Nordkalk

Limestone and Lime as a raw material

Håkan Pihl / Nordkalk Oy Ab

25.08.2023

Nordkalk in brief

Always near customers.
Almost **40** locations in Europe.

845
rock-solid professionals.

Safety comes first, **LTA1=4.3**,
93% of employees engaged in safety work.

Success built on solid limestone foundation.
125 years of history.

Aim for fossil-free operations.
Net zero by **2040**.

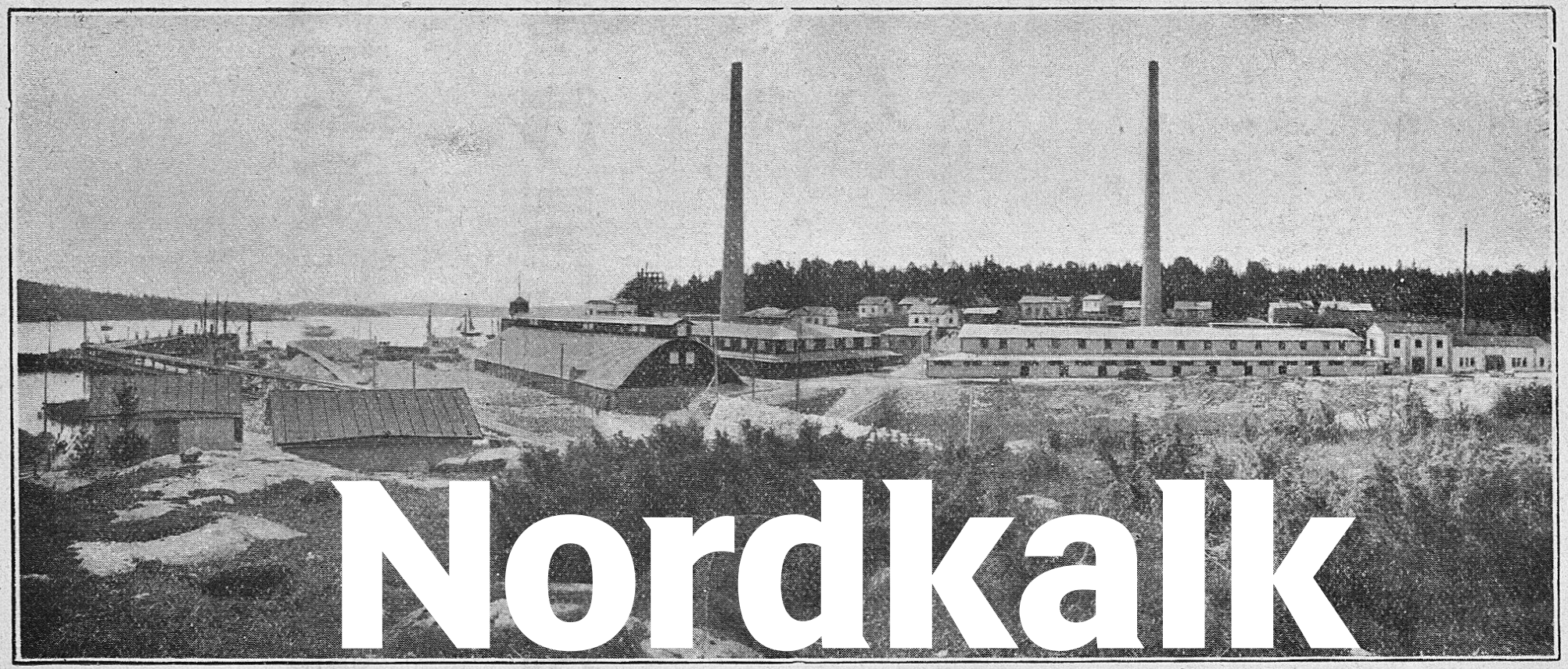
Seizing the opportunities of the Circular economy.
94% of extracted materials utilised.

* In Norway, Nordkalk is a co-owner of the affiliated company NorFraKalk AS, operating a lime kiln. Nordkalk is also a minority owner of Verdalskalk AS.

** In Turkey, Nordkalk has an affiliated company Nordeka Maden A.S. operating the Eskibalikli limestone quarry.

*** In Eisenhüttenstadt, Nordkalk operates ArcelorMittal's on-site lime kilns.

**** In Spain, Nordkalk is a co-owner of the affiliated company La Belonga.



Kalkhamnen och ugnarna.

