Seminar on exploration, sustainable access and extraction of raw materials:

Potential for exploration and exploitation in Greenland

- How to reach the 'hard to reach resources?' -

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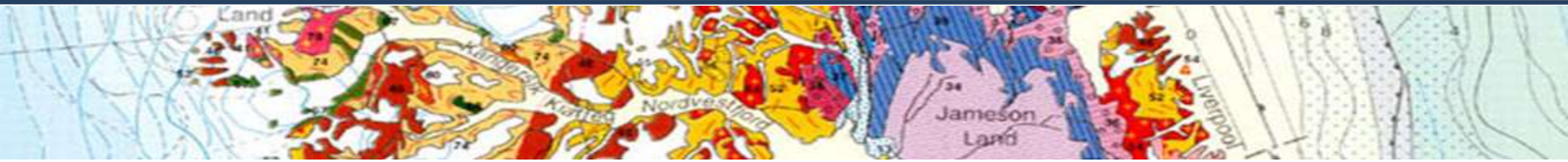

Geological Survey of Denmark and Greenland (GEUS)

- Danish research and advisory institution
- Located in Copenhagen with offices in Aarhus and Nuuk - active in Denmark, Greenland, Developing Countries, world wide
- A total of about c. 350 full time specialists, technicians and administrative staff. Approximately 200 hold PhD or MSc degrees
- Cover most geoscientific disciplines and activities – five programme areas:
    - Mineral resources, Energy resources, Water resources , Nature and climate and Data banks
- International collaborative partner; collaborative partner to the Greenland Government
- International research partner; Greenland as a natural laboratory…

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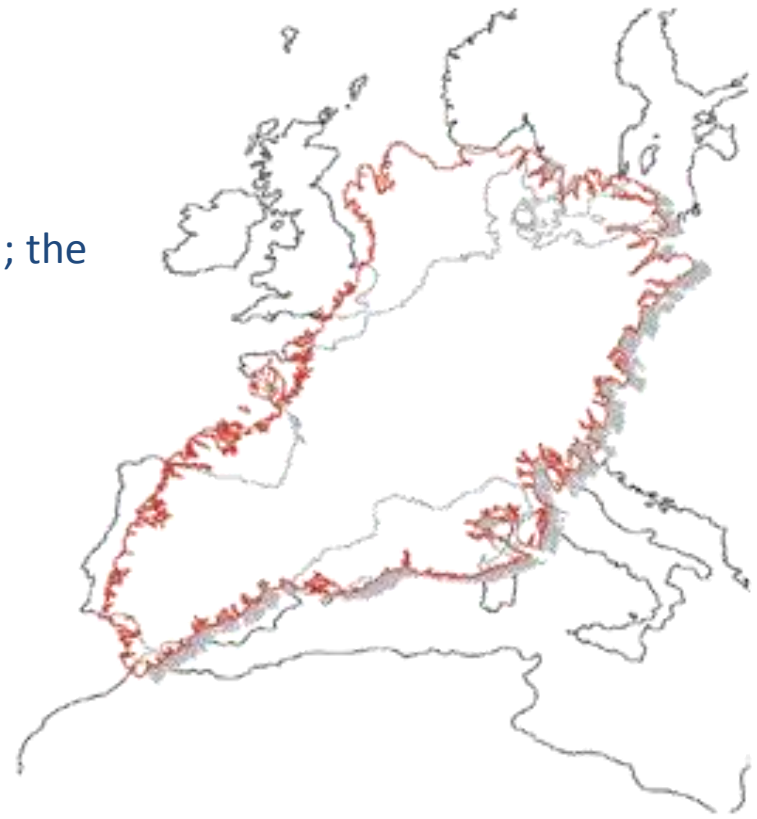
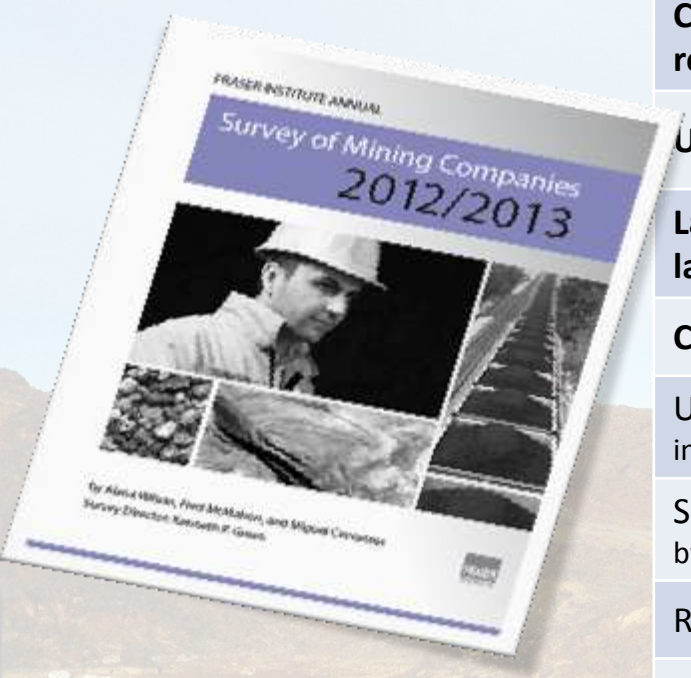
Greenland – a few facts?

