South-East Finland – Russia
ENPI CBC 2007 - 2013

SOUTH-EAST FINLAND - RUSSIA ENPI CBC PROGRAMME 2007-2013

Efficient use of natural stone in the Leningrad region and South-East Finland

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Activity 4: Evaluation of natural stone resources in the project area – Examples and Explanation of structures of databases

This project is co-funded by the European Union, the Russian Federation and the Republic of Finland

Contents

1. Introduction

Granite is the most important group of rocks quarried as natural stone blocks in Finland. The colours range from brown, grey, red, dark green, yellow to black. The main rock type is rapakivi granite, quarried in southwestern and southeastern Finland.

The Wiborg rapakivi granite batholith in southeastern Finland hosts mainly red and brown rapakivi granite varieties for production of natural stone. The unique visual appearance with rapakivi texture, in combination with high durability and long life cycles, makes these stones attractive. The Wiborg batholith represents a unique production area in the world: rapakivi granites are extracted as natural stone also in other countries, but in much smaller quantities than in Finland.

The extraction of red granite, pyterlite rapakivi granite, in the Wiborg batholith dates back to the 18th century. The granite has been used for several important buildings worldwide, especially in the St. Petersburg region where it has been used in ridges, foundations, quays, and as street paving. Much later the brown granite, wiborgite rapakivi granite, became into production. Quarrying of brown stone in the eastern parts of the batholith commenced at the beginning of the 1970's. Today, this area is one of the main locations for the production of brown granite in the world. The geological characteristics of the granite allow high annual production with large, gang saw sized blocks with a homogeneous brown colour.

The main aim of the Activity 4 in the ENPI project was to compile existing information about active and old natural stone quarries and new potential natural stone deposits in the project area. The information have been collected in a database and provided it for the companies, authorities and investors for further development and as a base for developing their business activities.

Main partners in the Activity 4 were:

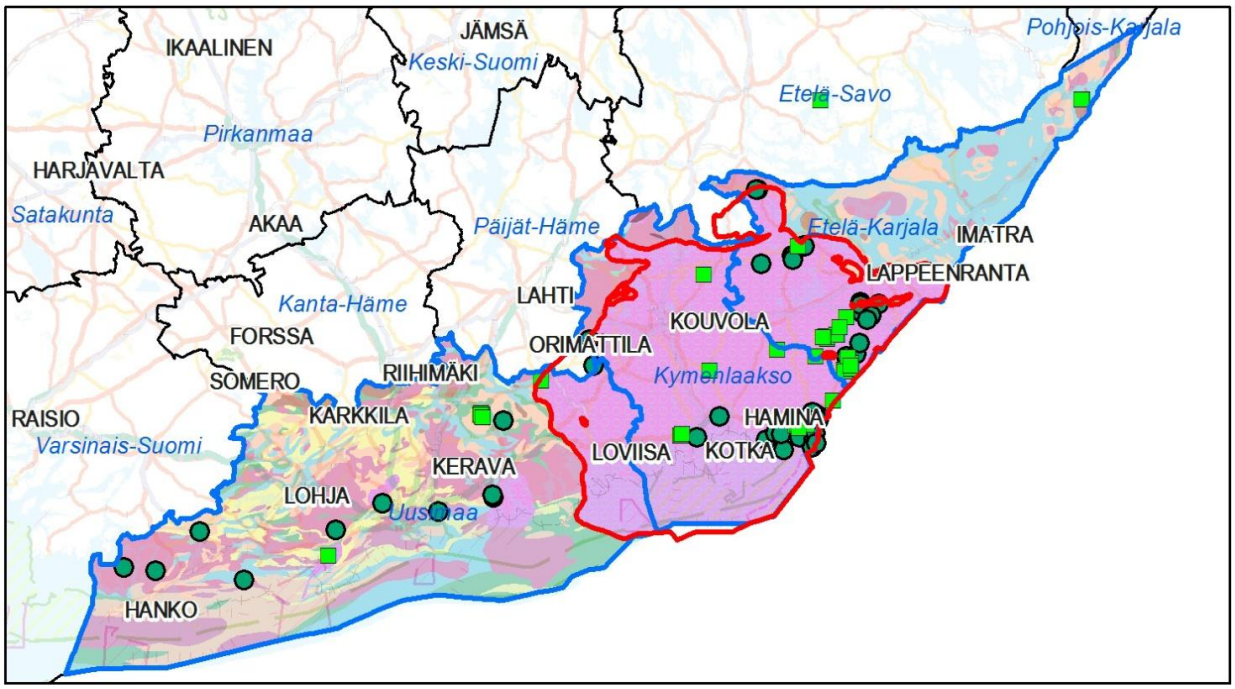
- GTK, as a leader of the Activity 4
- Federal State Unitary Enterprise "Petersburg Complex Geological Expedition"
- Associates.