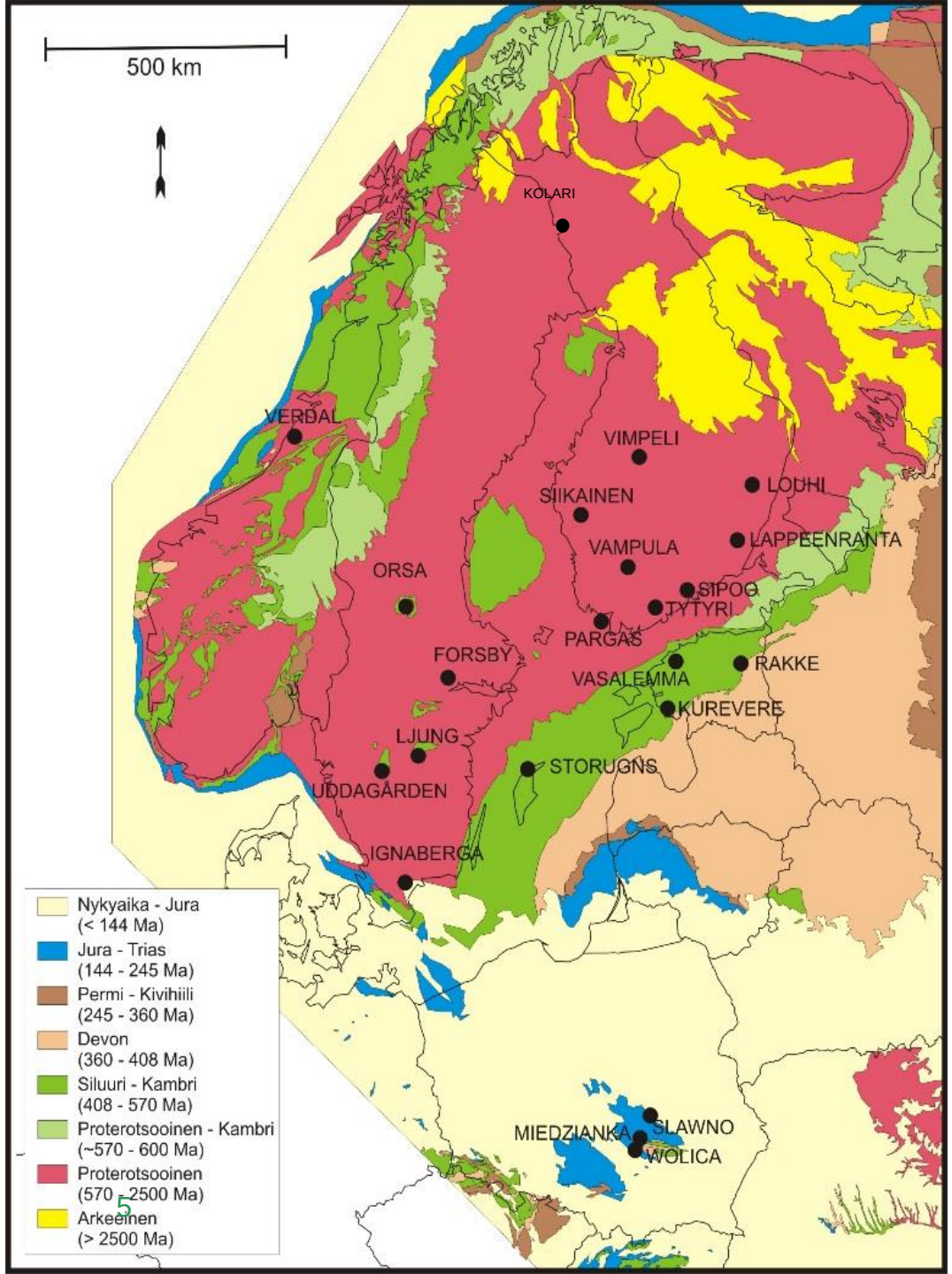
Till vänster kalkhamnen. Den år 1904 uppförda ringugnen. Gasringugnen till höger.
Närmast gasugnen till höger är gasverket och kraftstationen.

Pargas lime works in Finland, early 1900

Lime quality is depending on a few main issues

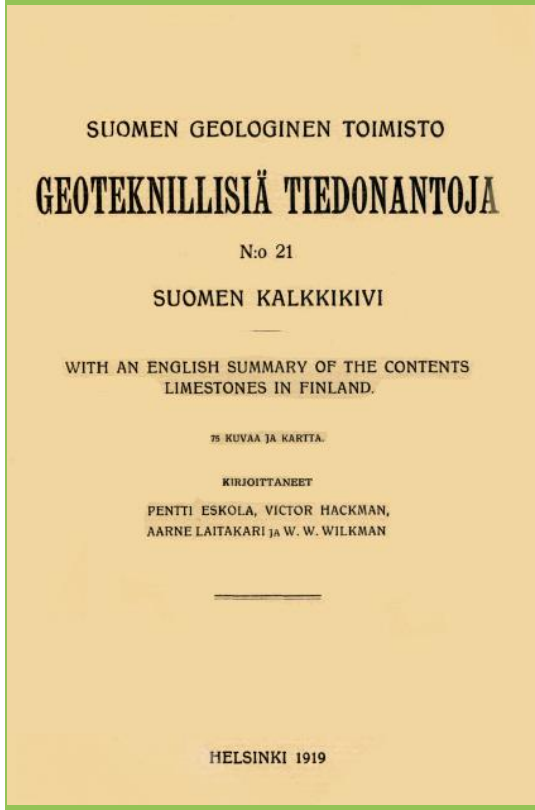
- LIMESTONE RAW MATERIAL
  - Every limestone deposit is individual to some extent
  - Main limestone types in the Nordics – sedimentary limestone (Gotland) versus recrystallized marble type (Pargas etc.)
- CALCINING TECHNOLOGY – KILN TYPES
  - Historical, earth kilns, ring kilns, simple shaft kilns
  - Today in the Nordics basicly long rotary kilns or modern shaft kilns
- FUEL
  - Wood, hard coal, gas, renewable or circular fuels
- HYDRATED LIME (SLAKING) PRODUCTION MAY BE CONSIDERED AS A CONCENTRATION TECHNIQUE
  - Medium quality CaO may be upgraded to good quality Ca(OH)2

Bedrock units



Analysis on Pargas limestone (marble) in the early 1900, see table, next page

- The limestone in the Limberg quarry is said to be pretty low in magnesiun, according to the analysis (next page)
- The limestone is used in the Pargas Kalberg AB cement works and in the two existing ring kilns. It is also shipped to other locations.


SUOMEN GEOLOGINEN TOIMISTO

GEOTEKNILLISIÄ TIEDONANTOJA

N:o 21

SUOMEN KALKKIKIVI

WITH AN ENGLISH SUMMARY OF THE CONTENTS
LIMESTONES IN FINLAND.