- 2.670 km N-S; 1.050 km E-W
  - Southern tip at the height of Oslo
  - Kaffeklubben Island or the Coffee Club Island ; the norhternmost point of land on the Earth
- Coastline 44.087 km
  - European Union ~66.000 km
- Total area 2.166.086 km^2
  - 12th largest nation
- Ice-free area 410.449 km^2
  - 60th largest nation; larger than Finland, Germany, Poland, Norway; Sweden is 450.000 km2; France is 551.500 km2
- 57.000 inhabitants
- 18 towns and 60 settlements
- Worlds largest island
- Fishery and block-grant is the main income



Greenland is in the top…

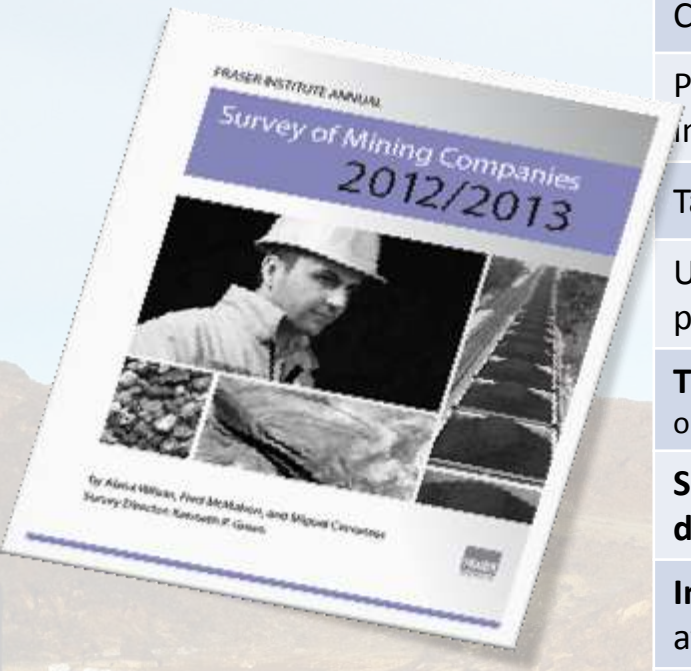


Fraser Institute 2013:
Survey amongst mining and exploration companies in the entire world 2013/2012:

- 742 companies (4100 asked)
- 96 juristriction evaluated

Fraser Institute Category	2012/2013	2011/2012
Current mineral potential assuming current regulations and land use restrictions	**1/96**	**2/93**
Uncertainties concerning disputed land claims	**1/96**	**2/93**
Labour regulations, employment agreements, and labour militancy or work disruptions	**3/96**	**14/93**
Corruption	**3/96**	**21/93**
Uncertainty concerning the administration, interpretation and enforcement of existing regulations	**4/96**	**12/93**
Security (includes physical security due to threat of attack by terrorists, criminals, guerrilla groups, etc)	**4/96**	**4/93**
Regulatory duplication and inconsistencies	**5/96**	**3/93**
Political stability	**5/96**	**2/93**
Growing (or lessening) uncertainty in mining policy and implementation	**5/96**	**10/93**
Uncertainty concerning environmental regulations	**6/96**	**13/93**
Geological database (includes quality and scale of maps, ease of access to information, etc.)	**9/96**	**31/93**
Legal processes that are fair, transparent, non-corrupt, timely and efficiently administered	**10/96**	**25**

Greenland is in the top…



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Fraser Institute Category	2012/2013	2011/2012
Composite policy and mineral potential	**11/96**	**13/93**
Policy mineral potential assuming no regulations in place and assuming industry best practices	**12/96**	**27/93**
Taxation Regime	**19/96**	**20/93**
Uncertainty concerning which areas will be protected as wilderness areas, parks or archeological	**19/96**	**5/93**
Trade barriers – tariff and non-tariff barriers, restrictions on profit repatriation, currency restrictions, etc.	↓ **26/96**	**34/93**
Socioeconomic agreements/community development conditions	↓ **48/96**	**31/93**
Infrastructure (includes access to roads, power availability, etc.)	↓ **83/96**	**75/93**
Room for improvement	↑ **84/96**	**88/93**

Projects with exploitation license

Black Angel Zn-Pb
Angle Mining Plc.
2010: exploitation license
Re-opening of former mine; construction, awaiting financing - currently on hold / insolvency

MVT type deposit
Underground, cable-car

Malmbjerg Mo
KGHM International
2008: exploitation license
Awaiting market improvements

