LESSONS LEARNED FROM THE LAST CENTURY – MINING WASTE AND REGULATION IN GREENLAND

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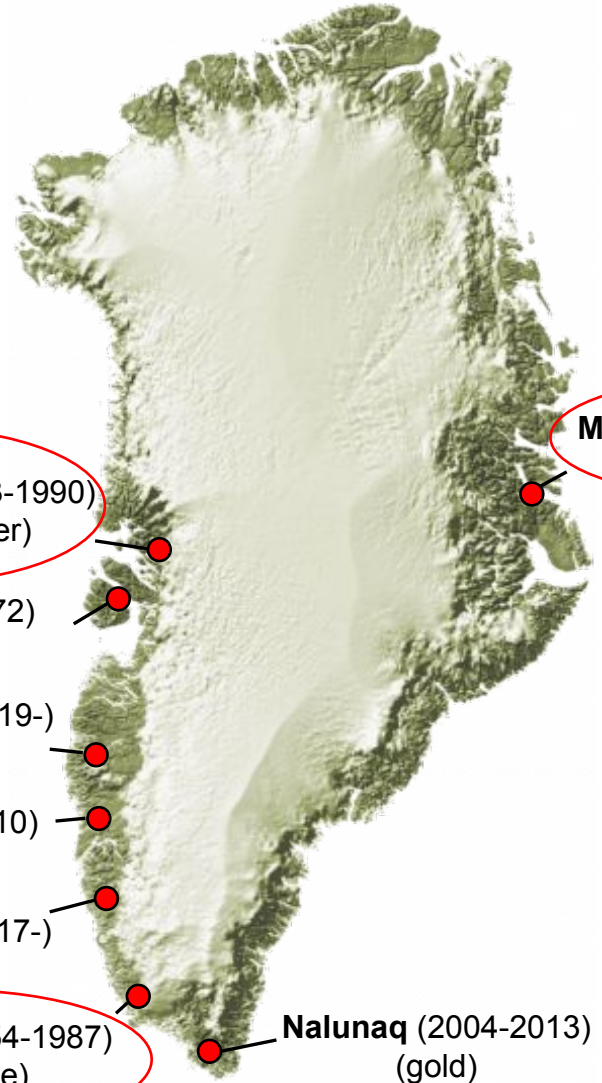
Arctic Mining: Environmental issues, mitigation and pollution control for marine and coastal mining- Workshop March 21-23, 2023

Photo: Jens Søndergaard

CURRENT AND FORMER MINE SITES IN GREENLAND

'LEGACY' MINE SITES



Mestersvig (1956-1963)
(lead-zinc)

Maarmorilik (1973-1990)
(lead-zinc-silver)

Qullissat (1924-1972)
(coal)

White Mountain (2019-)
(anorthosite)

Seqi (2005-2010)
(olivine)

Aappaluttoq (2017-)
(rubies)

Ivittuut (1854-1987)
(cryolite)

Nalunaq (2004-2013)
(gold)

Studies are documented in numerous scientific reports, notes and >50 research publications through the years. Reports are publically available and can be downloaded from https://dce.au.dk

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Greenland legacy mines:

THE CRYOLITE MINE IN IVITTUUT, SOUTH GREENLAND (1854-1987)

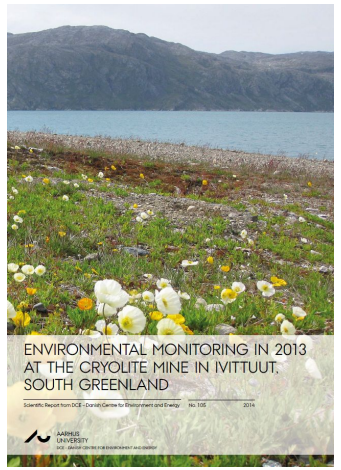
- A total of **3.7 mill t cryolite** (Na_3AlF_6) was produced, which was used as solvent in aluminum extraction.

MAIN ENVIRONMENTAL ISSUES

- **Pollution of the Arsuk Fjord** with mainly **lead** and **zinc**.
- Main source of pollution was **waste rock** used for construction along the coastline **leached by tidal water**.
- **Decreasing pollution trend** since the first study in 1982.
- Elevated pollutant levels found in key monitoring species (seaweeds/mussels) within an area up to **ca. 15 km from the mine** during the last monitoring **in 2013**.