75 KUVAA JA KARTTA.

KIRJOITTANEET

PENTTI ESKOLA, VICTOR HACKMAN,
AARNE LAITAKARI JA W. W. WILKMAN

HELSINKI 1919

Nordkalk

Pentti Eskola et.al., 1919 Suomen Kalkkikivi. p. 92
Suomen Geologinen Toimisto. Geoteknillisiä Tiedonatoja, N:o 21

N:o		Unsoluble	Fe_2O_3 + Al_2O_3	CaO	MgO	Loss on Ignition	$CaCO_3$	Notes
1	1905	0,37	0,26	51,96	3,46	43,82	92,8	Marble
2	1905	0,90	0,12	54,02	0,82	43,58	97,6	Coarse grained glass works stone
3	1905	2,15	0,24	53,74	0,82	43,03	96,0	Coarse grained white
4	1905	2,79	0,20	52,48	1,68	42,71	93,8	Medium grained grey
5	1917	0,42	0,46	52,18	3,54	44,12	93,2	Marble
6	1917	0,28	0,34	53,40	1,77	43,94	95,4	Medium grained
7	1917	1,06	0,30	54,20	1,07	43,30	96,8	Medium grained white
8 [1)]	1914-1917	2,4	0,8	52,90	1,3	42,40	94,5	
9 [2)]	1914-1915	3,18		52,99	1,13	42,28	94,5	

1) Analysis N:o 8 is an average of a long series of analysis, which are done during the ramp up of the cement plant

2) Analysis N:o 9 is an average of 27 analysis , which are done for the Riga cement plant, to which limestone was shipped from Pargas

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Quality categories in the early 20th century (1915 Masters thesis p.36) Sorting into 5 categories

- **Coarse spar type (crystalline) - the purest one**
  - Supplied for glass production
- **White, middle grained**
  - Lime calcination feed
- **Grey striped, middle grained**
  - Supplied for paper and pulp production
- **Fine grained white**
  - For casting of marble mosaic
- **Fine particle stones residue from all the above categories**
  - From the start sold to the iron works
  - Later on (1914 onwards) useful as raw material in the internal cement production

Quick lime production development in Pargas

- **Earth / Field kilns**
  - Batch calcination with wood as fuel
  - Some 30, or more, known kiln sites in the parish – used by the local farmers.
  - Earth kilns were deemed too unproductive and too fuel consuming in the late nineteenth century
- **Cylinder kilns**
  - Introduced as the first technological development step – continual operation
  - Fired at the bottom – still with wood.
  - Limestone feeding at the top and lime discharge at the bottom
  - Faced the same productiviy and fuel economy challenge as the earth kilns
- **Generator shaft kiln**
  - Was introduced in Finland and was 2-3 times more productive than the cylinder
  - NOT IN USE PARGAS, due to the quality of the limestone – it's decripitation
  - Coal fuel – the fuel was partly or wholly gasified before entering the calcination
- **Ring kiln**
  - The first small, not very successful one in Pargas was built in 1891. A second on started to produce properly in 1905.

Wood fired kilns threatened to exhaust the forrests

Demo event in 2016

Temp./Lämpötila

kl/klo	°C
9:00	980°
10:00	969°
10:30	980°
11:00	1012°
11:30	1000°
12:00	1008°
12:30	1015°
13:00	1026°
13:30	1046°
14:30	1092°

Replica of earth kiln in Pargas

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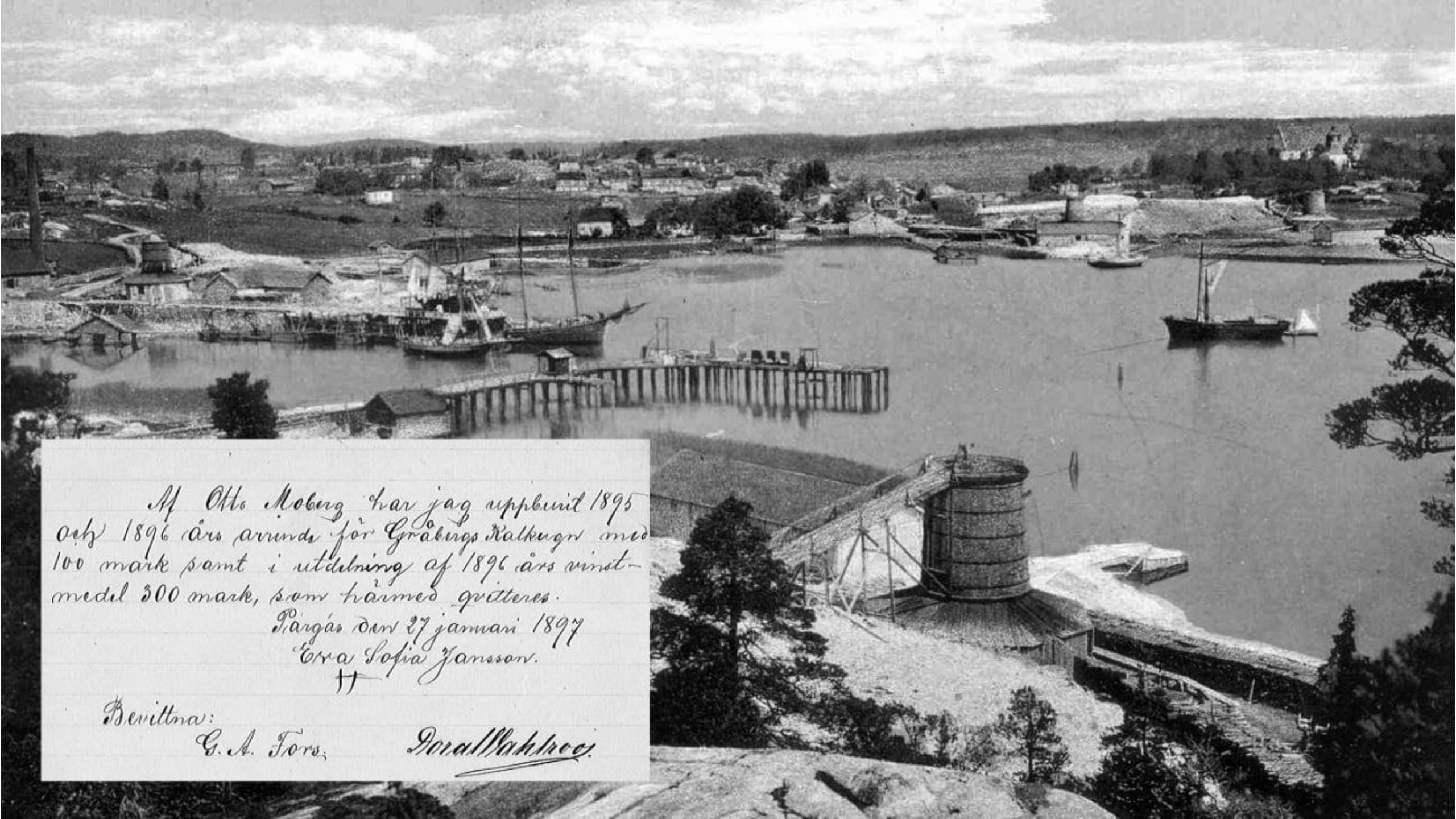


