Backfilling technologies for Estonian oil shale mines

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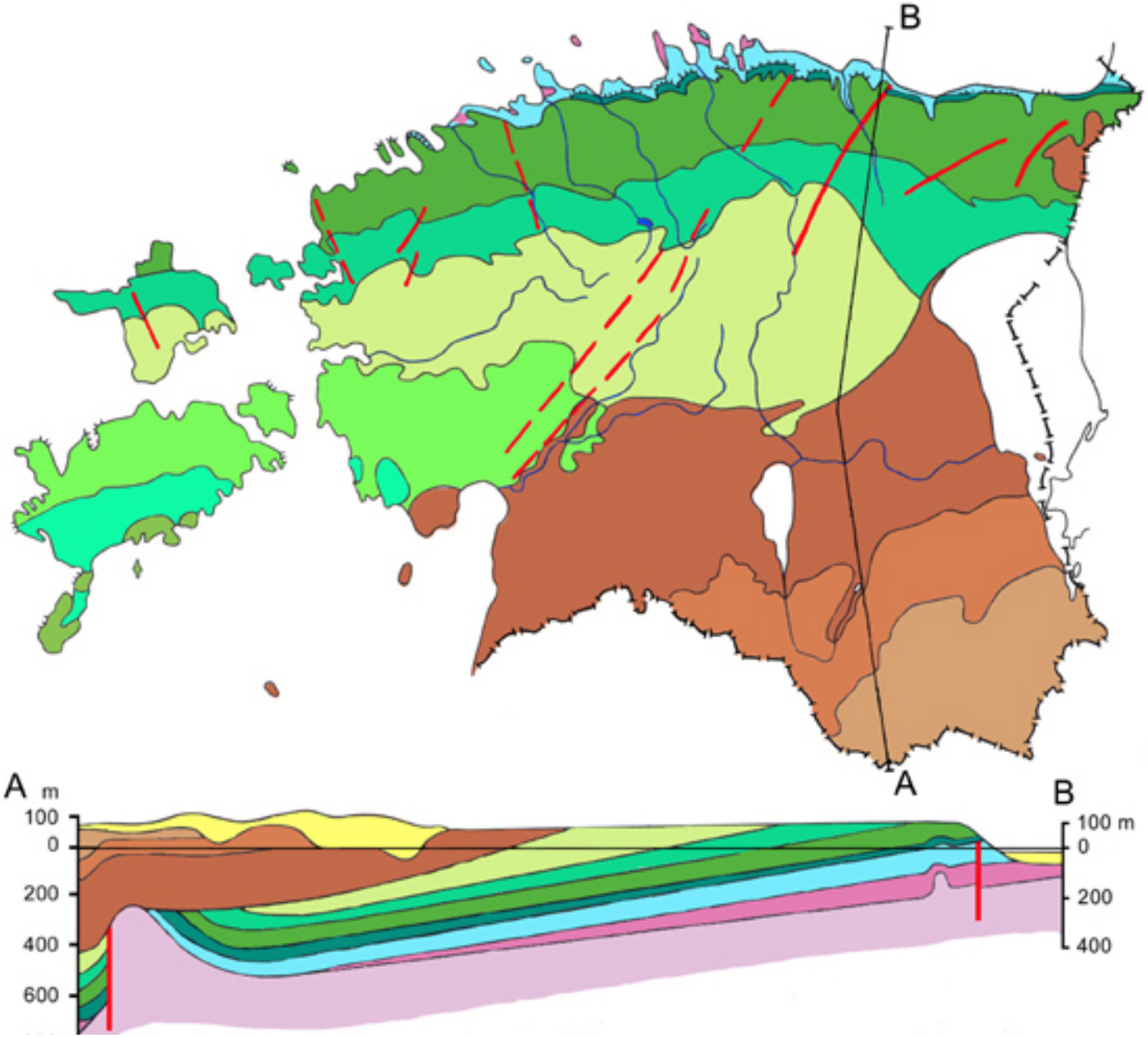
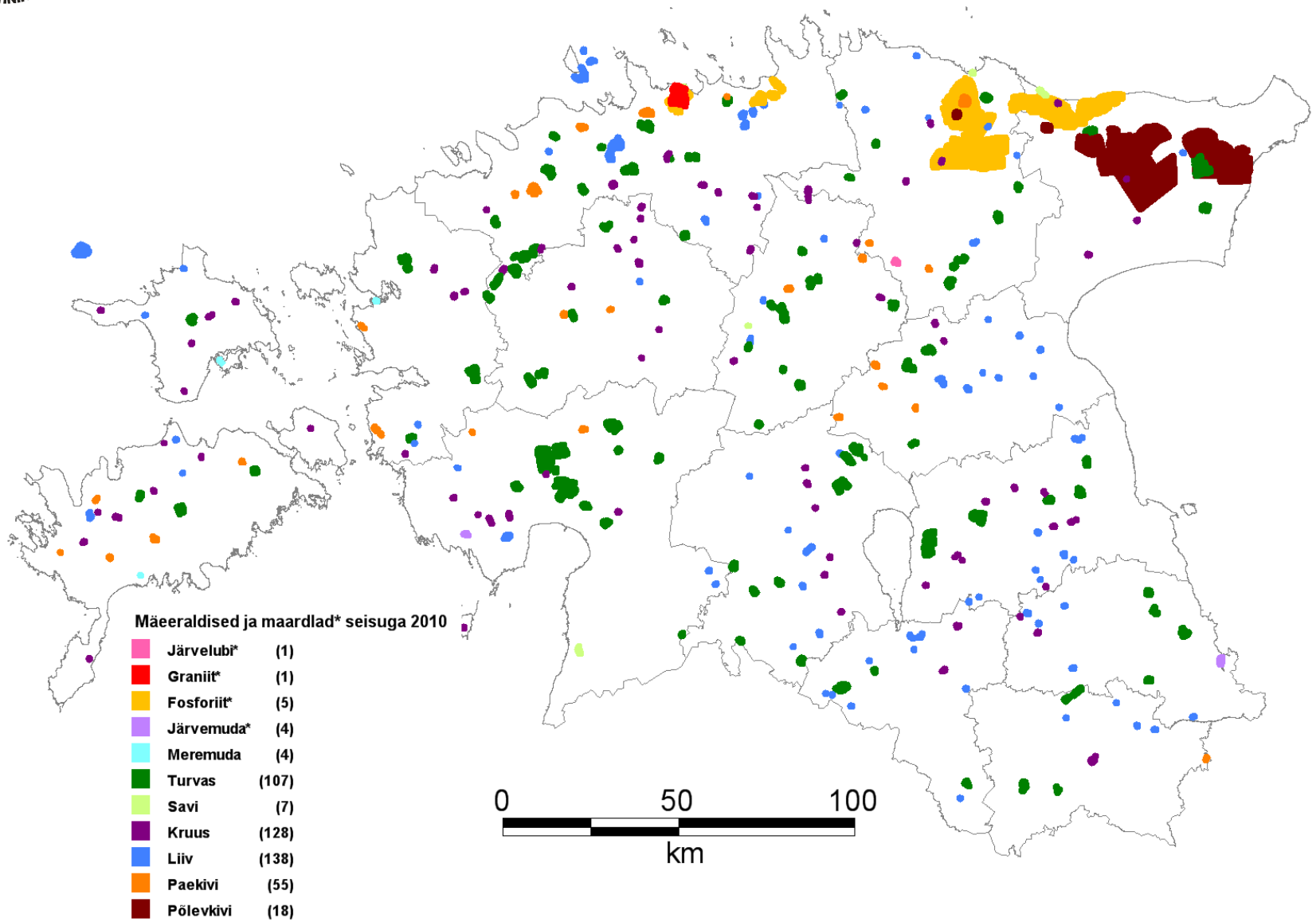
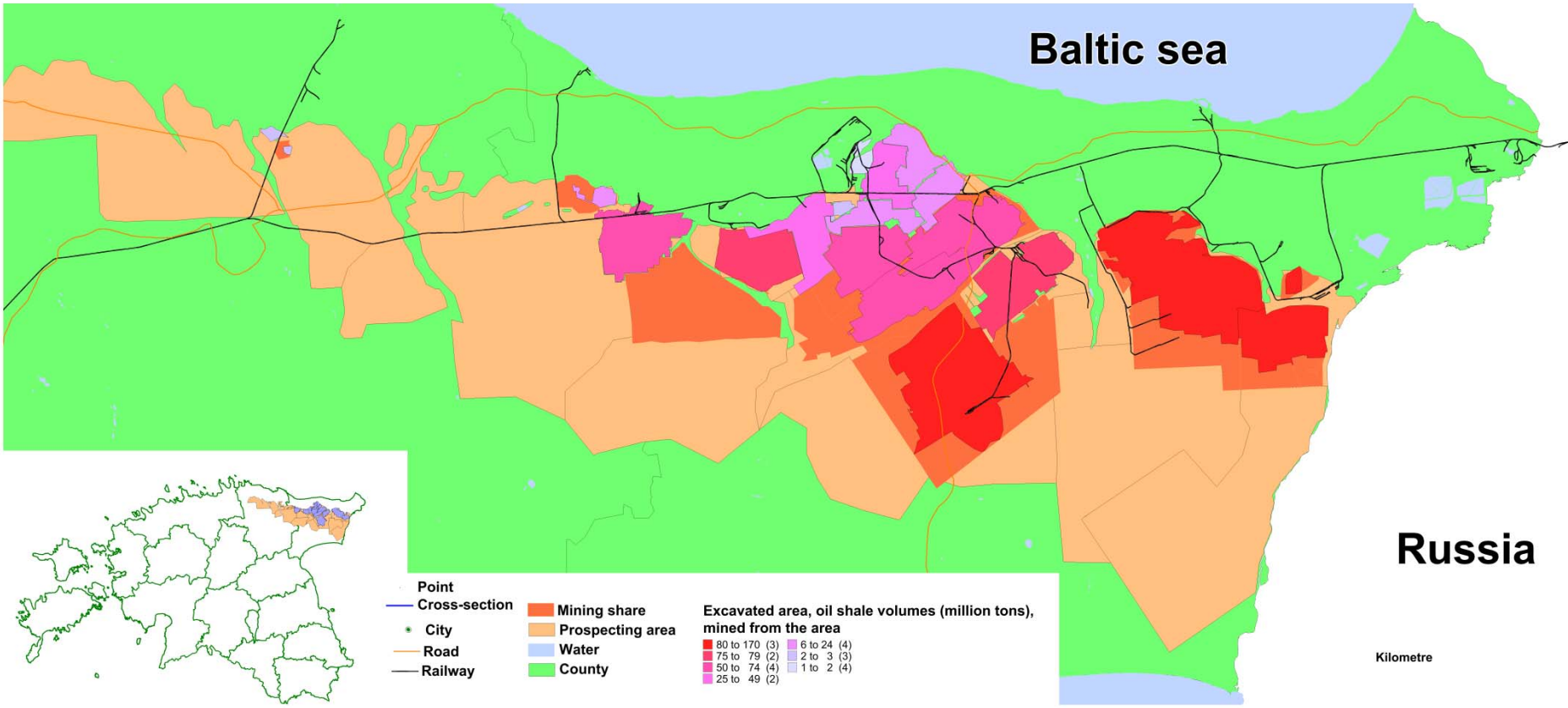
Estonia



