SITES
STONE WOOL

MASTERTHESIS
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01 QUARRIES
02 RESOURCE NETWORK
03 PRODUCTION
04 DISTRIBUTION
05 CONSTRUCTION
06 RECYCLING
07 LANDFILL

01 QUARRIES

01: Felsberg Quarry
Source: Google Earth, 2023

At the quarry near Felsenberg the company Käppeli AG mines “Felsberger” (Diabase), which is an igneous rock.

It is a basalta that is older than 300 million years and has undergone minor metamorphism (rock transformation). They were formed mainly by volcanism beneath the Paleozoic sea basin. [1]

Flumroc obtains around 20,700 tonnes of rock per year from this quarry. [2]

[1] : “Diabase”, steinrein.com, SteinRein, 2023

02: Crastatscha Quarry
Source: Google Earth, 2023

0 100

Near the village of Zernez the company Sosa Gera SA has been operating the quarry in Crastatscha since 2001, where the hard rock amphibolite is mined, which is a metamorphic rock. Amphibolite is formed by metamorphism of igneous rocks, such as basalt through high pressure and temperature conditions (up to 10 bar and 500 to 750 °C). [3]

To remove the stones from the mountain, dynamite is used. The stones are then removed by excavators and loaded onto trucks.

Flumroc obtains around 21'600 tonnes of rock from this quarry every year. [4]

[3] : Sosa Gera SA, 2023

[2,4] : Ysker Olaf, Project Manager Environment at Flumroc AG, 2023

03: Traces of Explosions
Source: Geoalpina AG, 2018

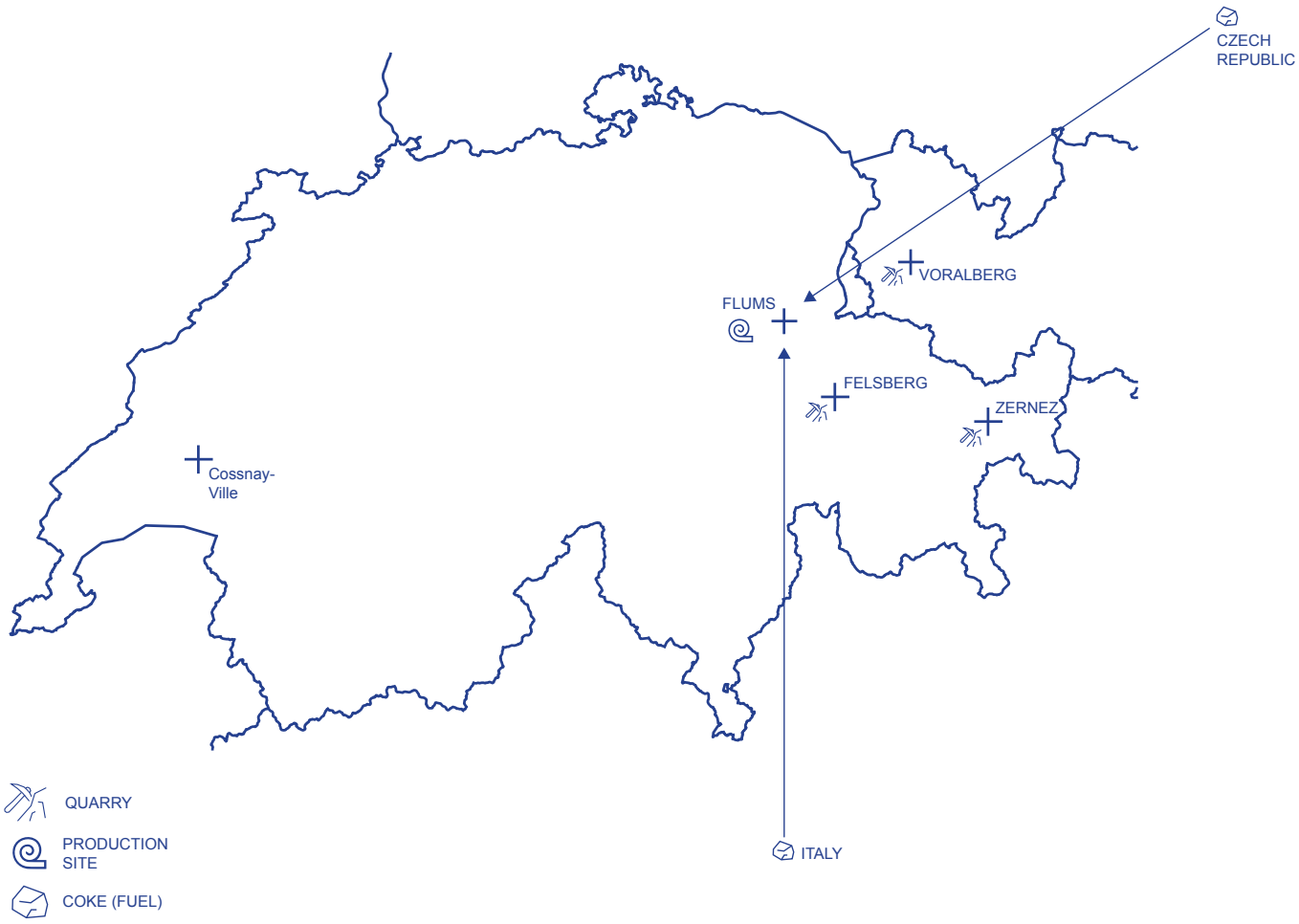
04: Sourced Amphibolite
Source: Geoalpina AG, 2018