2. General geological explanation

The project area is mainly located in Southern and South-eastern part of Finland covering the geological units of Western Uusimaa belt, Uusimaa belt, Saimaa area, Savo belt, Karelian domain and the eastern part of the Central Finland Granite complex. From the point of view of the natural stone resources, the most promising geological unit of the project area is the Wiborg rapakivi granite batholith, which is located mainly in south-eastern Finland but reaching also to Russia in the Karelian Isthmus.

The western Uusimaa belt as well as the Uusimaa belt is comprised of granitoids and metavolcanic rocks and migmatizing granites. The Saimaa area consists of supracrustal rocks such as schists and gneisses together with granitoids and metavolcanic rocks. There is also a high grade granulitic area in the Saimaa area that presents potential for commercial natural stone types.

The Savo belt consists mainly of metamorphic rocks with ore potential being not very promising as natural stone reserves. In the Central Finland granite complex area as well as in the Karelian Domain, there are granitic rocks as well as dykes of black stone. The geological map of the project area in Finland is presented in the figures 1 and 2.



Legend

- Regions of the project area
- Vyborg Rapakivi granite batholith (on the Finnish side)
- Quartz porphyry, basalt (c. 1.62 Ga)
- Rapakivi Granite, monzonite, syenite (c. 1.65-1.62 Ga)
- Gabbro, anorthosite, dolerite (c. 1.65-1.62 Ga)
- Granite, granodiorite, quartz monzonite, monzonite, syenite and metamorphic equivalents, in part hypersthene-bearing (c. 1.86-1.84 Ga and c. 1.82-1.76 Ga)
- Granite, pegmatite (c. 1.85-1.75 Ga)
- Granodiorite, tonalite, granite, monzonite, syenite and metamorphic equivalents, in part hypersthene-bearing (c. 1.91-1.88 Ga, in part as young as c. 1.84 Ga)
- Gabbro, diorite, ultramafic rock and metamorphic equivalents (c. 1.91-1.88 Ga, in part as young as c. 1.84 Ga)
- Quartzite, meta-arkose
- Mafic metavolcanic rock (c. 1.90-1.88 Ga)
- Felsic to intermediate metavolcanic rock (c. 1.90-1.88 Ga)
- Metagreywacke, metasiltstone, metasandstone, mica schist, graphite- and/or sulphide-bearing schist, paragneiss, amphibolite intercalations (c. 1.95-1.87 Ga and possibly older)
- Active quarry
- Old quarry (not active)

Figure 1. Geology of the Etelä-Karjala, Kymenlaakso and Uusimaa regions. Basemap: Bedrock of Finland - DigiKP. Digital map database [Electronic resource]. Espoo: Geological Survey of Finland. Version 1.0. Available at: http://www.geo.fi/en/bedrock.html