Mineral resources in Estonia



Oil Shale mining area

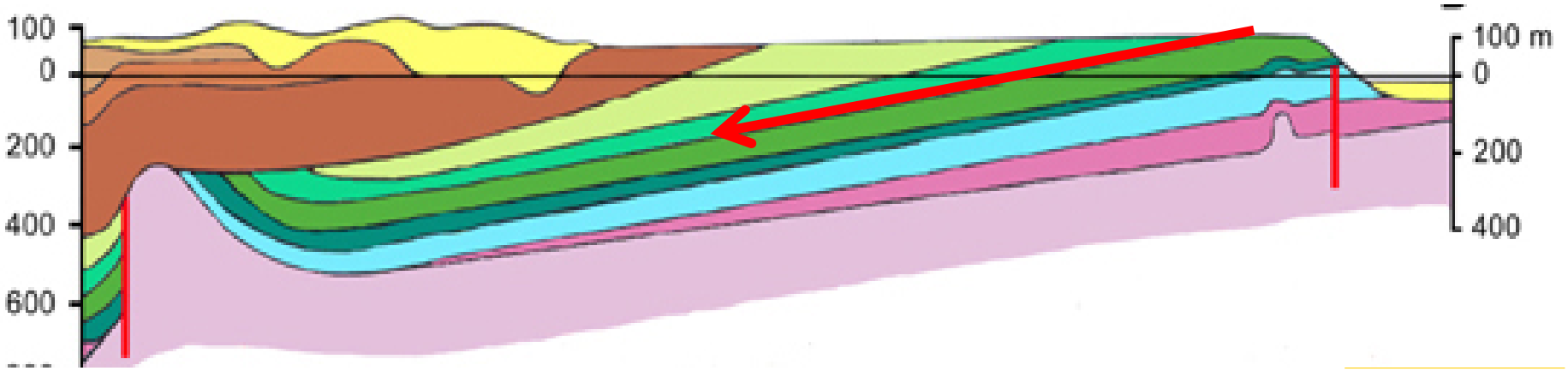


Oil Shale deposit

- Oil shale deposit is located partly in farming district
- Used for: power generation, 90% electricity in Estonia, oil, chemistry, thermal power.
- Half is underground room and pillar mining
- About 7 million tonnes of oil shale per year
- Plus separated limestone 40%
- +7 Mt/y surface mining

Oil shale deposit

- Largest number of underground mines was 13 with a total output of 17 million tonnes per year (31Mt/y total)
- Depth 80 m, Seam thickness 2,8 m.