02 RESOURCE NETWORK

The stones for Flumroc stone wool is quarried mainly in the vicinity of the production site: in the Grisons communities of Felsberg and Zernez. There is also a small amount of dolomite from nearby Vorarlberg and basalt from Germany.

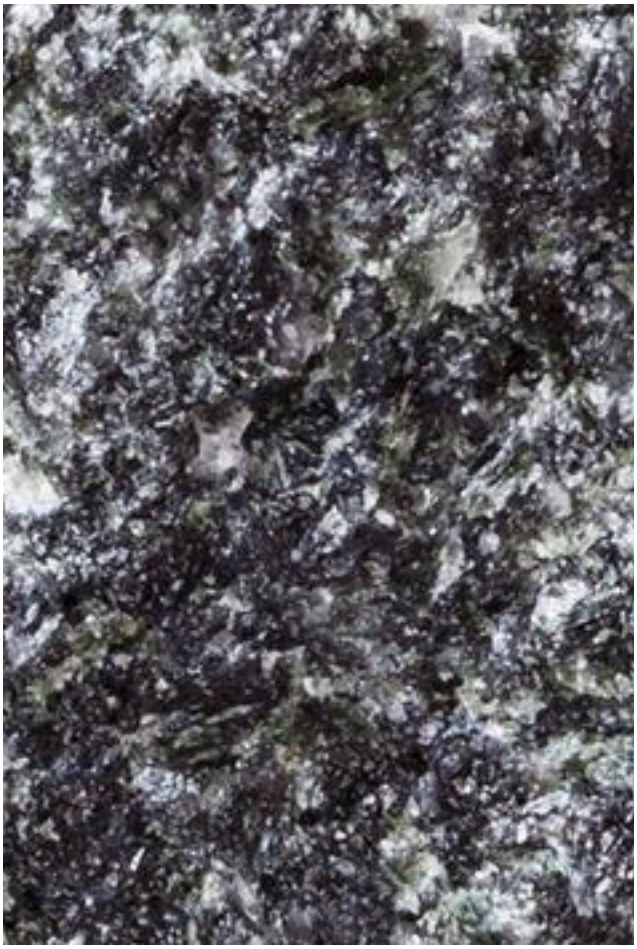
Coke from Italy and the Czech Republic is used as burning agent. But not for much longer, as Flumroc switches to an electrical furnance in 2024. [5]

[5] *:"Wasserkraft schafft Dämmkraft", Flurmoc, 2023*



05: Resource Map Flumroc
Source: Flumroc AG
Graphic: Own

06: Stone Types (Top Left to Bottom Right): Basalt, Amphibolit, Diabase, Dolomit



07: KIBAG Schollberg Werke, Sargans
Source: Google Earth, 2023

0 100

Flumroc obtains briquettes from Schollberg for the production of stone wool. These consist of three types of stone (from the quarries mentioned before), as well as Flumroc stone wool recycled flour.

The recycled stone wool is transported daily from the production site in Flums to Schollberg by truck, and the briquettes from Schollberg to Flums.

Every year, Flumroc obtains 90'000 t of resources from Schollberg, which corresponds to a daily average of 15 truckloads. [6]

[6] : Ysker Olaf, Project Manager Environment at Flumroc AG, 2023

08: KIBAG Schollberg Werke, Sargans
Source: KIBAG

03 PRODUCTION

09: Flums
Source: Google Earth, 2023

0 250

10: Old and New Cupola Furnace Chimney
Source: Own

11: Flumroc, Flums
Source: Google Earth, 2023

For the production of stone wool, the raw materials in the form of briquettes and coke are mixed and melted in a cupola furnace at about 1500 °C. The cupola furnace is used to melt the raw materials. Coke is used as an energy source to melt the raw materials.

The molten stone is then spun into fibres (a typical value for the mean fibre diameter is 3 µm) and impregnated to make it water-repellent.