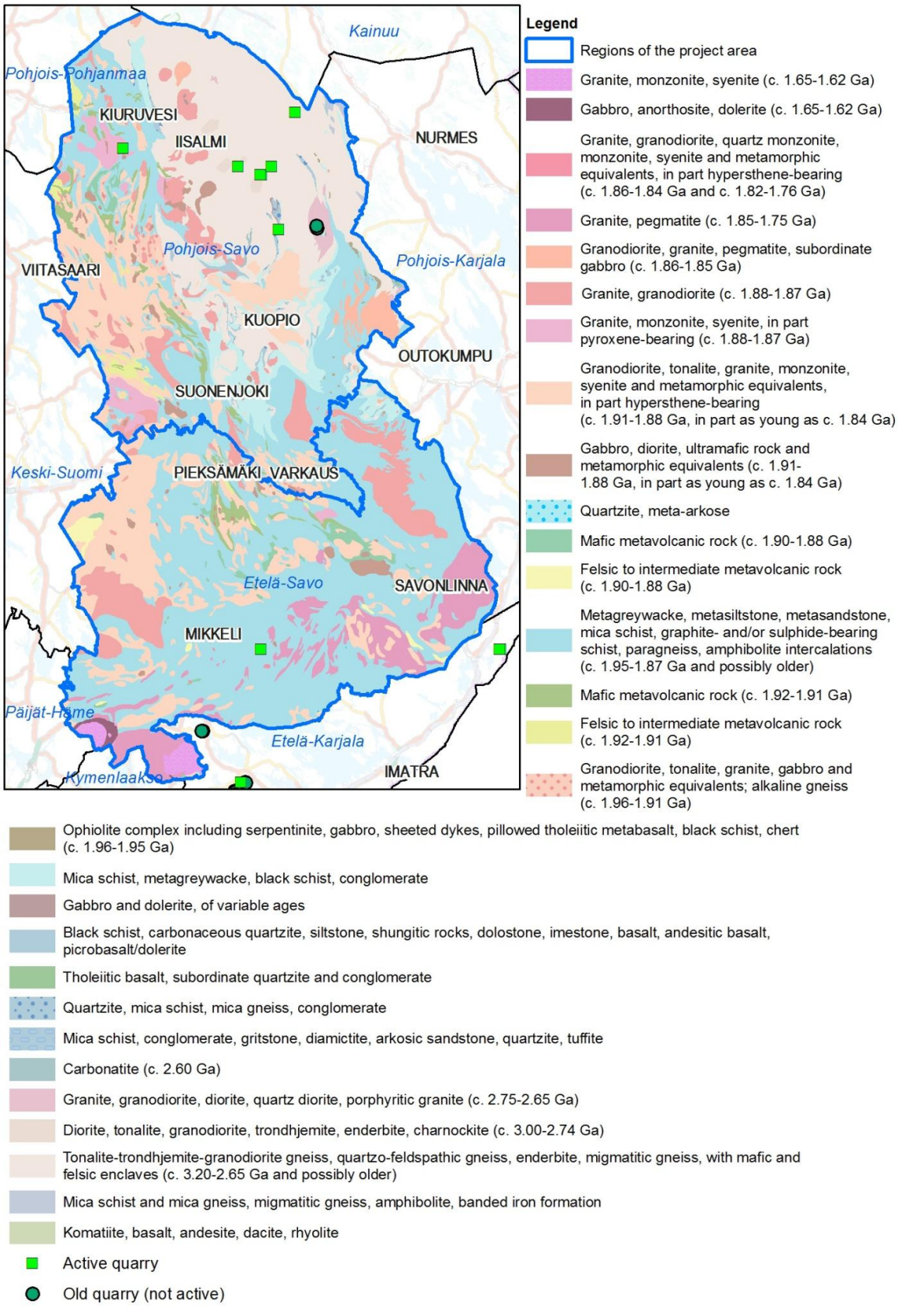


Figure 2. Geology of the Pohjois-Savo and Etelä-Savo region. Basemap: Bedrock of Finland - DigiKP. Digital map database [Electronic resource]. Espoo: Geological Survey of Finland. Version 1.0. Available at: http://www.geo.fi/en/bedrock.html

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3. Quarried stone types in Etelä-Karjala, Kymenlaakso ja Uusimaa regions

3.1. Active quarries

Almost all of the active quarries in the Etelä-Karjala and Kymenlaakso region are in rapakivi granite which is the main rock type of the whole area. In Etelä-Karjala the main natural stone production area is Lappeenranta – Ylämaa area representing brown wiborgite types of rapakivi granite (Fig 3) whereas pyterlite types of rapakivi granite (Fig 4) are mainly produced in Virolahti – Pyterlahti area, but also in Kotka (Fig 5) and Sippola areas (Fig 6). A dark green, big or small grain variety of the wiborgite (Fig 7) is quarried in the contact zones of the dark even-grained granite in Ylämaa area.