Climax-type porphyry Mo deposit
Open-pit, long haul-road

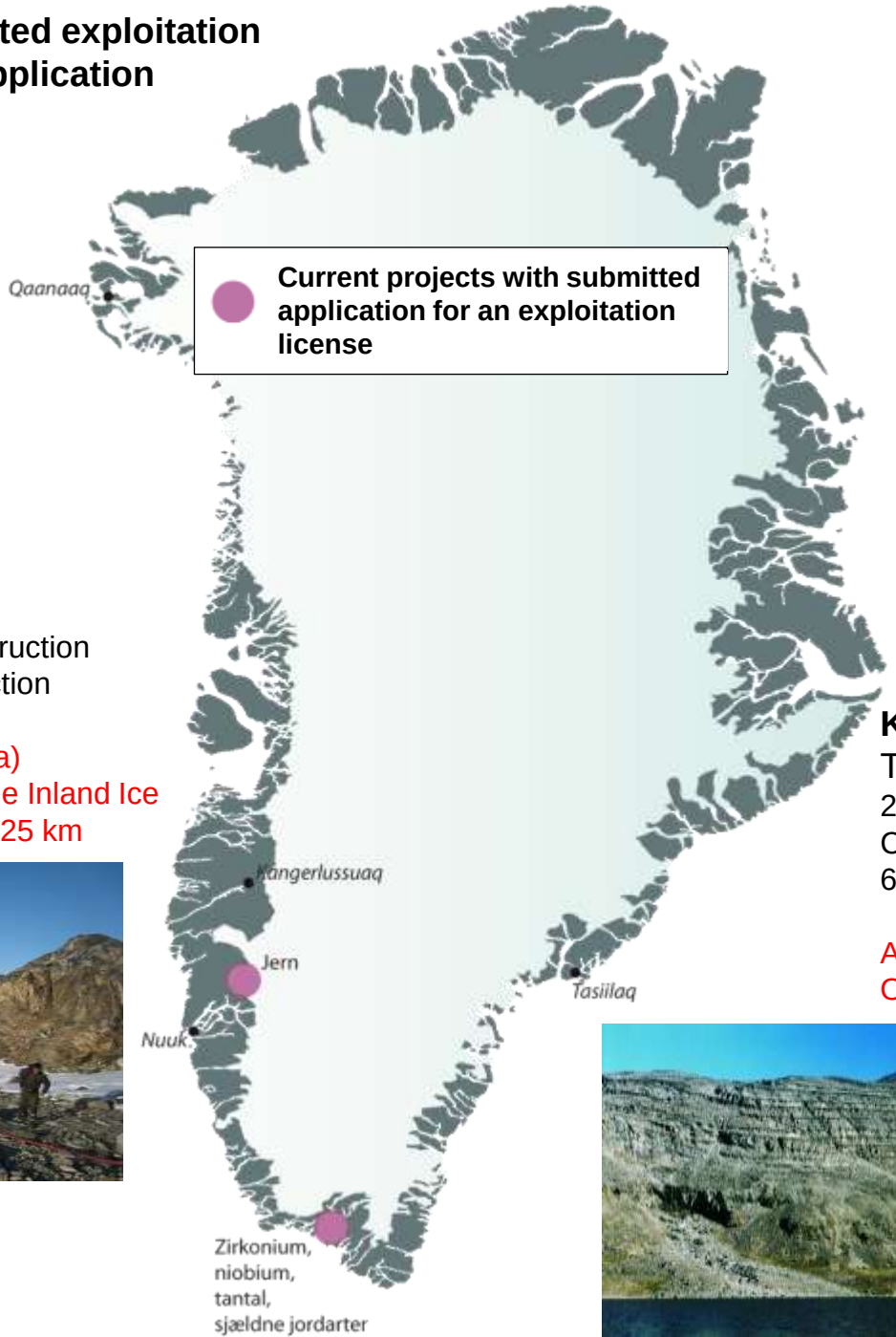
Seqi Olivine Mine
LKAB
2005: exploitation license
Production from 2005-09
Closed (2009)

Ultramaifc body – 150 Mt olivine
Open-pit

Nalunaq Gold Mine
Angle Mining Plc.
Production (2001 / exploitation license in)
Currently on hold / insolvency

Orogenic gold / hydrothermal vein
Underground

Projects with new granted exploitation license or submitted application for exploitation license



Isua Fe

London Mining

2013 – granted exploitation

CAPEX 14 billion DKK

2500 employees during construction

700 employees during production

Banded iron formation (3.8 Ga)

Situated near the margin of the Inland Ice

Open-pit mining, slurry-pipe 125 km

Kringlerne Zr-Nb-Ta-REE

Tanbreez Ltd.