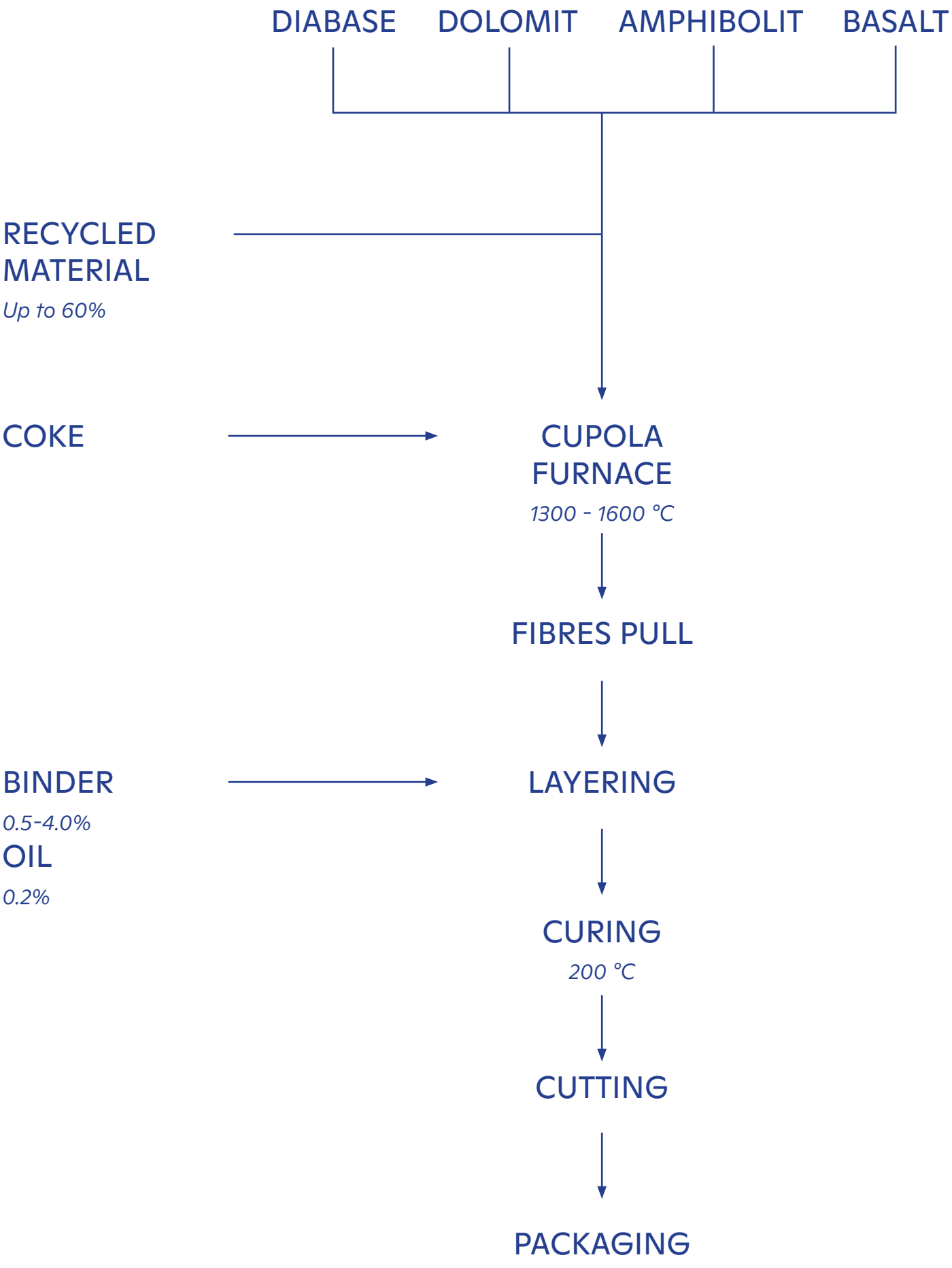
By adding binding agents, a coherent fibre carpet is obtained. The fibres are then collected in a web, laid down by a pendulum onto a conveyor belt and brought to the curing oven where the binder is cured at approximately 200°C.