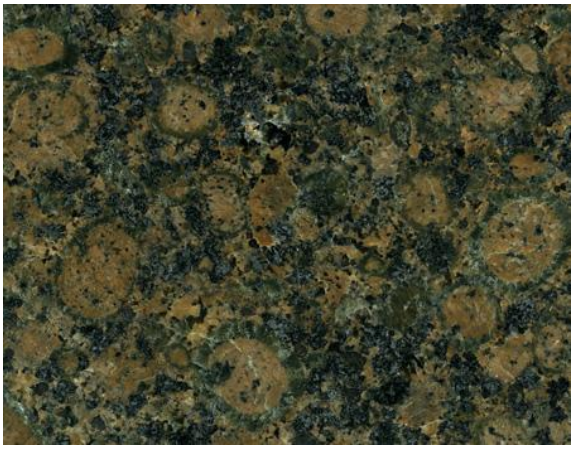

Figure 3.
Wiborgite type rapakivi granite
Baltic Brown -type
Picture: www.finstone.fi

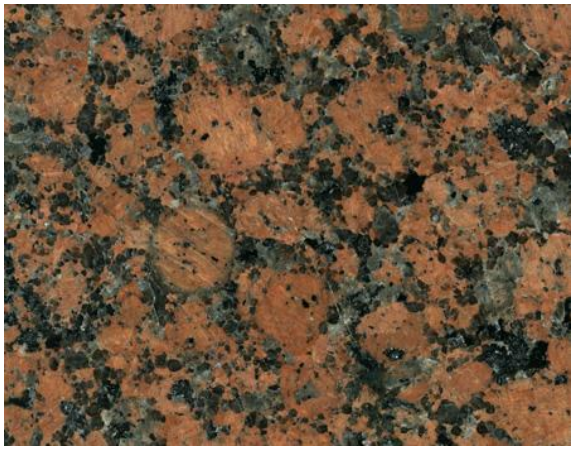

Figure 4.
Pyterlite type rapakivi granite
Carmen Red -type
Picture: www.finstone.fi

Figure 5.
Pyterlite type rapakivi granite
Eagle Red -type
Picture: www.finstone.fi

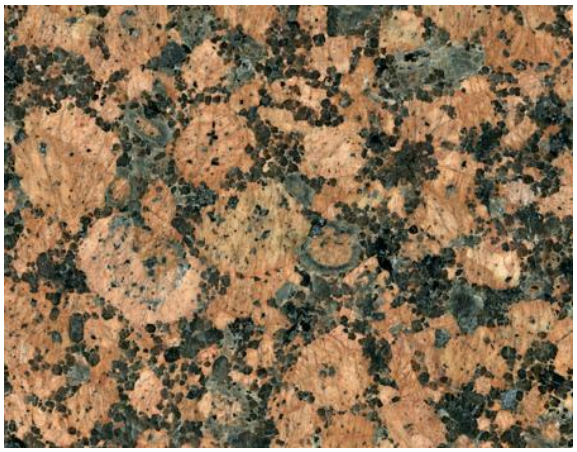

Figure 6.
Pyterlite type rapakivi granite
Karelian Red -type
Picture: www.finstone.fi

The rapakivi granites in the area are coarse grained and homogeneous without any orientation. They generally consist of K-feldspar, quartz, plagioclase, biotite and hornblende. The wiborgite type of rapakivi has typically round plagioclase feldspar rims around coarse K-feldspar grains i.e. ovoids giving a special texture for the wiborgite. Pyterlite type of rapakivi has also coarse K-feldspar ovoids, but without the plagioclase feldspar rims.

The brown wiborgite granites have been commercially named as “Baltic Brown” and the pyterlite types are called either “Carmen Red” or “Karelian Red”. “Baltic Green” is a commercial name for the stone type of dark green wiborgite (Fig 7).

Also black gabbro, called “Saari Black” is produced in Parikkala in Etelä-Karjala region, but in small scale. Geologically, the gabbro belongs to Southern Finland layered intrusion suite and is Svecofennian of age (1930 – 1780 Ma). The rock itself consists mainly of pyroxene, plagioclase and occasionally also olivine, hornblende and biotite (Häkli 1968). In natural stone industry classification the rock belongs to the group of so-called black stones.

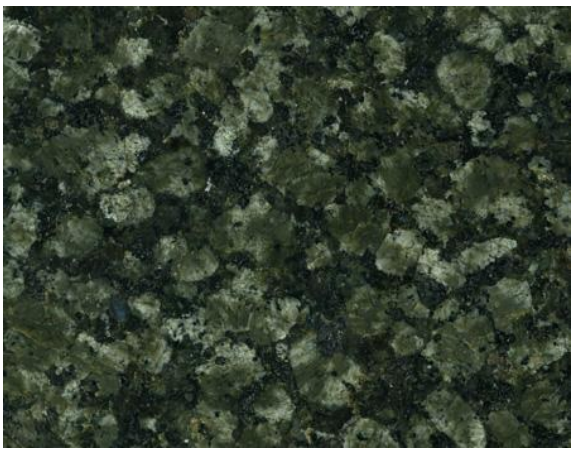

Figure 7.
Dark green coloured wiborgite rapakivi granite
Baltic Green -type
Picture: www.finstone.fi

In Uusimaa region the natural stones produced are migmatitic granites and also rapakivi granite. The most produced is the Mäntsälä migmatite, which goes by the commercial name “Aurora” (Fig 8). Mäntsälä migmatite consists of plagioclase, quartz, potassium feldspar, biotite and amphibole.

