, a big hammer or a two-pood cast-iron bomb attached to a handle. Thicker layers were broken by means of an "ox".

In the quarries belonging to the Tallinn Town Council, the material produced was sorted at the end of the day into building limestone and the lumps suitable for sculpturing construction details. They were then handed over to the master builder, who together with a town council servant eliminated unsuitable production. The limestone needed in Tallinn came from the northern and southern quarries of Lasnamäe.

The Lasnamäe limestone forms a building-stone complex some 8 m thick and comprising 56 layers with specific names. The limestone was worked by layers. In the Lasnamäe building-stone complex the layers are separated by a thin layer of marl, which is frequently underlain by a thin layer of clayey limestone. The latter alternate with hard, weatherproof layers suitable for pavement slabs and stone-cutting.

The Lasnamäe building stone occurs in a large area extending from Paldiski along the klint as far as Sillamäe. Over time, the rock began to be used throughout Estonia.

In the limestone areas south and south-east of Tallinn, local varieties of limestone were also used in medieval times.

The dolostones of the Röa member, Porkuni Stage (hereafter the Röa dolo-
A pattern typical of Lasnamäe building stone in parallel cut

A pillar made of Lasnamäe limestone in the building of the Great Guild, Tallinn

Bedding planes of Lasnamäe limestone in the wall of the Väo limestone quarry

Justitia: a sculptured relief from Lasnamäe limestone, 1629
Röa dolostone comprises joints of coquinoic limestone, crop out in an area extending from Läänemaa to Lääne-Virumaa. In the thirteenth century, the Röa dolostone, an excellent solid material for stone carving, was used in the Lääne-Nigula, Ambla, Järva-Madise, and Järva-Jaani churches. In the fifteenth century, it was widely used in Lääne-Virumaa in the Porkuni stronghold, and sculptured details were made for the Kadrina, Väike-Maarja, and Viru-Jaagupi churches. In the seventeenth through the nineteenth centuries, the Röa dolostone was used to decorate the manor houses at Kuru, Mõdriku, Muuga, and Porkuni. Since the end of the nineteenth century, it has come to be used in farm houses also. Inju manor house in Virumaa was constructed of a unique variety of limestone: the Inju yellow.

*Coquinoic limestone from Lääne-Virumaa*

A detail of the Nõo Church portal made of coquinoic limestone

*Borealis* or coquinoic limestone occurs in the topmost part of the Juuru Stage. It is composed of brachiopod shells which accumulated in masses, lithified, and became cemented together by calcite.
The *Borealis* limestone is at its thickest (10 m) in western Virumaa. The layers are usually 10 to 20 cm thick. The complex displays a large variety of colors: gray, yellow, yellowish, greenish, and reddish. The suitability of this rock for a wall stone has been proved by the well-preserved buildings, the oldest of which date from the beginning of the Middle Ages. The best example is the Vao stronghold. In stone masonry, the use of *Borealis* was restricted mainly to the medieval grave tablets in the Ambla and Palamuse churches, altar slab in the Väike-Maarja Church and the portal of the Nõo Church. The *Borealis* limestone is a promising finishing stone.

The dolostones worked in the Paide and Mündi quarries in Järvamaa were widely used in medieval times in the Paide and Viljandi strongholds and in the Plistvere, Koeru, Põltsamaa, and Türi churches. The Paide quarry was closed in the second half of the nineteenth century. The Mündi quarry was still among the largest in Estonia in the middle of the nineteenth century. It was closed in the second half of the twentieth century, its reserves exhausted.

Aphanitic limestone from the Rägavere quarries was used as a building stone in Rakvere Castle in Virumaa in the thirteenth century. The sculptural details of the castle were made of the Lasnamäe building limestone and Orgita dolostone.