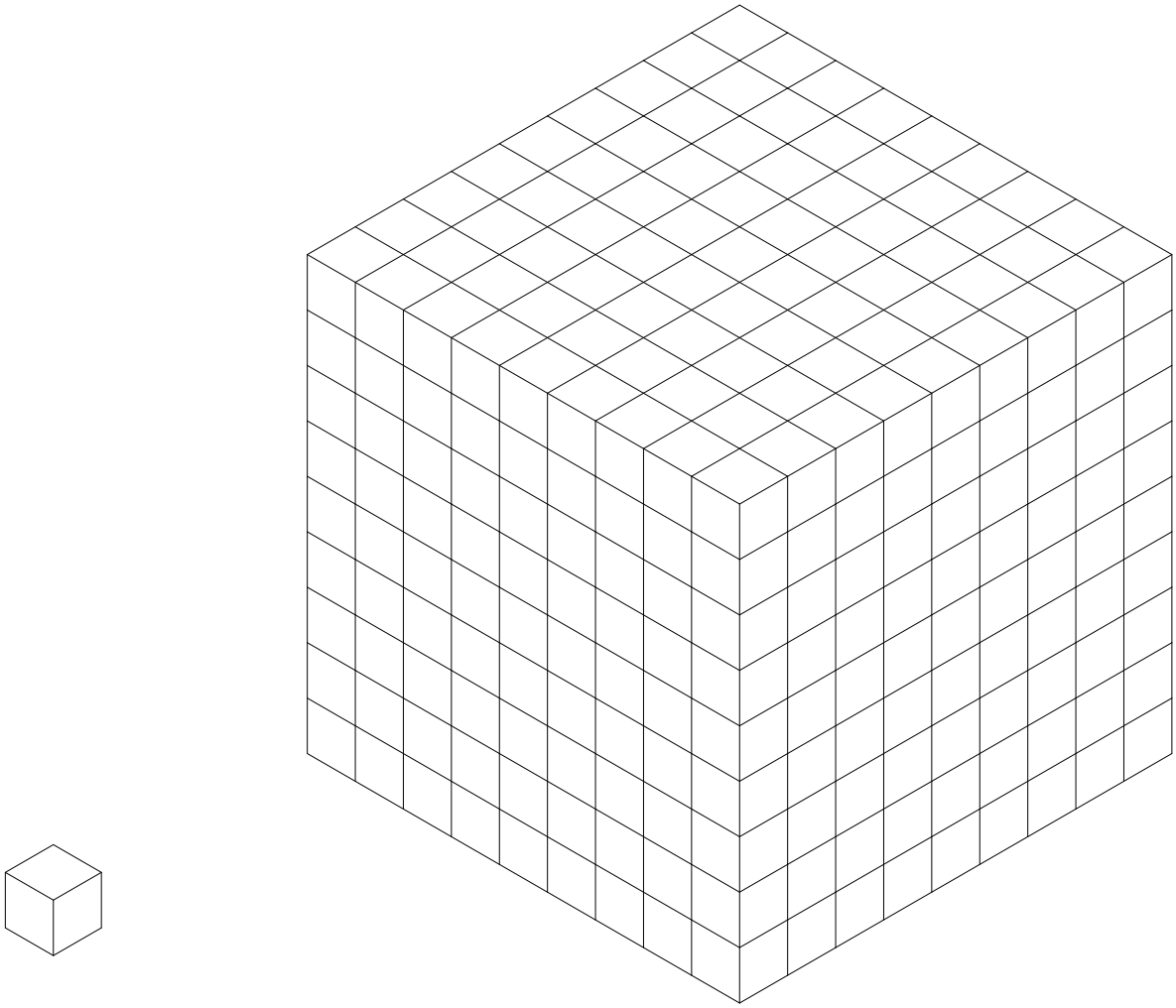
It is produced continuously and the desired end product is prefabricated from it, especially with regard to fibre structure, raw density and insulation thickness. The binder is then left to harden in a special oven. Finally, the stone wool is cut into sheets or mats on the saw line.

The resulting waste is returned to the production cycle. [7]

[7] : Production Process Stone Wool, ETH Material Archiv, 2023

12: Production Process for the Case of Flumroc Graphic: Own


DIABASE
DOLOMIT
AMPHIBOLIT
BASALT
RECYCLED MATERIAL
Up to 60%
COKE
CUPOLA FURNACE
1300 - 1600 °C
FIBRES PULL
BINDER
0.5-4.0%
OIL
0.2%
LAYERING
CURING
200 °C
CUTTING
PACKAGING