Figure 8.
Mäntsälä migmatite.
Auroro -type
Picture: www.finstone.fi

Figure 9.
Equigranular rapakivi granite
Myrskylä Red -type
Picture: www.finstone.fi

Myrskylä Red –type granite is equigranular and fine to medium grained rapakivi granite quarried actively in small scale in Uusimaa region (Fig 9). Another produced stone type in Uusimaa region has been the Porkkala Red granite, which is rapakivi granite belonging into the Kymi rapakivi suite and is situated on the west side of Helsinki. The quarry is not in an active use at the moment.

3.2. Old quarries and boulders

During the times there have been a lot of small quarries in the southern part of Finland, especially near the shore area. The rock type produced in the old quarries has been usually granite, granitic rock, schist or black gabbroic or dioritic rock whereas in southeastern Finland the quarried rock type was mostly rapakivi granites of different type, commonly equigranular rapakivi granite.

Boulders

For older constructions also local boulders have been utilized since the quarrying has been too difficult. Constructions where local boulders haven been utilized are for example old fortresses and castles. One of them in the project area is the Suomenlinna Sea Fortress just outside of Helsinki. Other sites can be found in the vicinity of Kotka and Loviisa as well as in Savonlinna, which hosts the Olavinlinna castle (Figs 10 and 11).

Figure 10. Inner court of the Olavinlinna castle in Savonlinna. Picture Joonas Toivanen, GTK.

The stones used as boulders have reflected the local bedrock and the effects of the glacial transportation. The size and shape of the boulders have been the major factor in choosing the appropriate materials for the constructions. In some cases, when the buildings of the sites were built during a long time (hundreds of years) also parts can be found that have been made of especially quarried material. Such case is for example in the Suomenlinna fortress.

Figure 11. Stones in the outer wall of the Olavinlinna castle in Savonlinna comprise of various local rocks, mainly of schists and granites that have been collected from nearby.

3.2.1. Suomenlinna

In constructions starting from the 18th century stone from local quarries have also been utilized in the buildings. This can be seen for example in the Suomenlinna Sea Fortress, where the latest structures built in the 19th century and at the beginning of the 20th century have been made of quarried natural stone, which has been transported mainly from the nearby Helsinki and Espoo areas. In Suomenlinna the quarried stone has been used e.g. in building of the dry docks in the 19th century. The stone has been used in the dry dock's walls and stairs (Fig 12).

Figure 12. Wall and stairs made of quarried stone in the Suomenlinna dry docks. The wall on the left is made of boulders collected from nearby areas.

3.2.1. Old quarries in Helsinki area

As an example it is taken the Helsinki area, which has had many quarries supplying stone for local buildings (Fig 13). The quarried areas have usually had several small quarries that were used during the times by different companies or entrepreneurs.

The Helsinki area quarries are listed in the following.

- Bodom area granite quarries
    - Rapakivi granite, un-metamorphosed
    - Almost un-oriented structure with sparse jointing suitable for quarrying