2013: Submitted application

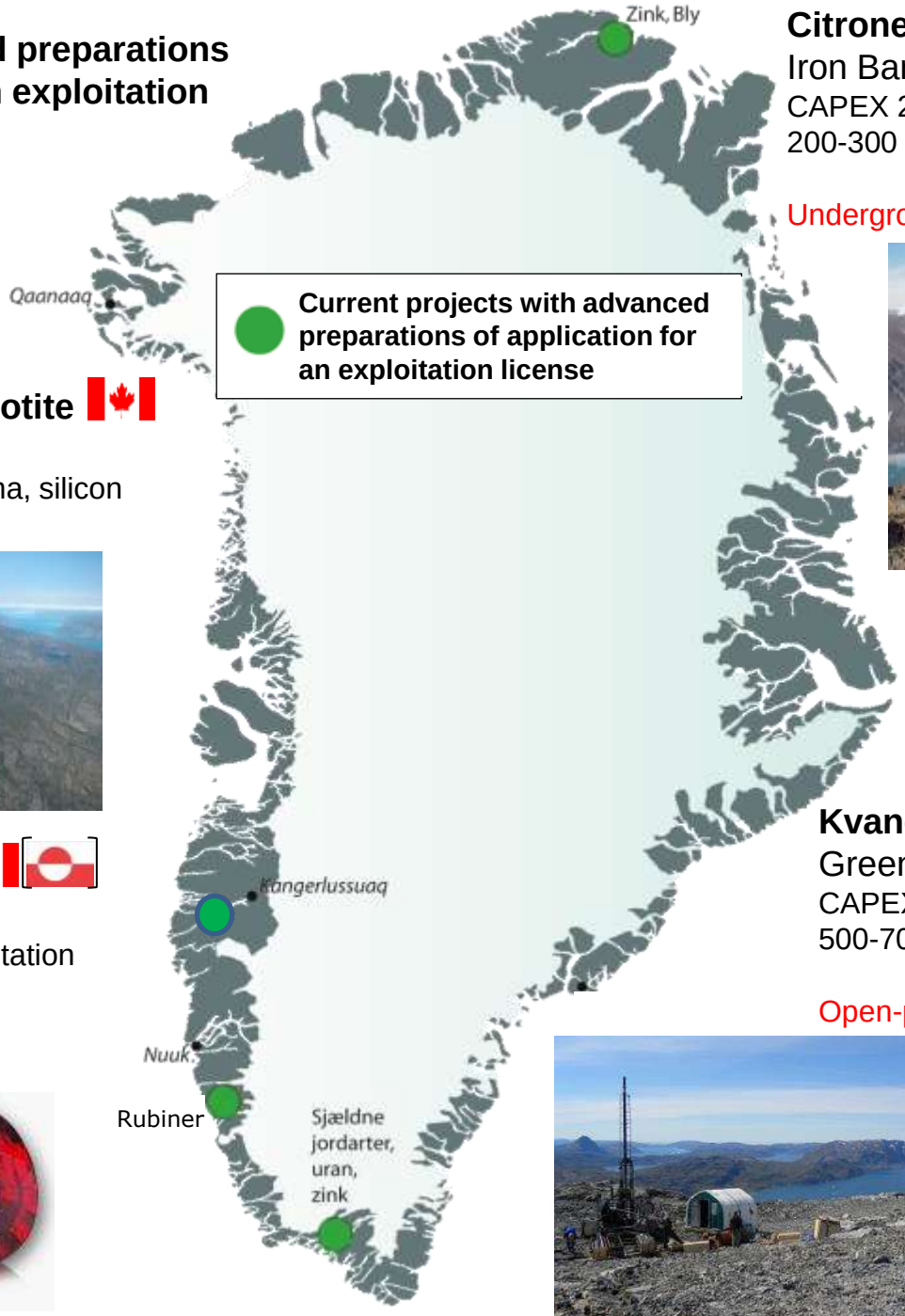
CAPEX 1.2 billion DKK

60-80 employees

Alkaline-intrusion hosted

Open-pit mining

Projects with advanced preparations of an application for an exploitation license



Citronen Fjord Zn-Pb
Iron Bark Ltd.
CAPEX 2.8 billion DKK
200-300 employees

Underground, mining in high arctic

White Mountain Anorthotite
Hudson Resources Inc.
Chemical compound - alumina, silicon and calcium