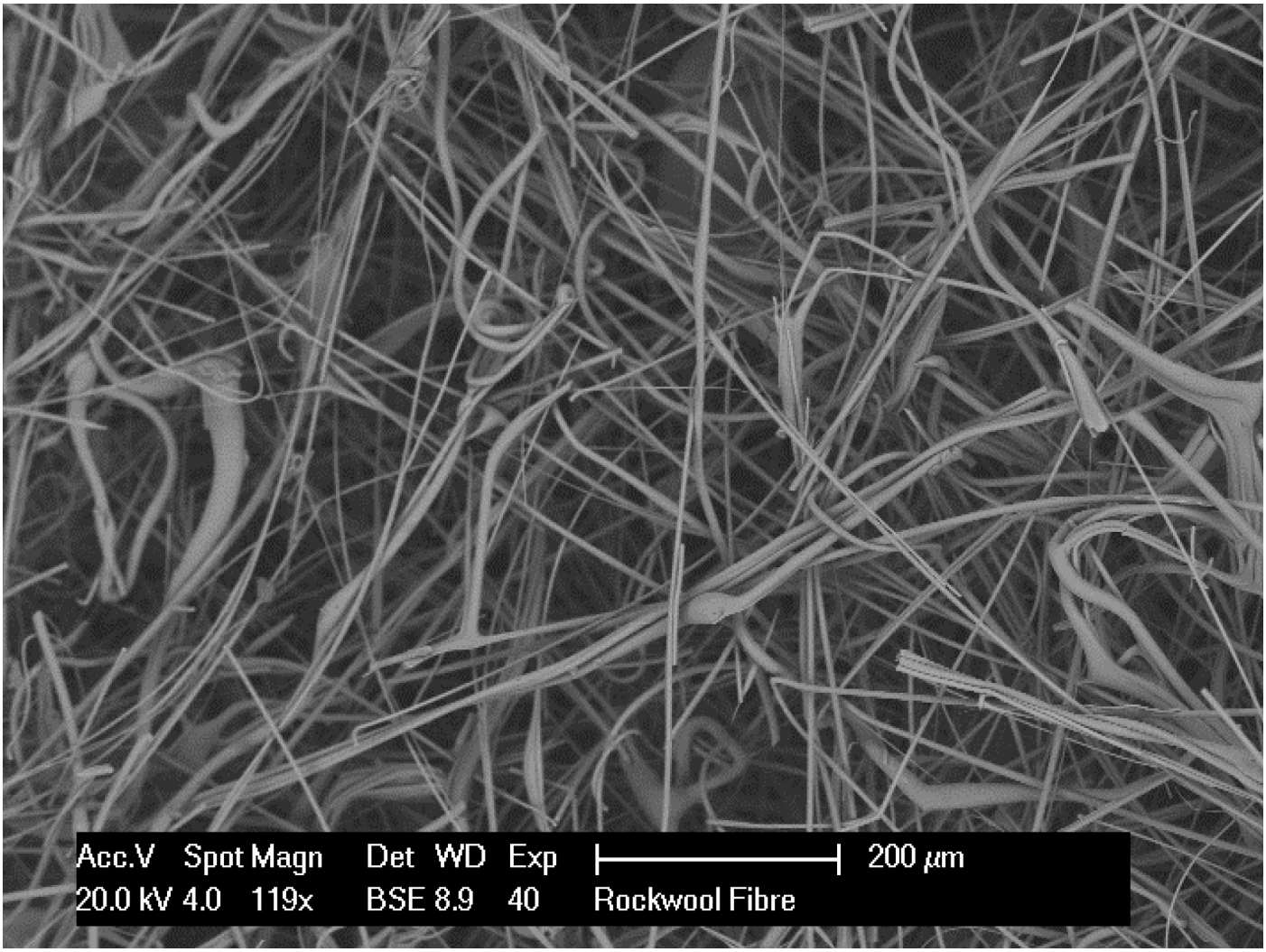
1 m3
Stone

2900 kg/m3

100 m3
Stone Wool

20-200 kg/m3

13: Volume Expansion in Production Process
Graphic: Own



14: Stone Wool Fibres in SEM
Source: Characterization and Modelling of the Mechanical Properties of Mineral Wool, Chapelle Lucie, 2016

Around the Pacific Rim and Hawaii volcanic activity produces eruptions of dust pumice and strands of a material which the locals refer to as “Peles hair”.[8] When bubbles of gas near the surface of a lava flow burst, it can stretch the skin of the molten lava into long threads.
These strands inspired the industrial insulation product of stone wool.

Within the industrial process the cupola furnace melts the harvested rocks into lava, creating a mini volcano in factory conditions, to produce the wool in commercially viable quantities.