Af Otto Moberg har jag uppburit 1895 och 1896 års arvoden för Gråbergs Kalkugn med 100 mark samt i utdelning af 1896 års vinstmedel 300 mark, som härmed qvitteras.

Pargas den 27 januari 1897

Erna Sofia Jansson.

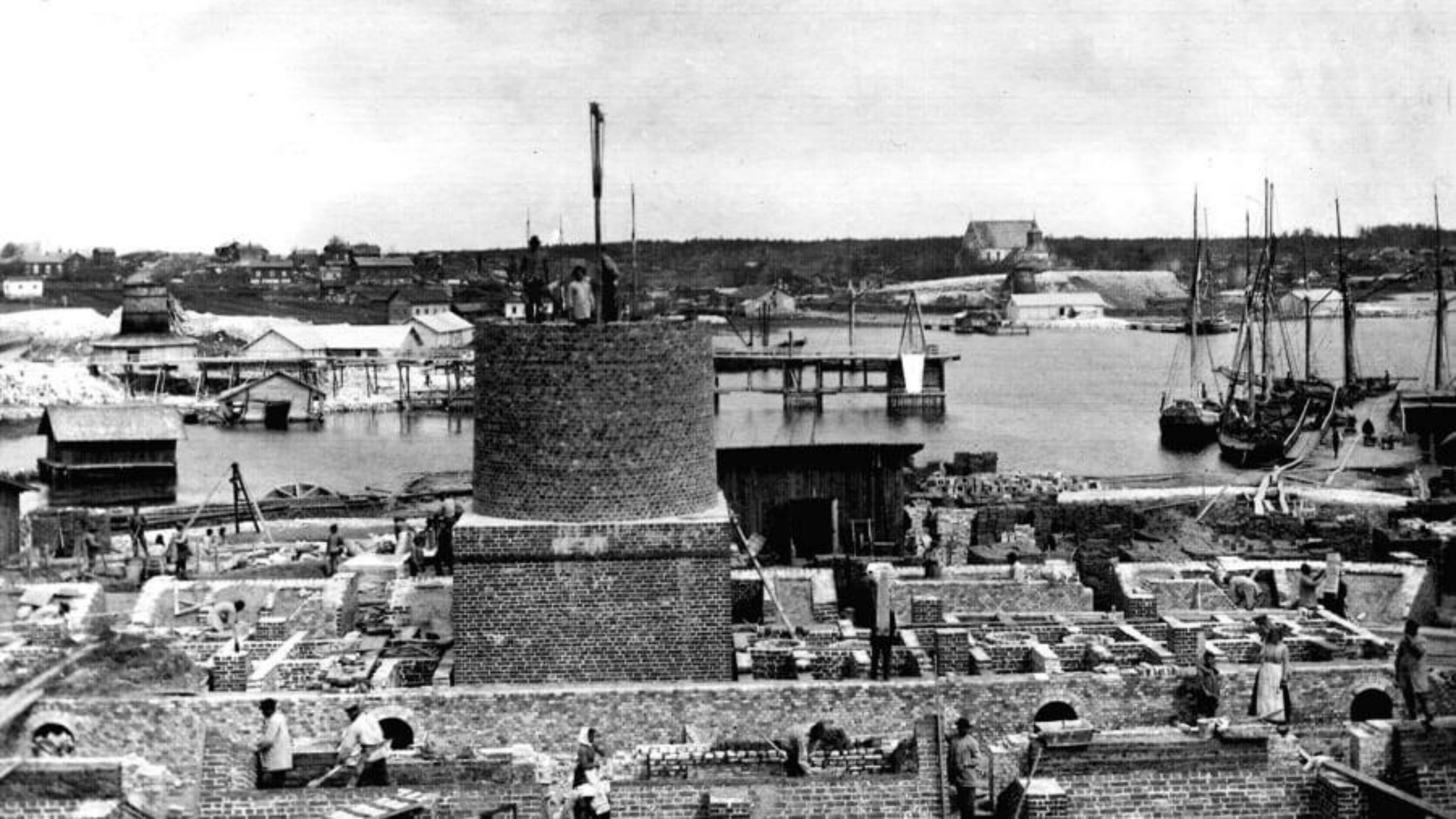
Bevittna:

G. A. Fors.

Donall Wahlroos.