Oil Shale

- Losses in pillars increase up to 40 %.
- Large amount of neutral (limestone) and hazardous waste (ash) is generated
- Using ash and limestone as backfilling materials could reduce the volume and area required for surface disposal
- The main source of the backfill material today is Heavy Media Separation (HMS). Oil shale seam consists 30 to 50% of limestone

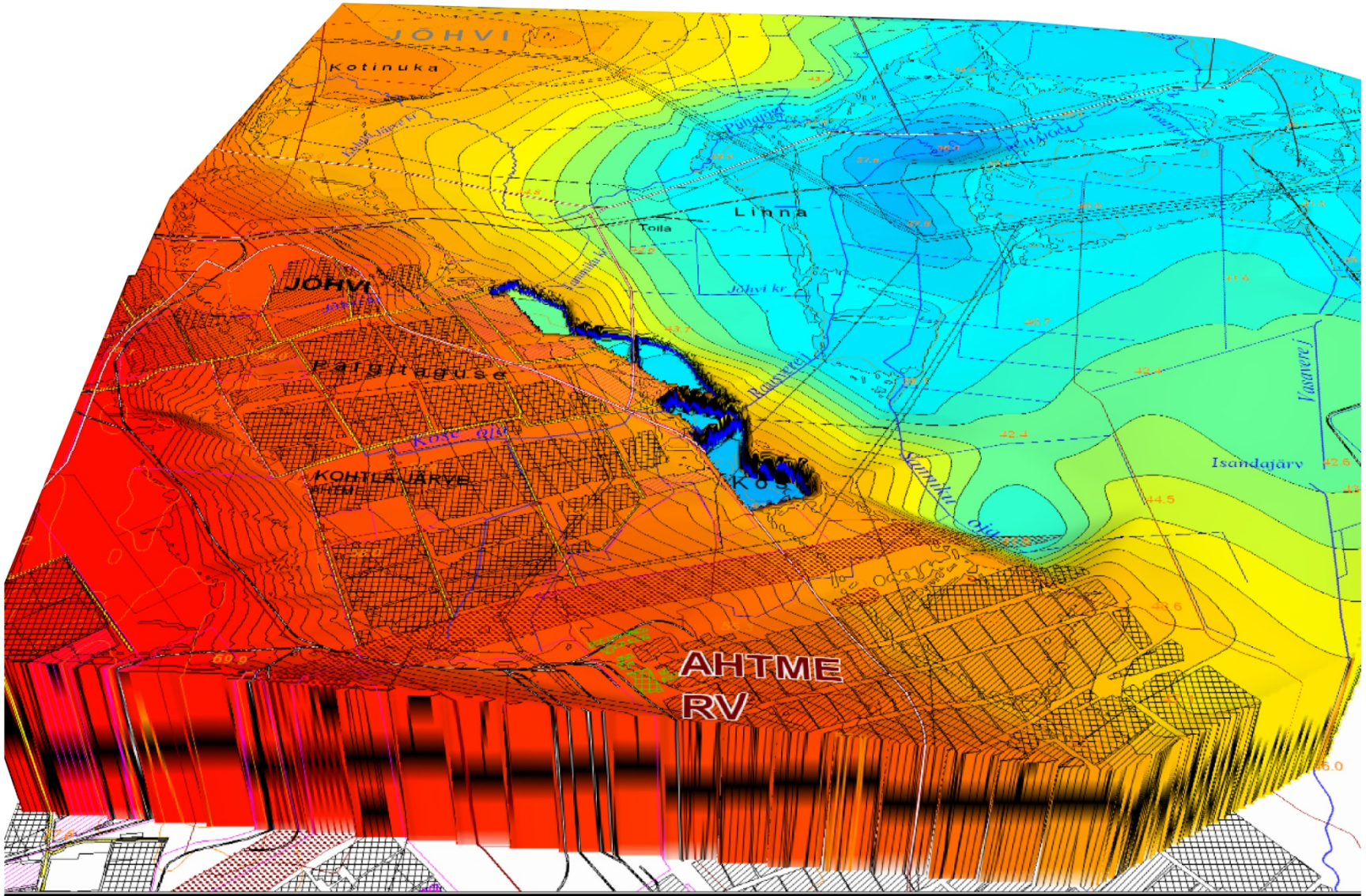
Steps

- 1. Underground and surface mining space modeling
- 2. Tests for the fill material
- 3. Determination of technological schemes for backfilling

Where and why?