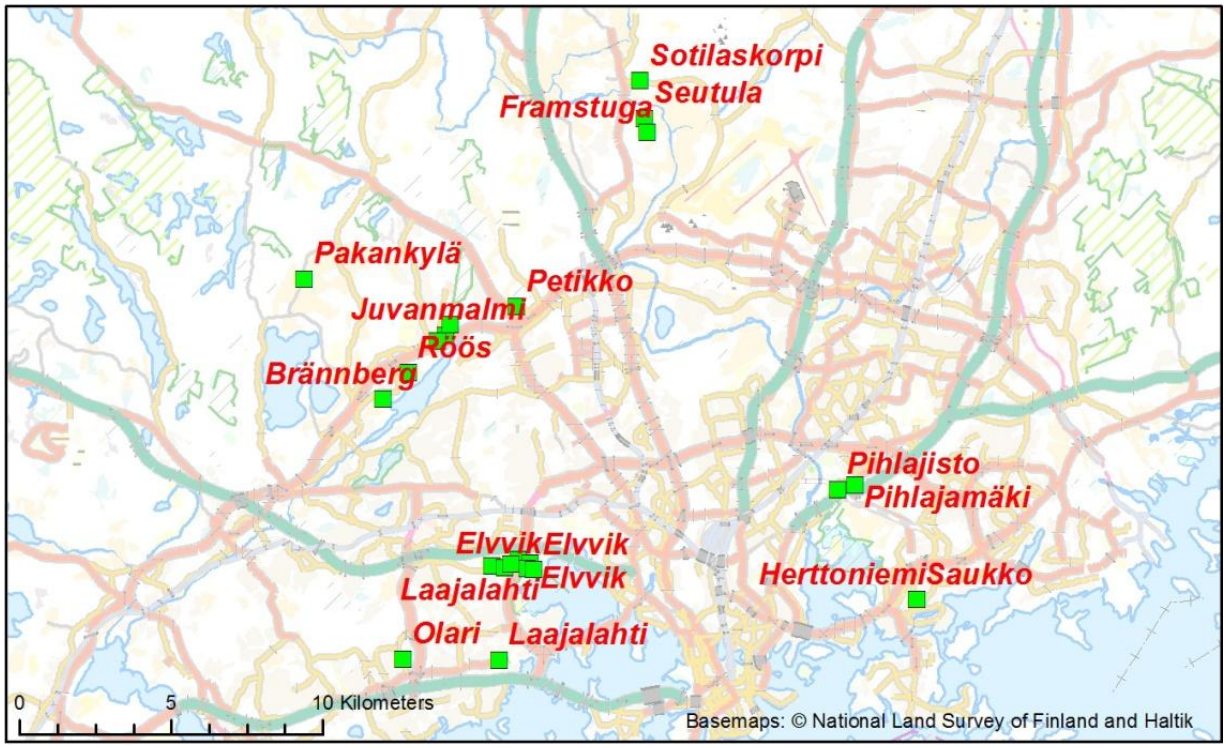

Figure 13. Map of the quarries in Helsinki area.

- At least 9 different quarry sites
  - Pakankylä
  - Brännberg
  - Röös
  - Juvanmalmi (many quarries)
  - Österbacken
  - Petikko
  - Sotilaskorpi
  - Seutula
  - Framstuga

- Leppävaara granite quarries
  - Quite large area consisting of dark red granite and quarried from several places
  - At least 8 quarries in the Laajalahti – Elvvik area

- Pihlajamäki and Pihlajisto
  - The area between Pukinmäki, Vanhakaupunki and Malmi cemetery consists of granitic migmatite used for constructions. The stone is reddish, heterogeneous and oriented.
  - Consisted of several small quarries producing mainly kerbs and setts.
  - Most of the quarries have vanished under the later constructed buildings

- Saukko
    - In south-west of Jätkäsaari there was a small island called Saukko that is now covered with soil filling and built-up. There it was quarried red migmatitic granite that was used in the buildings of Helsinki in the 19th century. The stone has been used in some elements of the Orthodox Uspensky Cathedral in Helsinki.
- Olari
    - There were several quarries in the Olari area in the beginning of the 20th century and the quarried stone was used for setts and kerbs in the Helsinki city area. Also some stone decorations were made like the gate columns.

Schist quarries

- Vartiosaari
    - In the island of Vartiosaari there were schist quarries that have produced roofing schist/slate
    - The slate has been used in the roofs of the Suomenlinna Sea Fortress

- Herttoniemi
    - There has been a small schist quarry area in the park between the water tower and Jättiläisenpolku Street.
    - The quarried rock has been amphibolite and amphibole bearing mica schist.
    - The site has been quarried in the 1940's and 1950's.

4. Quarried stone types in Pohjois-Savo and Etelä-Savo

4.1. Active quarries

There are some natural stone quarries in Pohjois-Savo and Etelä-Savo regions, too. Stone types produced in these quarries are used in buildings and environment constructions, but also as kitchen tops and gravestones. These stone types are utilised mostly in Finland, not so much exported. Some examples of these stone types are presented in the following figures (Figs 14, 15, 16, 17 and 18).