Ring kiln
1909 – more than 80 % was used as building lime
1912 – 56 % was used as buling lime

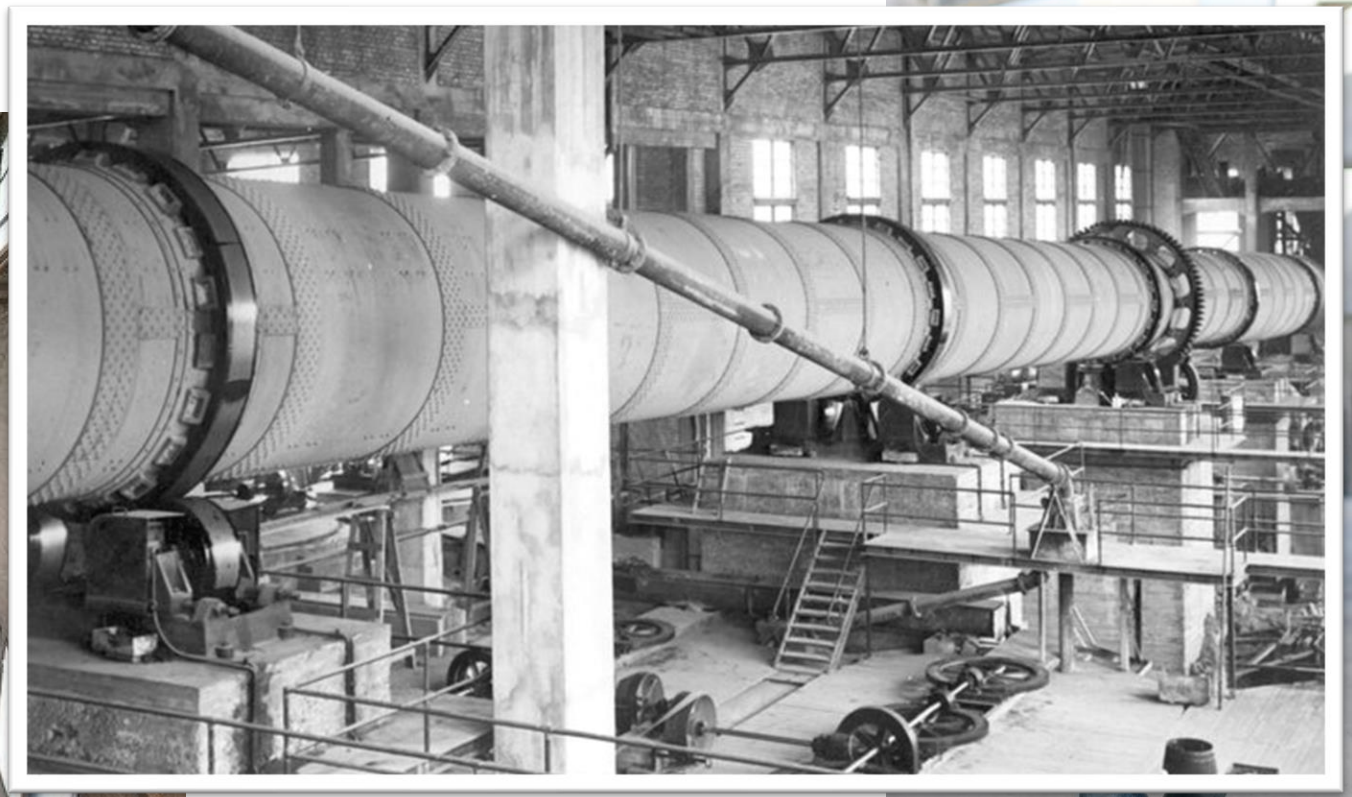
- Production principle was the same as in the earth kilns
- Capacity 50 tonnes quick lime per day
  - 8 times the cylinder (6 tonnes per day)
  - 4 times the generator shaft kiln
- 1905 – the production was 500 000 hectoliter – 50 000 m3 - hydrated (slaked) lime (30 Kton)
  - The market demand was fulfilled in 3 months production
- 1906 – 6 months of productions was recorded
- 1907 - 9 months of productions was recorded
- 1908 – now in production all the year, and this continued
- The market development even caused plans for another kiln unit
- There was an export market to Russia as well



Ring kiln (ProGradu pp. 31-32)

- Production principle was the same as in the earth kilns
- 16 burning chambers - The firing is exceeding in the ring as the clacination is proceeding. Oval construction, 50 times 20 meters, for the entire kiln.
- The lime is discharged in doors in the outer rim of the chambers
- Fuel feeding holes are located in the roof of the burning channels
- High – 60 meters – chimney is ensuring a good enough draft
- Stones are stacked in the chambers in order to ensure air circulation and the fuel feeding.
- Coal firing. Gas firing in the second kiln as demanded by the pulp customers.
- Continual operation in three phases, in a number of chambers per phase
    - 1) Limestone piling,
    - 2) Firing,
    - 3) Discharge of the calcined lime