Photo: Eclipse Metals

The mine pit and mining town in Ivittuut during operation



[Link to latest report]

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Greenland legacy mines:

THE LEAD-ZINC MINE IN MESTERSVIG, EAST GREENLAND (1956-1963)

- A total of **554,000 t ore** (58,000 t lead; 75,000 t zinc) was produced.

MAIN ENVIRONMENTAL ISSUES

- Pollution of the **terrestrial** and **marine environment** near Mestersvig with mainly **lead** and **zinc** (and some copper, cadmium, barium i.a.).
- Main pollution sources were:
  - **Dispersion of uncovered tailings** deposited downslope from the mine near Tunnelelv (river) ca. 10 km inland.
  - **Dust dispersion of concentrate** along the haul road from the mine to the harbor.
  - **Spills of concentrate from loading** at Nyhavn (harbor) and later **collapse of a quay area**.
- **Decreasing pollution trend** since first study in 1979.
- Elevated pollutant levels found within an area up to **ca. 10 km from the sources** during the last monitoring **in 2014.**

The mine and the tailings deposit near Tunnelelv (river)

[Link to latest report]

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Greenland legacy mines:

THE LEAD-ZINC MINE IN MAARMORILIK, WEST GREENLAND (1973-90)

- A total of **11.2 mill. t ore** (590,000 t lead; 2,327,000 t zinc) was produced.

MAIN ENVIRONMENTAL ISSUES

- Pollution of the **marine environment** near Maarmorilik with **lead** and **zinc** (and some cadmium, mercury i.a.)
- Main pollution sources were:
  - **Tailings** deposited in a small sill-fjord (to be elaborated)
  - **Waste rock** deposited on mountain slopes and in the fjord.
  - **Residues of ore and concentrate** from mine/camp
- **Decreasing pollution** since mine closure.
- Elevated pollutant levels found in marine key species within **ca. 12 km from the mine** during the last study in 2017.

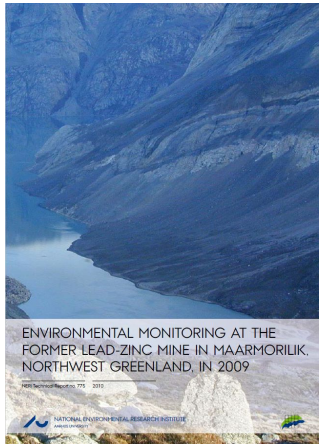
The mining town

The mine entrances

Photos: Jens Søndergaard

Photo: Gert Asmund

Environmental monitoring highlighted the major waste rock dump (above) to be a main source of pollution, so it was (partly) removed during mine closure in 1990.