Fig 14. Silver Green –stone type, Varpaisjärvi

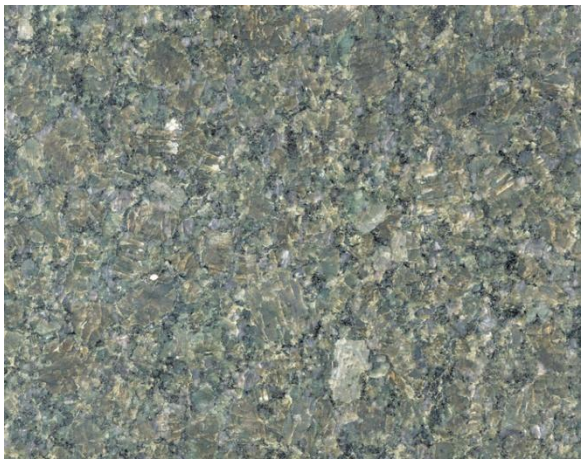

Fig 15. Green Sea –stone type, Kiuruvesi

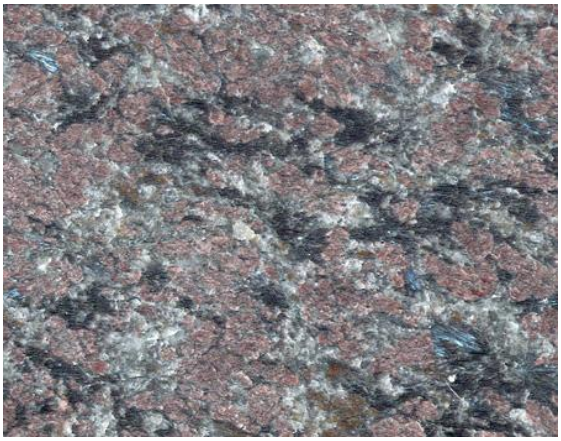

Fig 16. Lilac Pearl –stone type, Rautavaara

Fig 17. PG Black –stone type, Varpaisjärvi

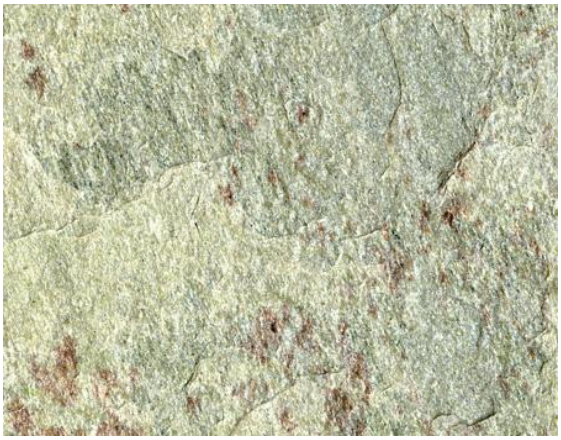

Fig 18. Nilsiä slate –stone type, Nilsiä

5. Durable Finnish Stone Types on the market in the project area

The durable Finnish Stone types in the project area are listed according to the name of stone type on the market in 2014 as follows:

5.1. Stone types In Etelä-Karjala and Kymenlaakso region

- Baltic Brown
- Baltic Green
- Carmen Red
- Karelia Red
- Eagle Red
- Rosso Marina
- Finlandia Red (New Balmoral)
- Kymen Red
- Kymen Brown
- Karelia Beige
- Saari Black

5.2. Stone types In Uusimaa region

- Myskylä Red
- Aurora

5.3. Stone types In Pohjois-Savo region

- Green Sea
- Silver Green
- Lilac Pearl
- PG Black
- Nilsiä slate

6. Database structures

The structure of database for quarries, deposits and occurrences is somewhat different in the Russian database than in a Finnish one. The structures are described in the following tables.

6.1. Russian database

Quarries

ID code of observation
Municipality town
Village
Name of deposit
Map sheet
Northern latitude
Eastern longitude
Area, m^2
Depth (m) of the top of the buried target (depth of the deposit)
Rock outcrops in the area
Thickness of the Quaternary rock (m)
Rock name
Colour
Grain size
Structure and texture of the rock
Photos
Research permit
License to exploitation
Entrails user
Geographical location
Authority approving reserves, protocol number, year of approving reserves
Geological characteristic
Geological age
Full index of the target (according to age)
Genetic type of deposit
Degree of deposit development
Category of evaluation of predicted or proved resources
Unit of predicted resources or proved resources measure
Predicted resources or proved resources
Output of component, blocks, raw material, %
Rock class according to the State standard 30108-94
Bibliography
Photos of architectural monuments where natural stone of this deposit was used
Deposit's code in the legend
Host rocks
Facies of deposit formation
Type of natural stone
Mining method
Alternative (old) name of the deposit