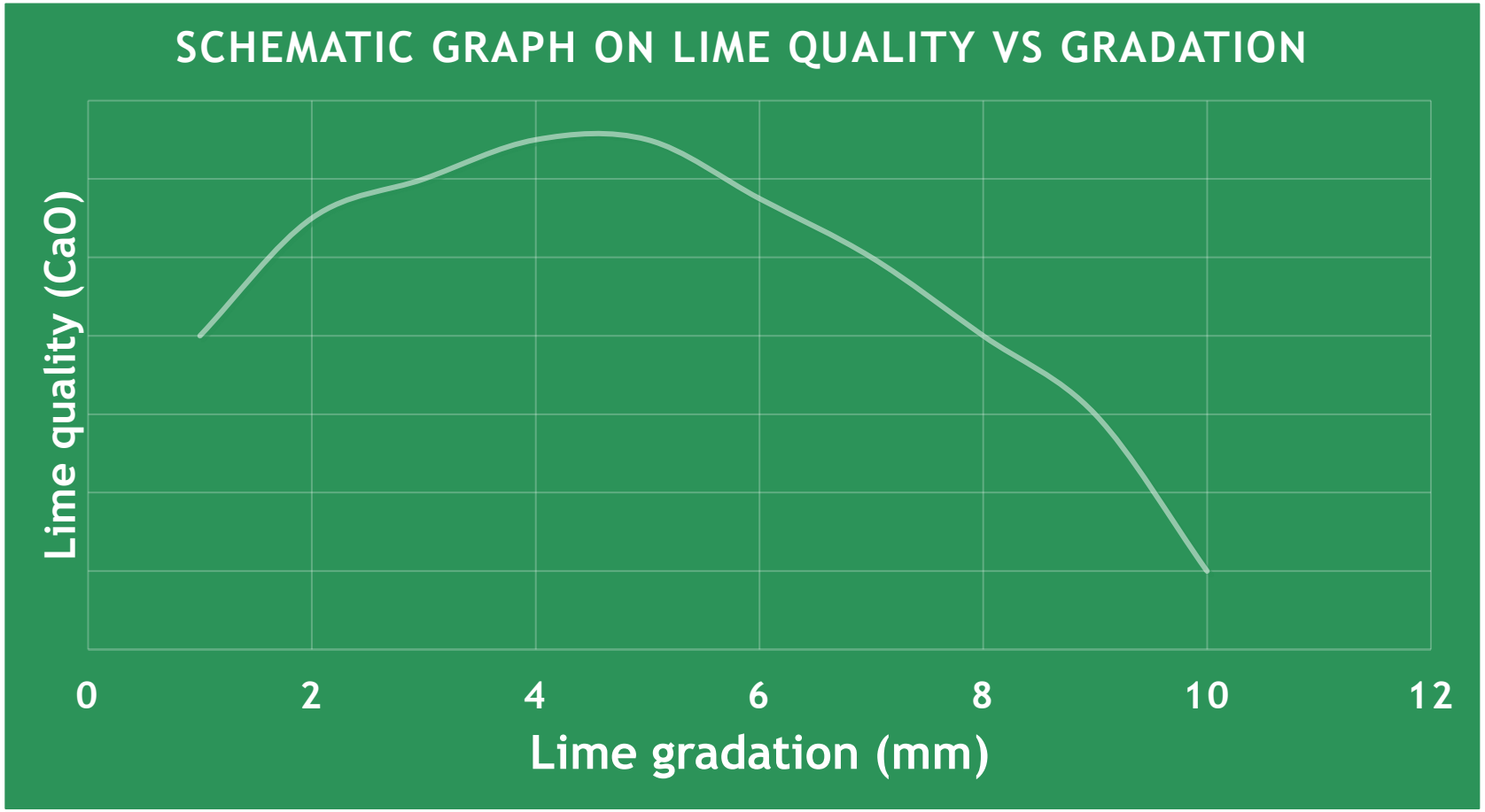
Long rotary kiln is in use today – since 1962. Gotland limestone is the raw material.



The role of impurities in the limestone

- A number of cataions may replace Ca in the calcite
- Magnesium is most common – dolomitization
  - Lower calcination temperature – overburning
  - Retarded hydration may cause cracking by expansion in construction products
- Silicates in the stone – sand
- Clay in young sedimentary type of limestone (➔ marl)
  - Hydraulic lime
  - Nordkalk is NOT producing such a lime quality

The role of the gradation of the calcined lime



A narrow limestone fraction should be used in the calcination.

2:1 for upper and lower size is ideal.