[8] : Bynum Rock, A Brief History of Insulation, 2021

STONE WOOL

Cluster of Stone-Fibres

VOLCANIC ERRUPTION

Lava stretched into fibres

Spontaneous + Natural

Appropriation of the Natural Phenomenon

Fast + Artificial

CUPOLA FURNACE

Lava spun into fibres

15: Work Yard Flumroc
Source: Own

16: Discharge of Coke Delivery
Source: Own

17: Coke Storage
Source: Own

18: Fibre Spinning
Source: Flumroc

19: Carpet Layering
Source: Own

20: Curing
Source: Own

21: Packaging
Source: Own

22: Indoor Storage
Source: Own

23: Outdoor Storage
Source: Own

24: Outdoor Storage
Source: Own

04 DISTRIBUTION

25: HUG Baustofflager Binz, Zürich
Source: Google Earth, 2023

0 30

26: Outdoor High Rack Storage
Source: Own

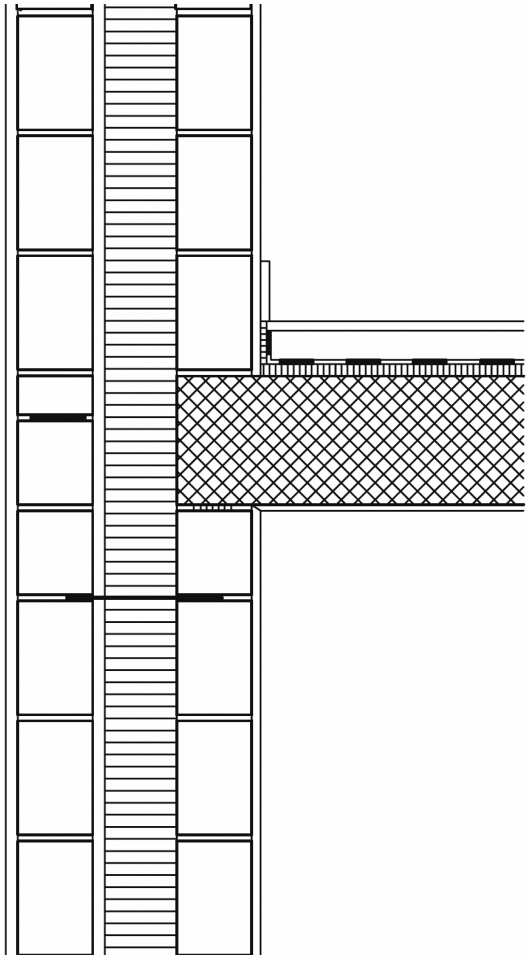
27: Outdoor High Rack Storage
Source: Own

28: Storage Operations
Source: Own

29: Ordered Goods
Source: Own

30: Indoor High Rack Storage
Source: Own

05 CONSTRUCTION



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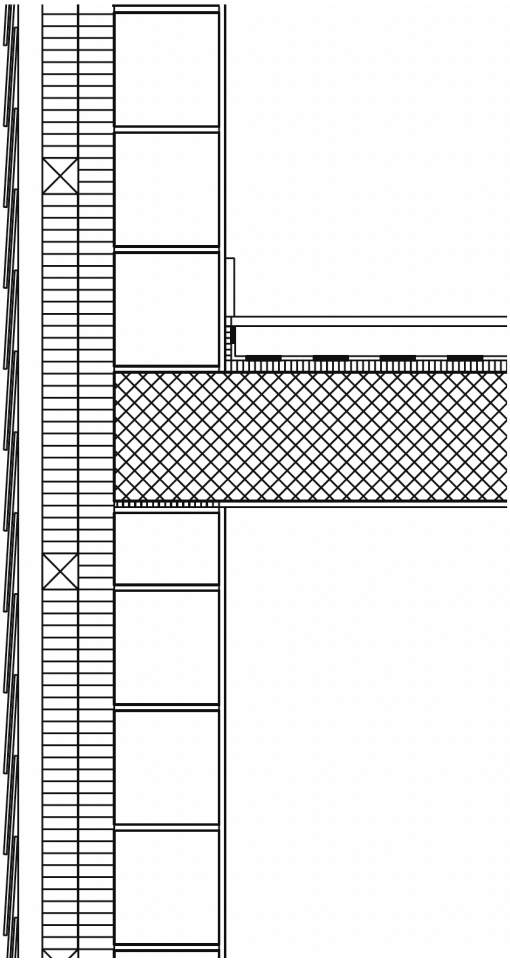