Deposits

Map sheet
Date of the occurrence discovery
Geological characteristics
Geological age
Full index of the target (according to age)
Occurrence's code in the legend
Genetic type of occurrence
Name of rock
Colour
Grain size
Structure and texture of the rock
Host rocks
Facies of occurrence formation
Category rating forecast resources
Category of evaluation of predicted resources
Predicted resources
Bibliography
Photos of architectural monuments where natural stone of this occurrence was used

6.2. Finnish database

Occurrences

Field	Description	Value example
ID	Unique ID code	
Municipality/Town	Name	
Village	name	
Place	Name	
Observer	Name	
Latitude	Latitude deg, min, sec	
Longitude	Longitude deg, min, sec	
Latitude	Latitude decimal	
Longitude	Longitude decimal	
Positioning method	Map, GPS or other	
Area of the occurrence	Square meters	
Topographical levels - lowest	z_coord (m)	
Topographical levels-highest	z_coord (m)	
Description of the area		
Volume estimation	Calculated estimate of the deposit (m^3)	
Evaluation of environment	Possible restricting factors	
Nearest inhabitation	m	
Logistic conditions	Distance to roads, road conditions	
Suitability/further actions	Discard, clarifications, further study	
Occurrence type	Occurrence classification	
Rock class	Scientific rock class	
Rock name	Scientific rock name	
Mineralogy	Main minerals	
Jointing	Description	
Schistosity	Description	
Alteration of the rock	Alteration type and degree	
Structure of the rock	Description	
Texture of the rock	Description	
Grain size	mm or written description	
Weathering	Weathering degree (1/no – 4/totally)	
Colour	Colour of the rock	
Estimate of block size	According to observations (m^3)	

Active quarries

Field	Description	Value example
ID	Unique ID code	
Municipality/Town	Name	
Village	name	
Place	Name	
Map sheet	Number	
X	National latitude coordinate	
Y	National longitude coordinate	
Latitude	Latitude decimal	
Longitude	Longitude decimal	
Area	Square meters	
Topographical levels - lowest	z_coord (m)	
Topographical levels-highest	z_coord (m)	
Exposing of the rock area	poorly exposed (1) – well exposed (3)	
Quaternary coverage	estimated depth of coverage (m)	
Rock type	Rock name according to classification	
Commercial name		
Colour	written	
Grain size	mm or written description	
Structure and texture of the rock	Description	
Quarrying started	year	
Quarrying ended (if ended)	year	
Total amount	m^3	
Quarrier 1	Company or person	
Quarrier 2	Company or person	
Quarrier 3	Company or person	
Reference building / site 1		
Reference building / site 2		
Reference building / site 3		
Usability	Different applications	
Photos	Link to photos	
Research permit	No / Yes, description	
Quarrying permit	No / Yes, description	
Land ownership	Owner, Address / unknown	

Old quarries

Field	Description	Value example
ID	Unique ID code	
Municipality/Town	Name	
Village	name	
Place	Name	
Map sheet	Number	
Y	National latitude coordinate	
X	National longitude coordinate	
Latitude	Latitude deg, min, sec	
Longitude	Longitude deg, min, sec	
Latitude	Latitude decimal	
Longitude	Longitude decimal	
Area	m^3	
Topographical levels - lowest	z_coord (m)	
Topographical levels-highest	z_coord (m)	
Exposing of the rock area	poorly exposed (1) – well exposed (3)	
Quaternary coverage	estimated depth of coverage (m)	
Rock type	Rock name according to classification	
Stone type (industrial)	Industrial classification	
Commercial name		
Colour	written	
Grain size	mm or written description	
Structure and texture of the rock	Description	
Quarrying started	year	
Quarrying ended (if ended)	year	
Total amount produced	m^3	
Quarrier 1	Company or person	
Quarrier 2	Company or person	
Quarrier 3	Company or person	
Reference building / site 1		
Reference building / site 2		
Reference building / site 3		
Usability	Different applications	
Photos	Link to photos	
Research permit	No / Yes, description	
Quarrying permit	No / Yes, description	
Land ownership	Owner, Address / unknown	