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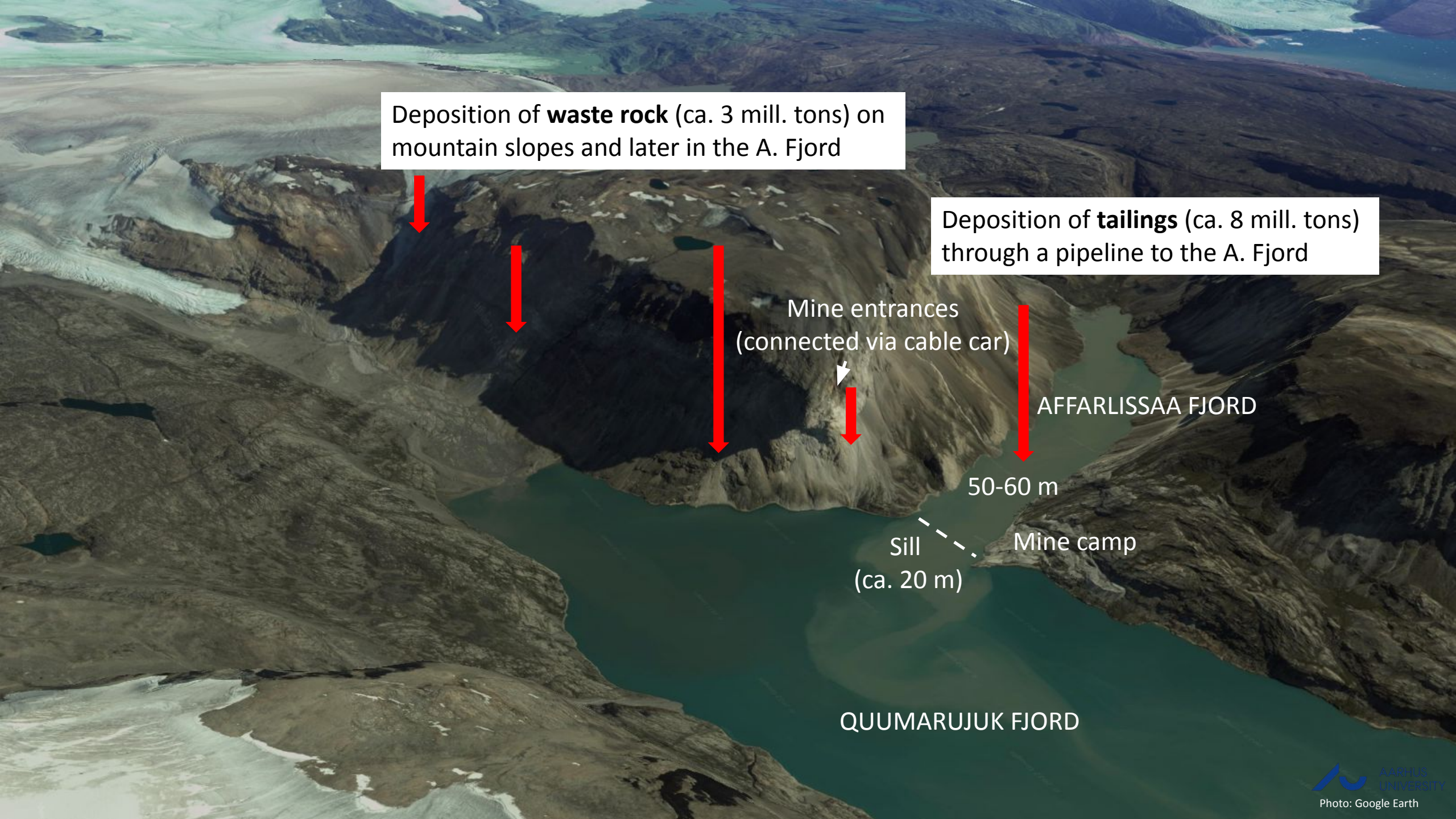
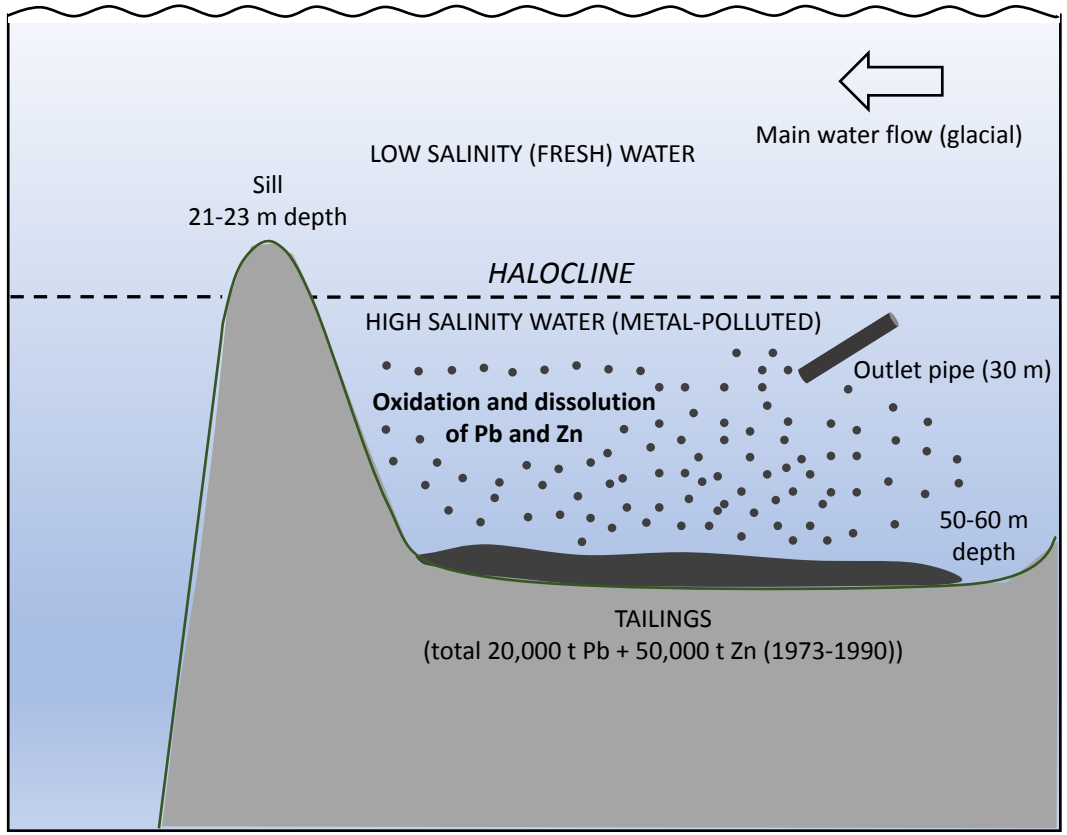