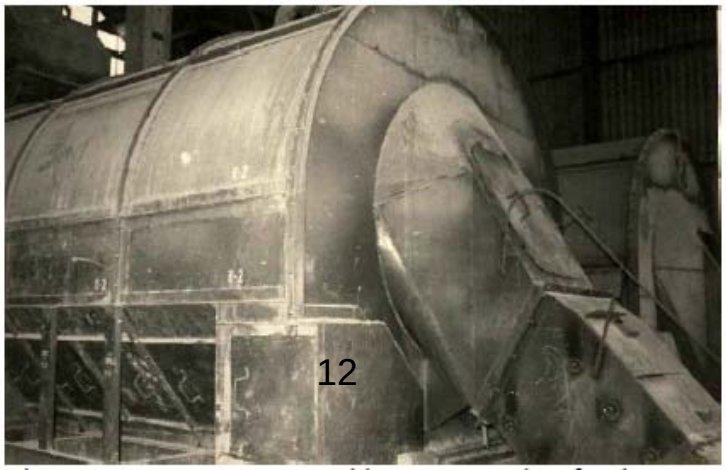
- A quasi-stable area has been detected in large areas. Areas of collapse, subsidence and zones of stability have been determined.

Oil shale deposit



Backfill mix components

- Water, limestone (waste rock from oil shale mining), ash
- If limestone could be separated from the oil shale in situ -> reduction in haulage costs
- Dry separation -> tests in drums
- + crushing buckets



Selective crushing (stripping)