On the way from Sillamäe toward Narva, one will come across buildings made of multicolored limestones. The picture is most impressive in the town of Narva. In the thirteenth century Narva dolostone was used as building and carving material in the Hermann Castle. One of the oldest objects (1521) cut from the Narva dolostone and stored in Narva Museum is the ring-shaped cross dedicated to Paul Weddel. The colorfulness of the rock is vividly expressed in the reddish and greenish walls of Alexander Church and Pimeaia Garden.

In the Middle Ages, Estonian limestone and its end products (gravestones, porch stones, stairs, arches of inner portals, vault stones, and floor slabs) were exported to Finland, Sweden, Riga, and Prussia.

After the Middle Ages the nomenclature of building stones gradually widened. In
most cases, the manors and towns situated in limestone areas had their own quarries.

In 1844–1846, a big quarry was opened at Kernu to produce limestone for the Winter Palace in Petersburg. In 1881, new quarries were put to use in the vicinity of the Vasalemma railway station. From those quarries building stone was exported to Finland, Sweden, and Petersburg.

The nineteenth and twentieth centuries witnessed the triumph of brick in the building industry. Large industrial complexes were founded in Tallinn, Kunda, and Narva. Limestone yielded the palm to bricks. Even the openings in smooth limestone walls were lined with bricks. Similarly to the period of historicism limestone was used in its natural state in church buildings (Kaarli, Rapla, Jüri), town palaces (Tallinn, 6 Kohtu St.), and manor houses (Ungru, Vasalemma, Laitse, Inju). The cult of a mythical rustic stone spread in Germany and the Scandinavian countries and reached Estonia. Rusticated stones came to be used (the Tallinn Drama Theatre, Rotermann’s Salt Storage). Attempts were made to ennoble the buildings through the choice of material.

The use of limestone in the 1930s and 1940s is associated above all with the names of the architects H. Johanson, A. Kotli, and E. J. Kuusik. The best part of H. Johanson’s creation was designed to be made from the blocks of the Lasnamäe limestone, while A. Kotli tended to prefer the "marble" of Vasalemma.

During the same period, the mechanical processing of limestone began. The foundations were laid for the production and use of sawn dolostone and limestone cover slabs. At the end of the 1920s, a detailed study of limestone properties was undertaken in many quarries. The limestones and dolomites on Saaremaa Island and the limestones in and around Rakvere, Kalana, and Tamsalu were studied in particular detail.

During the first years of Soviet time, the Lasnamäe building limestone and the marble of Vasalemma were used as raw materials in the manufacture of wall stones, foundation stones, and stair stones.

The use of limestone for building decreased rapidly in the second half of
Above: Smithy from Oluva farm, Kahala village, Kuusalu parish, early 18th century.
Below: limestone use in a farm, western Saaremaa, first half of the 19th century.
Estonian Open Air Museum
the twentieth century. The production and processing of limestone was concentrated on Saaremaa Island, where finishing slabs were mostly produced. However, the selection of the rock and the quality of the end products were often poor. This was because of the shortage of knowledge; relevant skills and experience about where and how to use different limestone layers had disappeared together with the old stonemasons. The present-day limestone industry in Estonia is based on well-known limestone varieties including the Lasnamäe building limestone, Kaarma and Orgita dolostone, Ungru limestone, marble of Vasalemma and the recently added Selgase dolostone. Limestone is used mostly as an internal and external finishing material in private houses, in landscape gardening and, to a lesser extent, in public buildings.

In connection with the ever-expanding house-building and road construction, the demand for aggregate is continuously increasing. In recent times, there has been a shortage of limestone for that purpose.

**Limestone – technological stone and raw material in cement production**

Technological limestone is a raw material in the manufacture of pulp and paper and building materials, in machine-building, and in agriculture. With the development of new branches of industry at the end of the nineteenth century, the use of limestone as a raw material gained momen-
Cement plants were launched at Kunda (1870) and Aseri (1899). In the 1880s–1890s, lime plants were founded at Tamsalu and Rakke. The dolostone produced in the Üügu Cliff on Muhu Island was transported to the metallurgical plants of Petersburg and the Kaugatuma limestone to the Pärnu Pulp Plant. The pure coral Jaagarahu limestone was exported to Germany, Sweden, Finland, and Latvia.