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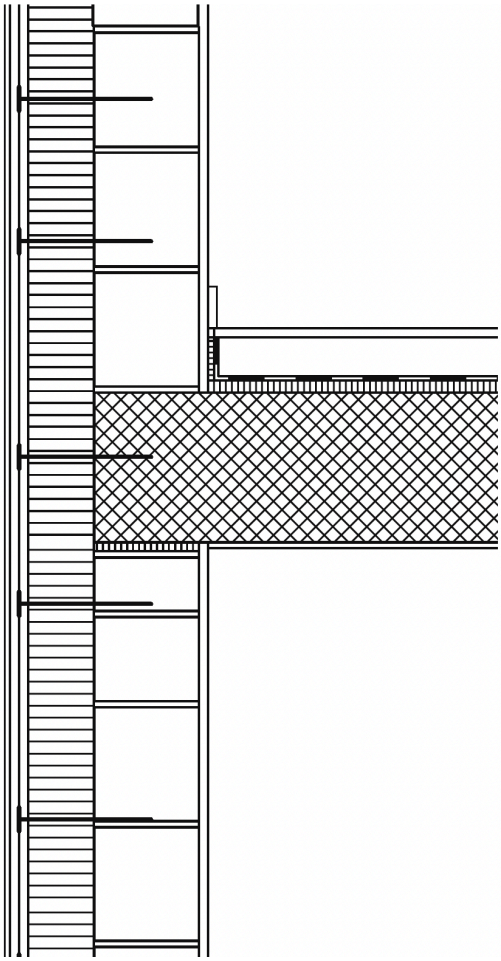
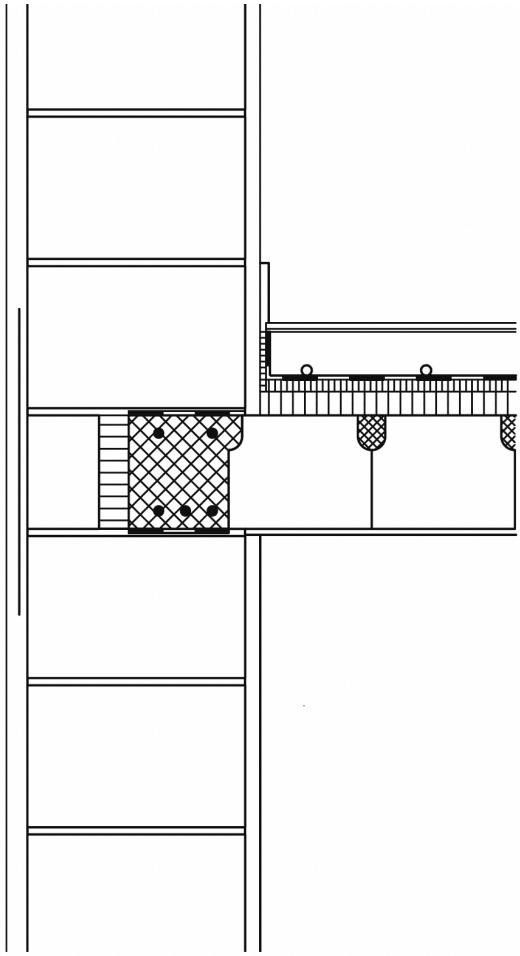


03

01 Double-leaf Construction
02 Ventilated Construction
03 Rendered External Insulation
04 Single-leaf Masonry
05 Timber Panel Construction
06 Timber Platform Frame Construction
07 Exposed Concrete

01-07: Construction Details
Source: Deplazes Andrea, Constructing Architecture, p. 146, 2005



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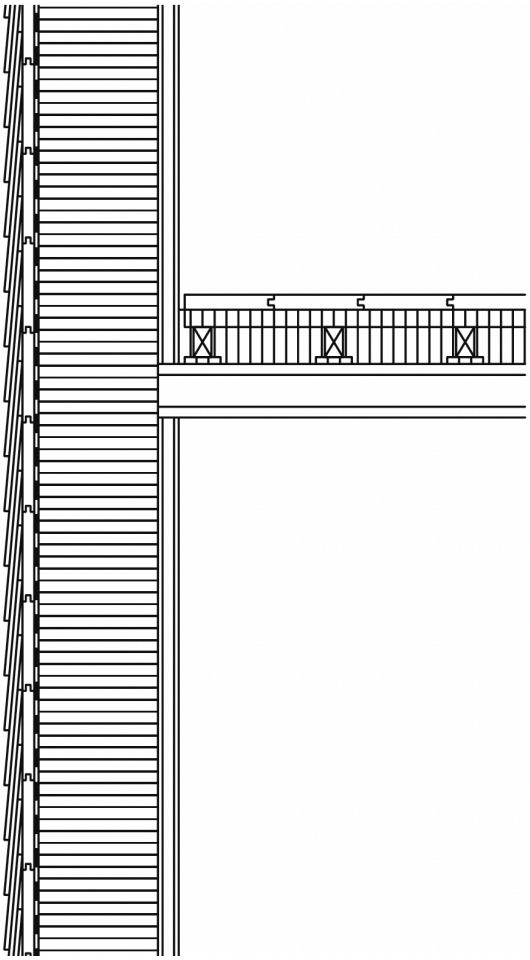