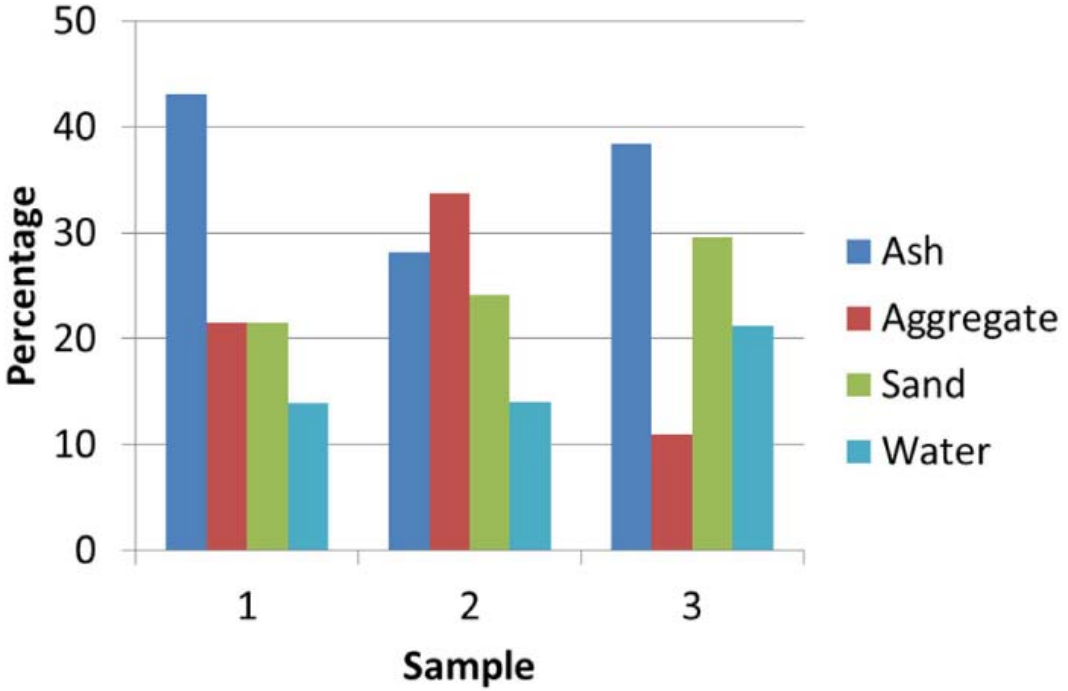
Tests

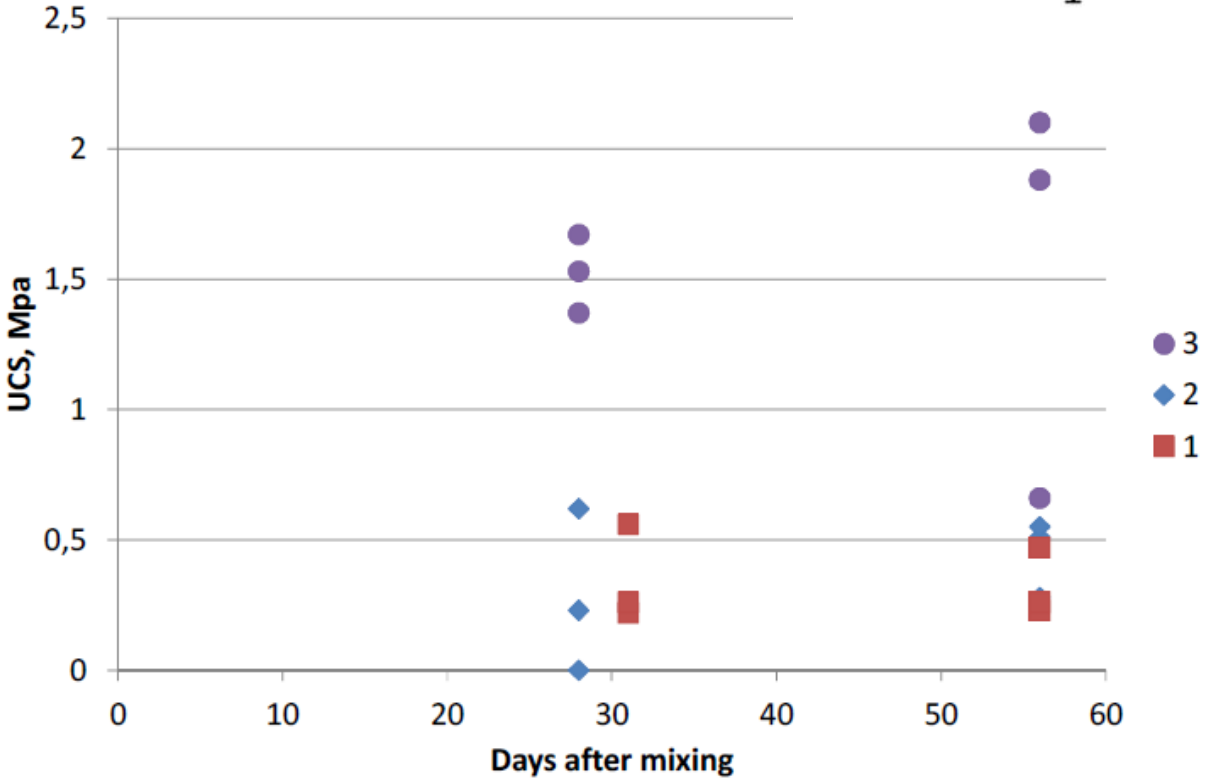
- - dry casting of waste rock to the mined out rooms and adding ash and water mixture
- - pumping wet mixture with piston pump to the rooms
- Experiments continued with new ashes (new burning and heating technologies) and waste rock aggregates.