As of 2005, the limestone deposits recorded in Estonia included one for cement production and 22 for technological limestone. In the Kunda Cement Plant the local Lasnamäe building limestone is used as a raw material.

Granular and aphanitic limestone and Borealis limestone or coquinoid limestone are suitable for use as a technological raw material. In the pulp and paper industry and metallurgical industry, only very pure limestone can be used. In such limestone, the CaO content must be at least 53%, Mg less than 1.5%, SiO₂ – 1.05%.

Ruins of limestone ring kiln at Rakke, 1910

Old bottle kiln of Kunda Cement Plant, 1870
there are suitable limestone deposits. Karinu coquinoid limestone is burnt at Rakke. Recently, several small companies have shown an interest in lime burning. Two of them are already working in the Lümanda Parish on Saaremaa.

Besides the traditional ways of limestone application, powdered hydrate lime is used for cleaning drinking water, while milled limestone is suitable for the purification of waste gases emitted by hydroelectric power stations. Limestone is also used in agriculture to reduce soil acidity; about a third of our fields need to be limed. There are five technological dolostone deposits in Estonia. The dolostone used in the glass industry must be very pure and comprise at least 18% MgO; this kind of limestone has been studied in the Hellamaa deposit on Muhu Island. During the years under Soviet power, this rock was used for a long time in the Järvakandi Glass Works.

Lime is currently burned mainly in Järvamaa and Lääne-Virumaa where

Ruins of lime-burning kiln at Mihkli Salumäe, Pärnu County
LIMESTONE – A NATIONAL STONE OF ESTONIA

TERMS

aphanitic limestone – cryptocrystalline limestone

Baltica paleocontinent – continental block (the area of the present-day East European Platform), which was located in the Souther Hemisphere and separated from the supercontinent Rodinia 630 million years ago

bedrock – part of the platform; a big structural unit of the Earth’s crust. Overlies the basement composed of hardened igneous and metamorphic rocks; consists of hardened sedimentary rocks. Forms the lower part of the sedimentary cover, which includes besides the bedrock also the overlying Quaternary cover

bioherm complex – fossiliferous reef formation with surrounding rocks

deposit – locality of mineral resources; a concentration of mineral matter with its quality, bedding conditions, and economic characteristics suitable for commercial use

dolostone – dolomitized limestone; sometimes with cavities left by leaching out fossils

fossil – the remains of an organism preserved in the rocks

glauconite – a green, siliceous, iron mineral of complicated composition, commonly occurs as grains

iron ooid – a rounded, small, grainlike formation composed of iron minerals

klint – an extensive bedrock escarpment on limestone coast

muddy limestone – microcrystalline or cryptocrystalline limestone formed of lime mud and almost devoid of skeletal fragments of organisms (detritus)

oncolite – a small, rounded, concentrically laminated, and calcareous sedimentary structure resembling an onion; formed by the activity of blue-green algae and bacteria

outcrop – an area where rocks appear above the surface of surrounding land or are covered with a thin layer of unconsolidated Quaternary deposits

ox – a tool for breaking limestone layers loose

Paleobaltic Sea – a shallow, flat-bottomed sea that covered the Baltica paleocontinent 488 million to 416 million years ago

period – a basic unit of the world’s geological time scale; a distinct portion of time in the evolution of the Earth, lasting tens of millions of years

reef – a ridge on the seafloor made up of the skeletons of carbon-secreting organisms

sediment – a loose material (laid down either on land or in water) and a sedimentary rock (lithified sediment)

stratotype – a type section for characterizing a geological subdivision or its boundaries

stromatoporoid – a big, loaflike fossil, an extinct colonial form belonging to sponges

system – rocks formed during the periods
REFERENCES


## IUGS ICS Geological Time Scale 2004 (www.stratigraphy.org)

adapted and modified by Estonian Commission on Stratigraphy (www.gi.ee/ESK/)

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