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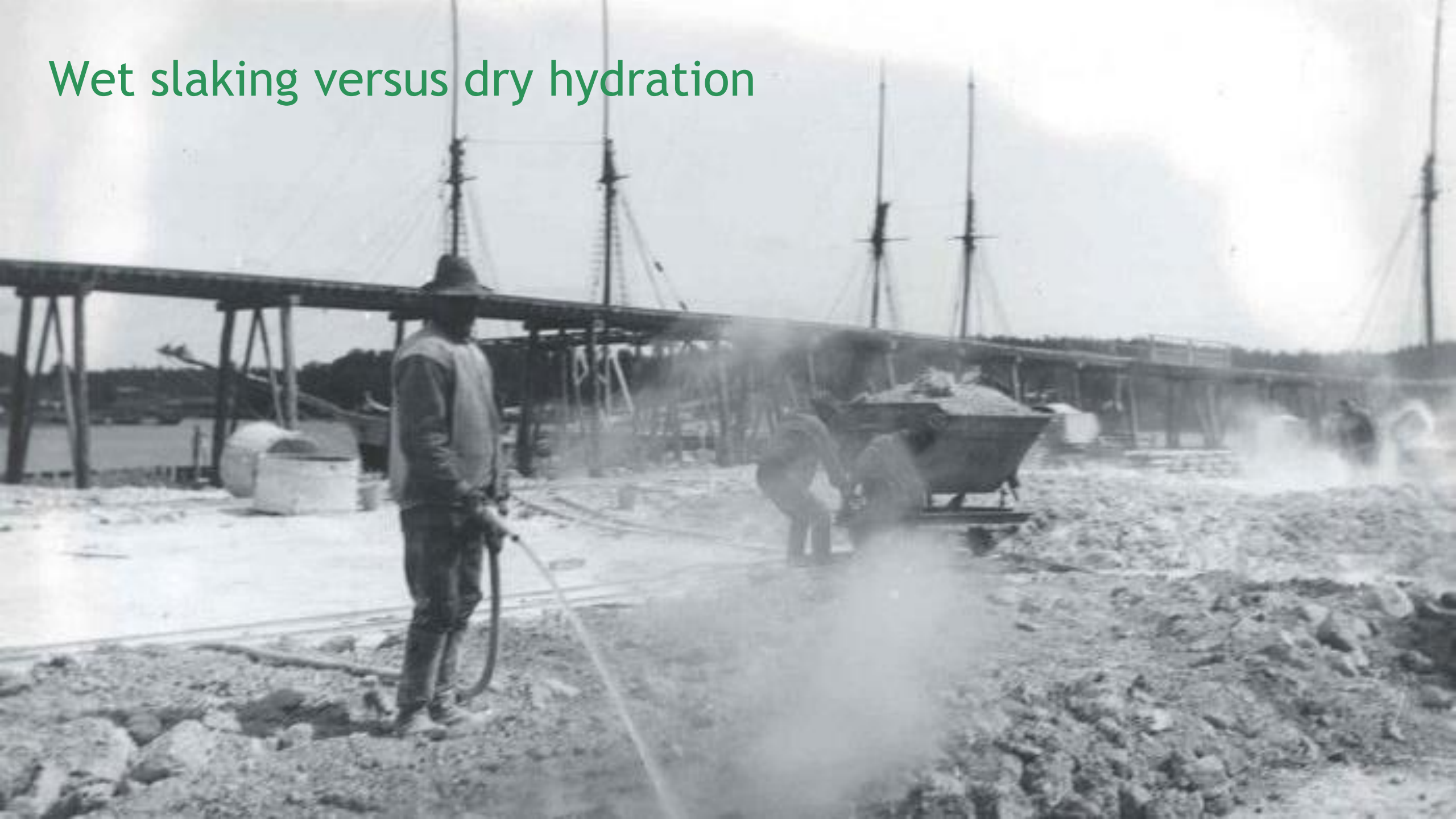
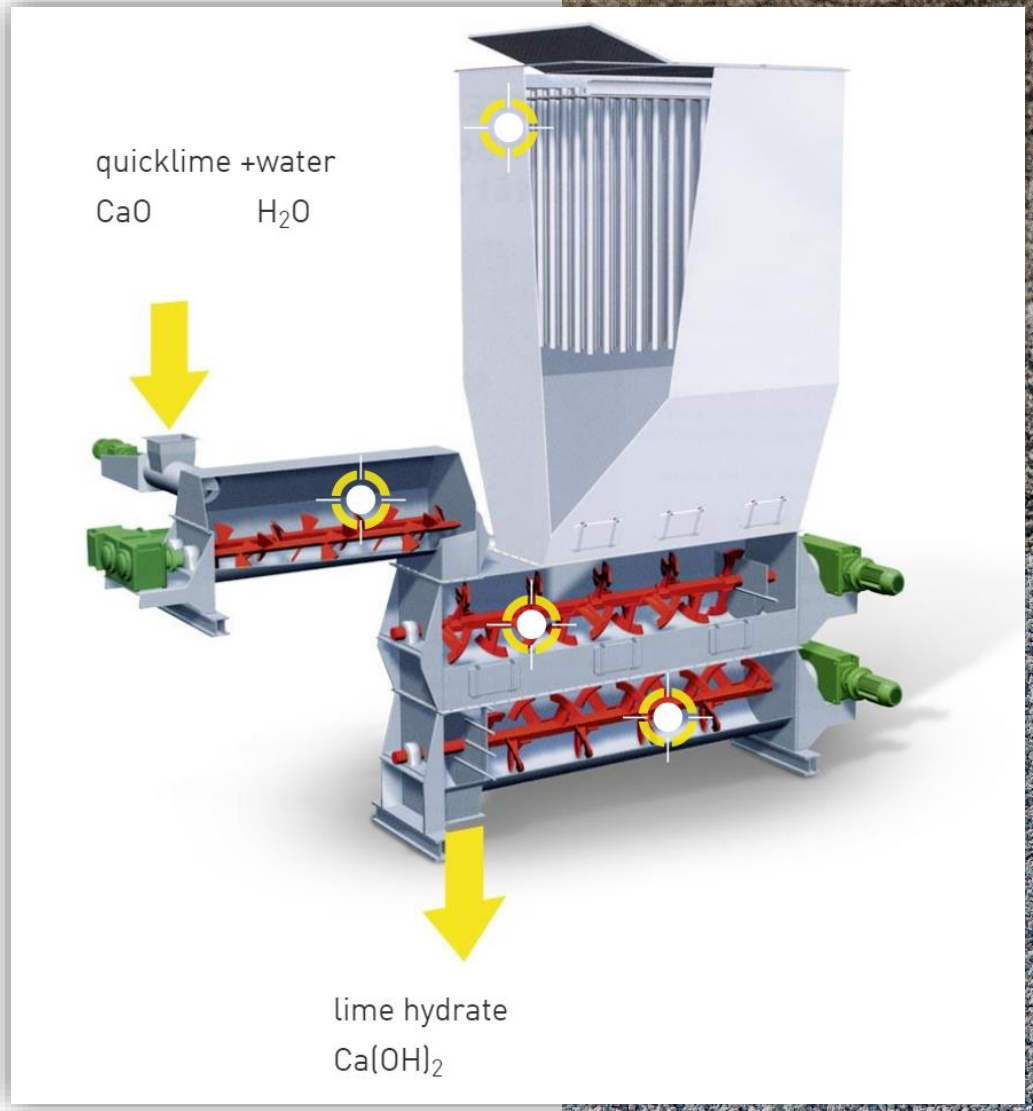
Wet slaking versus dry hydration