Open-pit

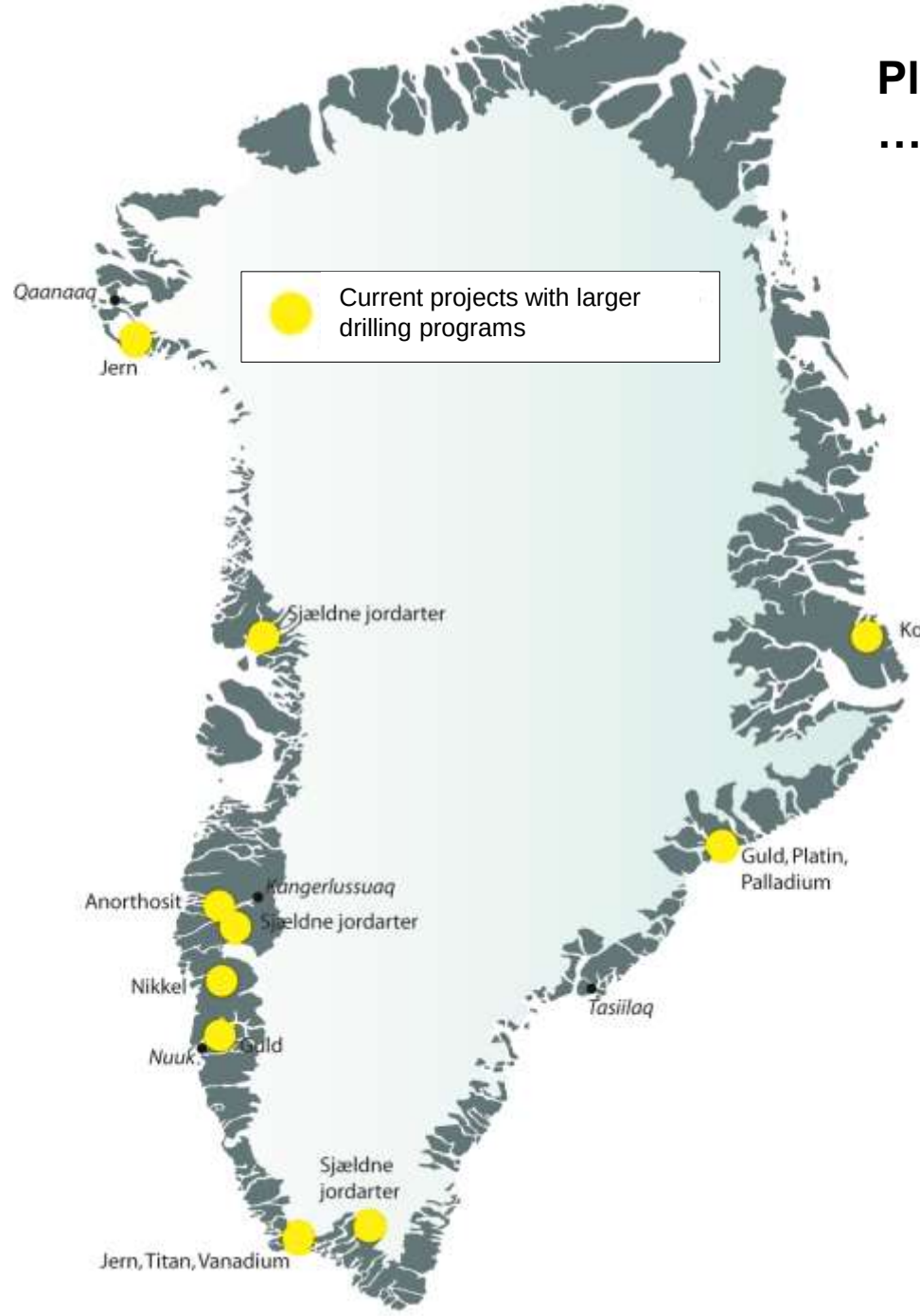
Fiskenæsset Rubiner
True North Gems Inc.
Submitted application for exploitation
CAPEX 0.2 billion DKK
50 employees