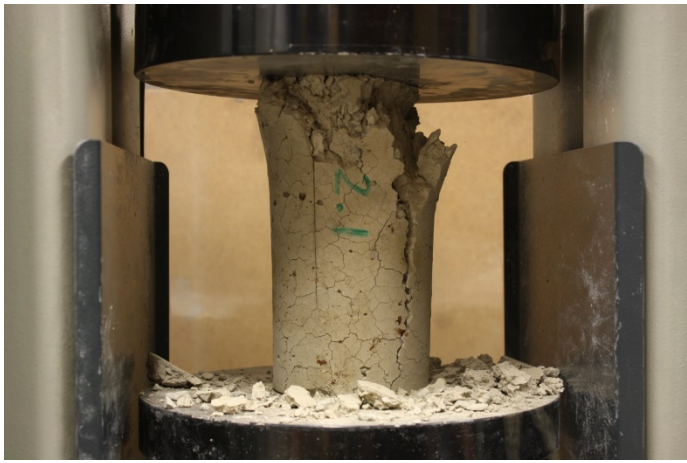
Backfilling tests

Tests with samples

- 8 degrees C temperature and 90% humidity
- + keeping in water


50
40
30
20
10
0
Percentage
1
2
3
Sample
Ash
Aggregate
Sand
Water

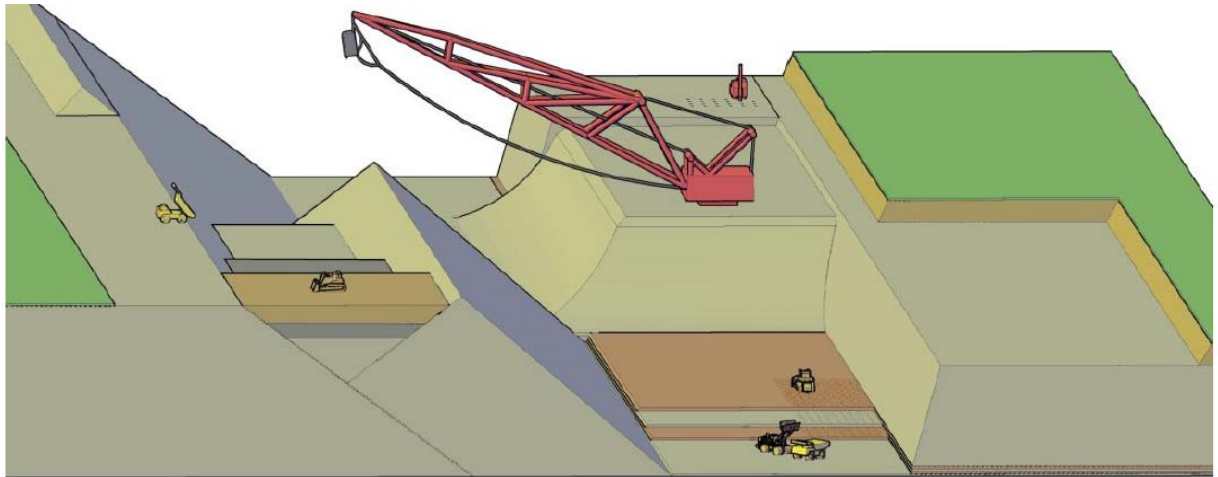

2,5
2
1,5
1
0,5
0
UCS, Mpa
0
10
20
30
40
50
60
Days after mixing
3
2
1



- Warming effect – higher UCS, increases to 10MPa
- Higher water content resulted in higher compressive strength

Surface mine backfilling

- Space between the spoils could be used for depositing ash and at the same time for stabilising spoils.
- Increase overburden thickness
- Peat and quaternary sediments could be mixed with ash.



Backfilling technology?

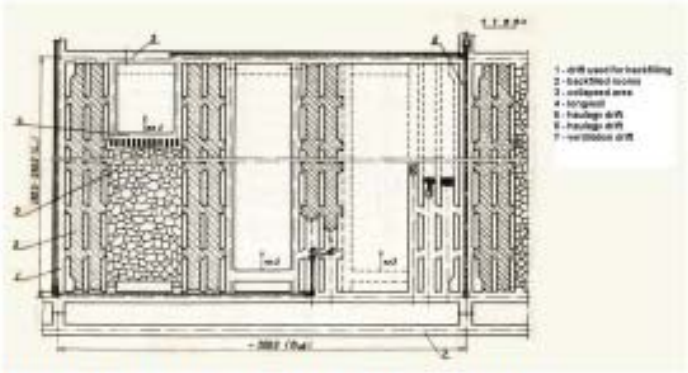


Figure 10: Partial backfilling with waste rock.

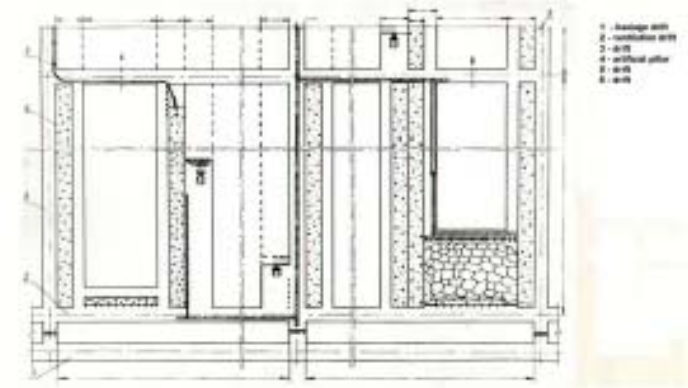


Figure 11: Combined room and pillar mining with partial backfilling with hardening material.