Lime hydrate

- 1912 – erection of a modern hydration unit in Pargas (not the one in the picture at left)
- Separation of the slaking residue is essential and improves the quality of the hydrate dramatically
  - Hard or dead burned lime particles
  - “Sand” contribution from the limestone
- Long enough maturing of the hydrate is important in building lime
- Magnesium (dolomite) content in the limestone will cause troubles in the building lime
- In wet slaking lime is slaked with excess water to a lime putty or lime milk



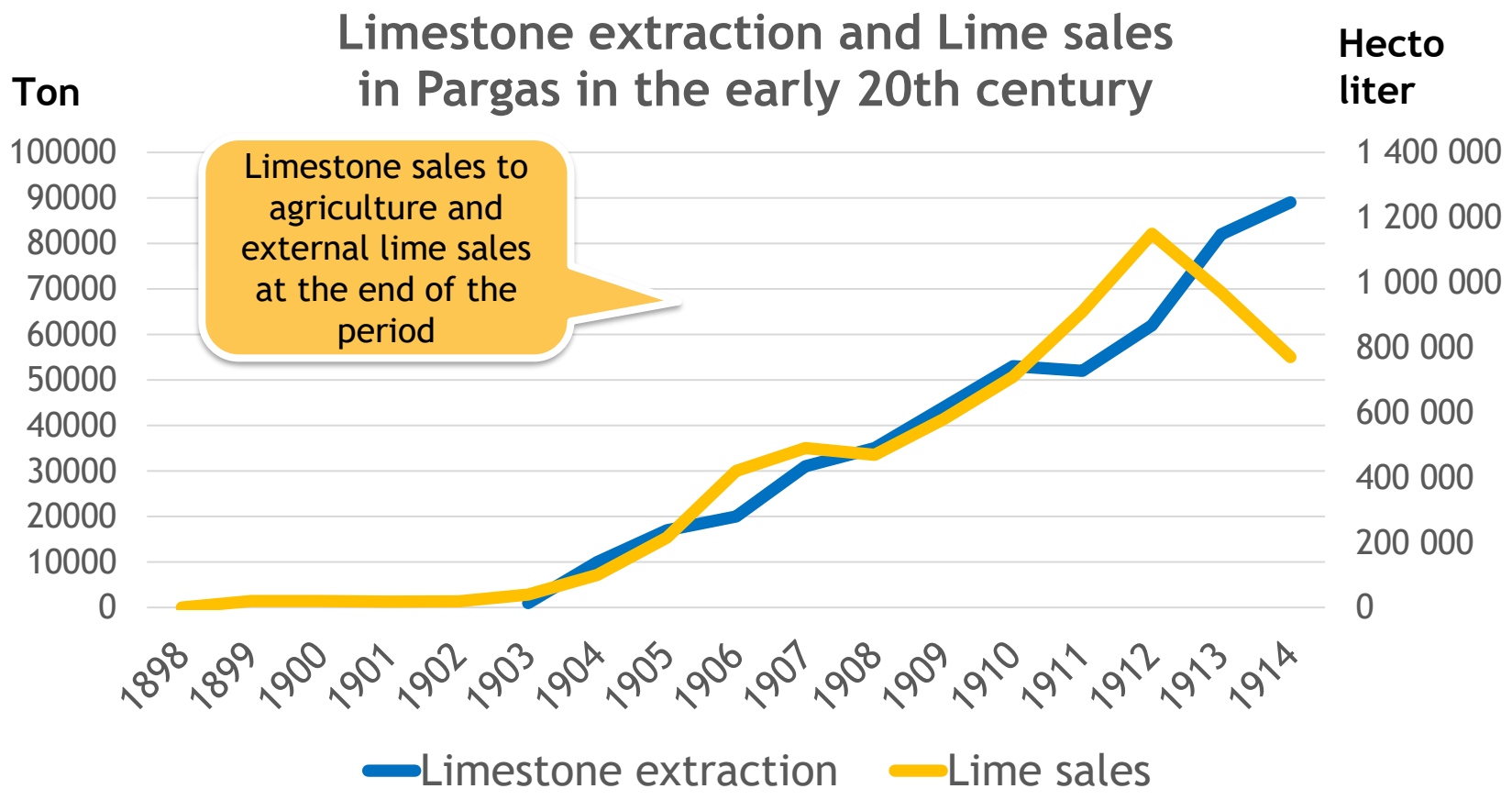
Shipping controlled the market in the early 20th century

- Lime producers sold the product to the shipping entreprenurs

- M/S *Glückauf* is a two masted, steel frame ship which was built in Bremerhaven in 1898.
  Pargas Kalkbers Aktiebolag bought the ship in Germany in 1904 and she was renamed to M/S Kalk.
  Later on she served in sand shipping when she was sold to new owners.

- Pargas Kalkbergs Aktiebolag was established in 1898
  - In the first years the sales was controled by Helsingfors Kalkugnsaktiebolag.
  - Emil Sarlin was hired as the first industrial engineer and managing director
  - Pargas kalkbergs Aktiebolag aquired the Helsingfors company in 1905

Strong growth development with the new ring kiln in production (Source: W.Stenmark, 1915)



Helsinki mortar factory

Prior to the industrial production of mortar the recepie at the working sites was:

1 part per volume hydrated lime
3 parts per volume sand
Water as needed

Early mortar manufacturing was based on wet slaked lime, but the Helsinki factory used dry hydrate – as was used when mixing at the working site.

Thank You

Thank you.

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#lifestone #limewisesolutions

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