Deposition of **waste rock** (ca. 3 mill. tons) on mountain slopes and later in the A. Fjord
Deposition of **tailings** (ca. 8 mill. tons) through a pipeline to the A. Fjord
Mine entrances (connected via cable car)
AFFARLISSAA FJORD
50-60 m
Sill (ca. 20 m)
Mine camp
QUUMARUJUK FJORD
Photo: Google Earth

Greenland legacy mines:

SUBMARINE TAILINGS DISPOSAL IN THE A-FJORD, MAARMORILIK

Summer/autumn

Stratification = little outward transport of pollutants



Winter/spring

Vertical mixing some years = major outward flush of pollutants

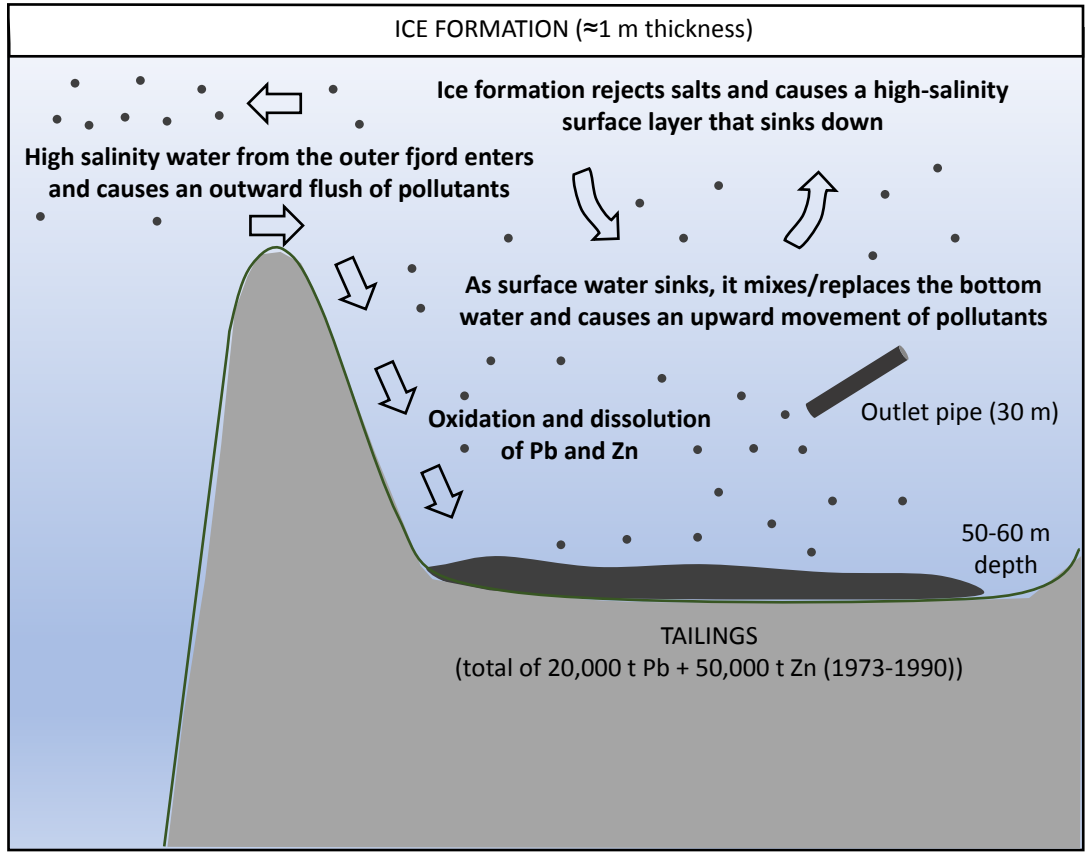


Illustration: Jens Søndergaard

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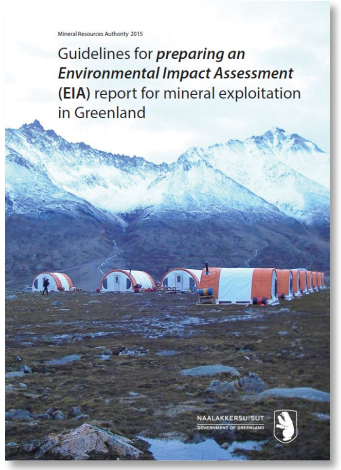
Greenland legacy mines:

MAIN LESSONS LEARNED & IMPROVED REGULATION

- **Environmental Impact Assessments (EIAs)** needs to be made prior to mining operation following strict guidelines and BAT/BEP principles with involvement by all stakeholders (incl. public hearings) to highlight and minimize impacts **-> Specific EIA guidelines have been developed for GL incl. environmental quality criteria for water and air**
- **Thorough geochemical test work** is needed prior to regulation to assess potential leaching of pollutants using representative waste samples and tests designed to simulate the specific deposition **-> Specific recommendations for geochemical test work in EIAs have been developed for GL**
- **Mine waste deposition** needs to be thoroughly evaluated prior to deposition. Reactive mining waste should not be placed in the tidal zone and places exposed to excessive weathering, risk of floods etc. Deposition on land in areas with permafrost, on steep slopes, or in the sea makes it practically impossible the recover the waste again, if an unexpected pollution occurs **-> Extensive knowledge on arctic mine waste deposition is now part of the knowledge base at DCE/GINR and will be cont. updated**



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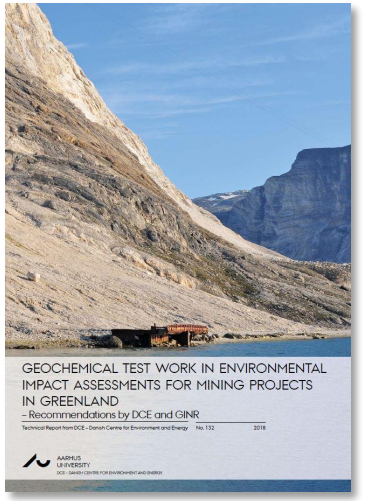

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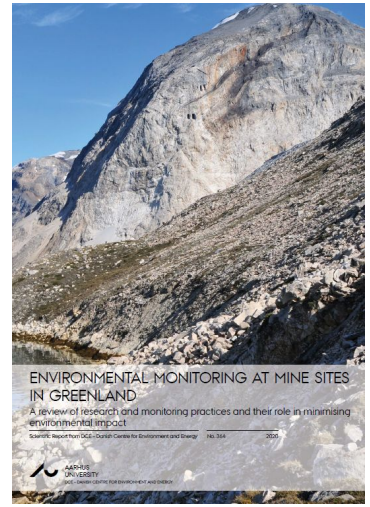
Greenland legacy mines:

MAIN LESSONS LEARNED & IMPROVED REGULATION

- Regulation needs to take **seasonal dynamics in environmental conditions in the Arctic** into account. Distinct seasonal dynamics were observed in fjords in Maarmorilik but also in e.g. river water chemistry at Citronen Fjord, North Greenland **-> This is now part of the EIA guidelines and knowledge base at DCE/GINR**
- **Thorough environmental monitoring** is needed to ensure compliance with regulation and for early identification of unexpected environmental issues **-> Specific recommendations for monitoring, sample collection etc. have been developed for GL**
- **A challenge for environmental regulation of mines in the Arctic:** Not two mining projects are similar -> The Arctic pose some unique environmental conditions and challenges -> Numbers of arctic mines are relatively limited -> **A need to share and update knowledge and experiences in mining between Arctic countries to improve regulation (such as this workshop☺)**



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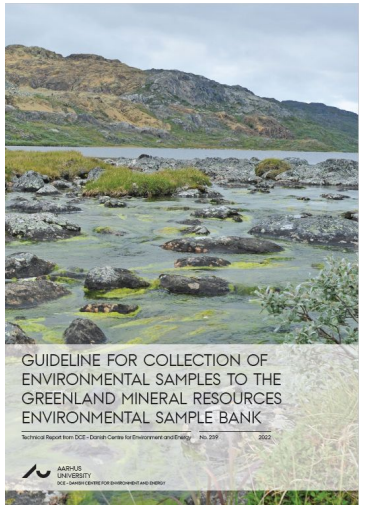

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THANKS FOR YOUR ATTENTION!

For further questions, please contact: Jens Søndergaard, js@ecos.au.dk

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