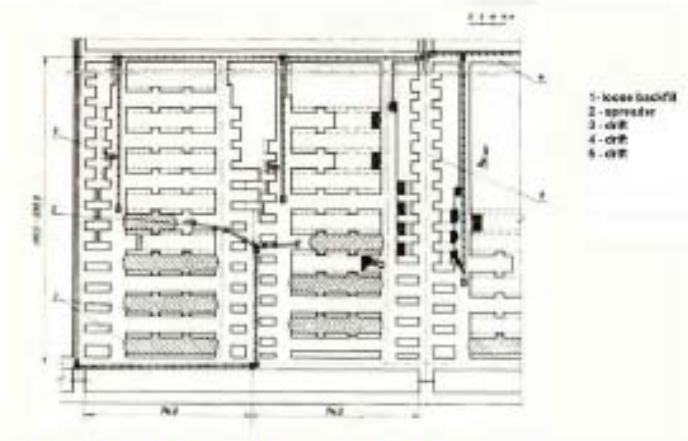
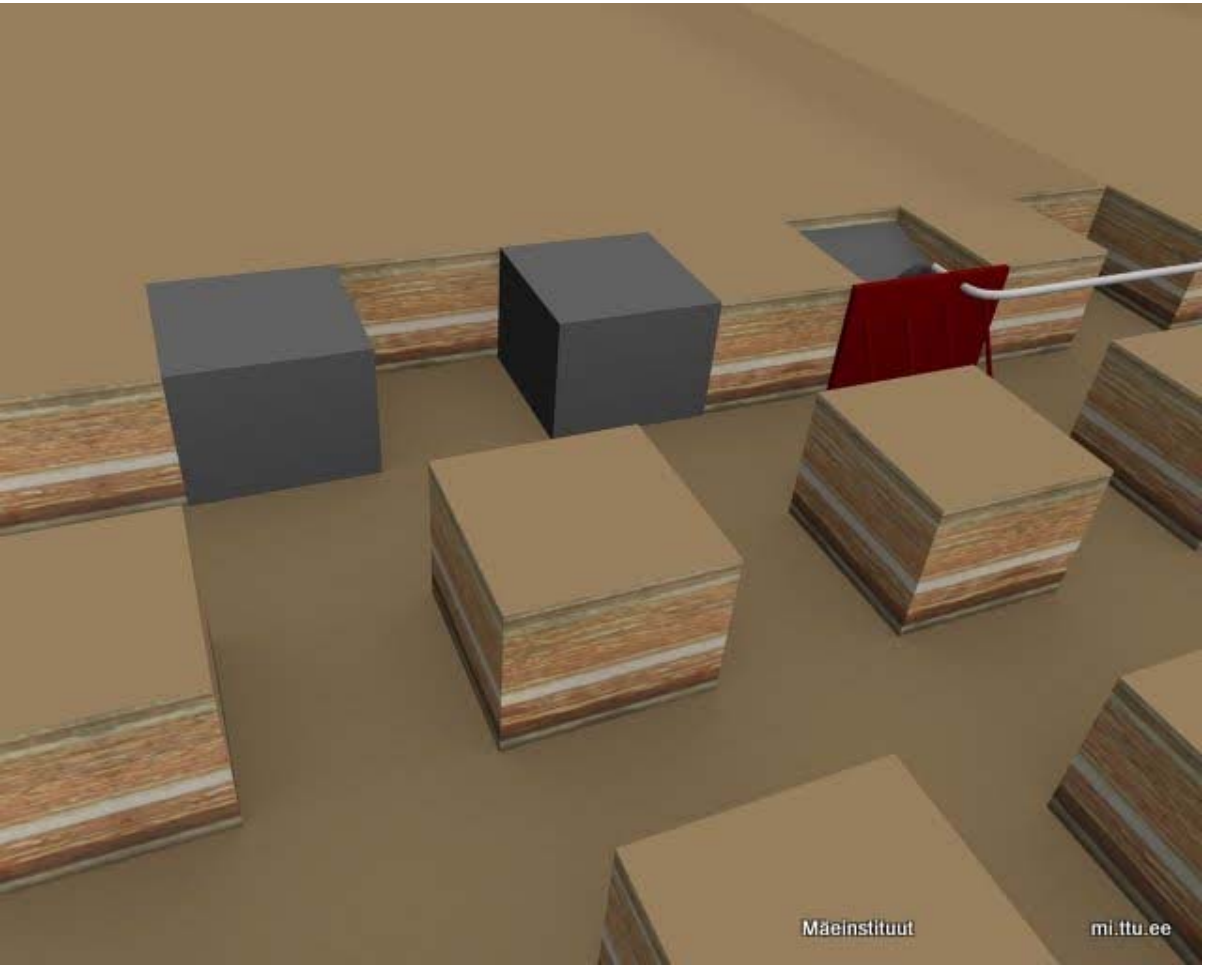


Figure 12: Mining with combined pillars.



Information

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