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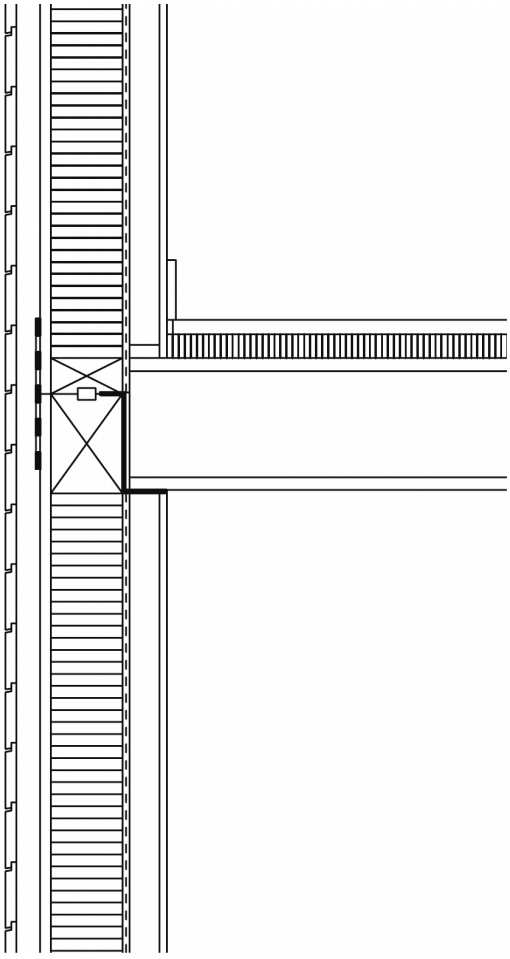

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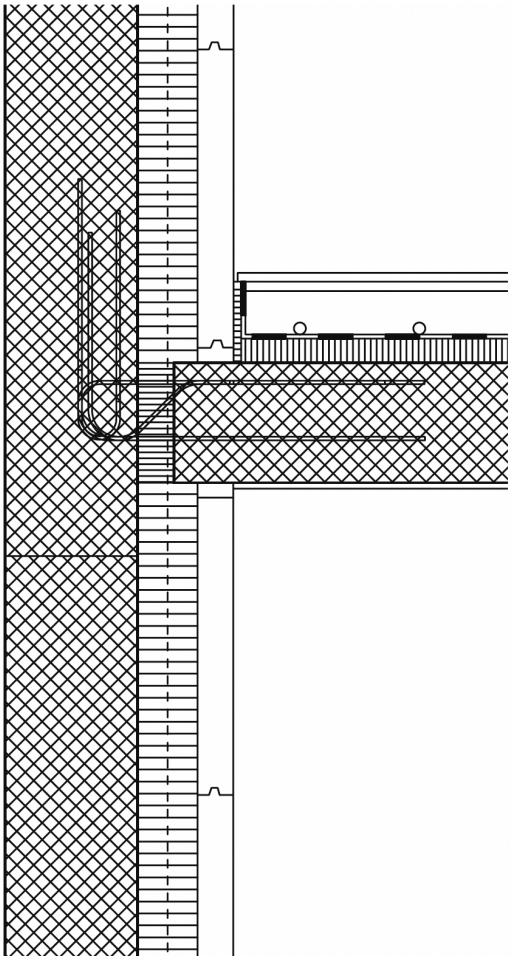

07

31: Flumroc Construction Mock-Up
Source: Own

32: Insulation Doubling for Retrofitting
Source: Own

33: Construction Site Storage
Source: Own

34: Mounting Patterns
Source: Own

35: Facade Retrofitting
Source: Own

36: Installed Insulation Panels
Source: Own

37: Recycling Bags Flumroc
Source: Own

38: Construction Trough
Source: Own

06 RECYCLING (FLUMROC)

39: Flumroc Recycling, Flums
Source: Google Earth, 2023

0 50

40: Recycling Facility Flumroc
Source: Own

41: Returned Goods
Source: Own

42: Delivered Recycling Bags
Source: Own

43: Sorted Material
Source: Own

44: Shredded Stone Wool Flour
Source: Own

RECYCLING (SPROSS)

45: Spross Recyclingwerk, Zürich
Source: Google Earth, 2023

46: Arrival of Recycling Goods
Source: Own

47: Construction Waste (Including Insulation)
Source: Own

48: Sorting for the Landfill
Source: Own

49: Demolition Waste
Source: Own

50: Shredder for Insulation
Source: Own

07 LANDFILL

51: Deponie Chalberau, Zürich
Source: Google Earth, 2023

52: Scale at the Entrance
Source: Own

53: Truck Unloads Material
Source: Own

54: Waste Collage
Source: Own

55: Cement Covered Stone Wool
Source: Own

56: Stone Wool Scraps
Source: Own