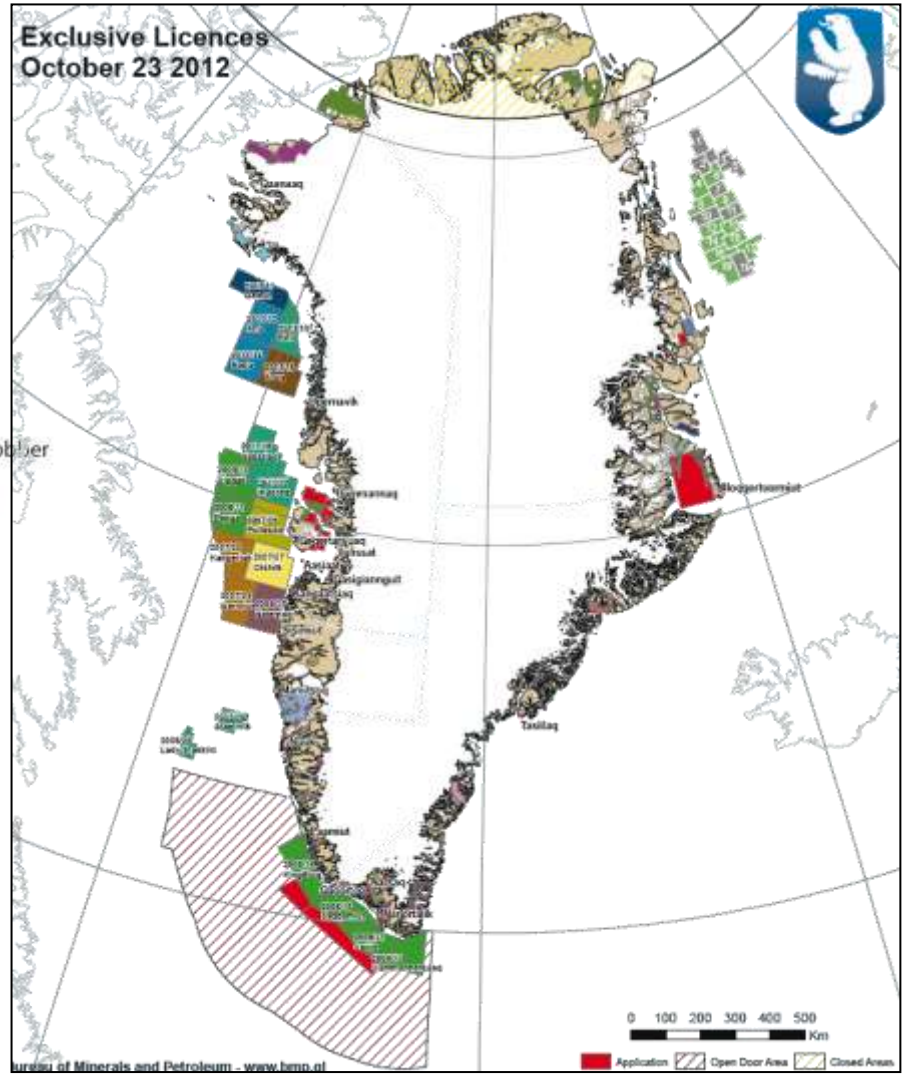
Open-pit

Kvanefjeld REE-U-Zn
Greenland Minerals and Energy Ltd.
CAPEX 4.5 billion DKK;
500-700 employees

Open-pit, processing outside Greenland?

Plenty of other exploration projects…
…and with rooms for more





Critical mineral resources? – **potential in Greenland…**

Critical mineral	EU 2010	US NAS 2007	Watch list (EU 2010)	Potential in Greenland	Primary product ● or by-product ○
REE	X	X		Very high	●
PGM	X	X		Very high	●
Niobium	X	X		Very high	●/○
Tantalum	X			Very high	●/○
Fluorspar	X			Very high-High	○ of REE
Gallium	X			High	○ of PGE
Tungsten	X			High	●
Vanadium			X	High	○ of Fe
Graphite	X			High	●
Germanium	X			High	○ of Zn
Beryllium	X			High	●/○ of REE(?)
Chromium			X	Moderate-High	●/○
Cobalt	X			Moderate-High	●/○
Antimony	X			Moderate	●/○
Indium	X	X		Low-moderate	○
Lithium			X	Low-moderate	○
Magnesite			X	Low	●
Magnesium	X			Low	●
Manganese		X		Low	●
Rhenium			X	Low	○

Product of Supply Risk and Impact of Suply Restriction

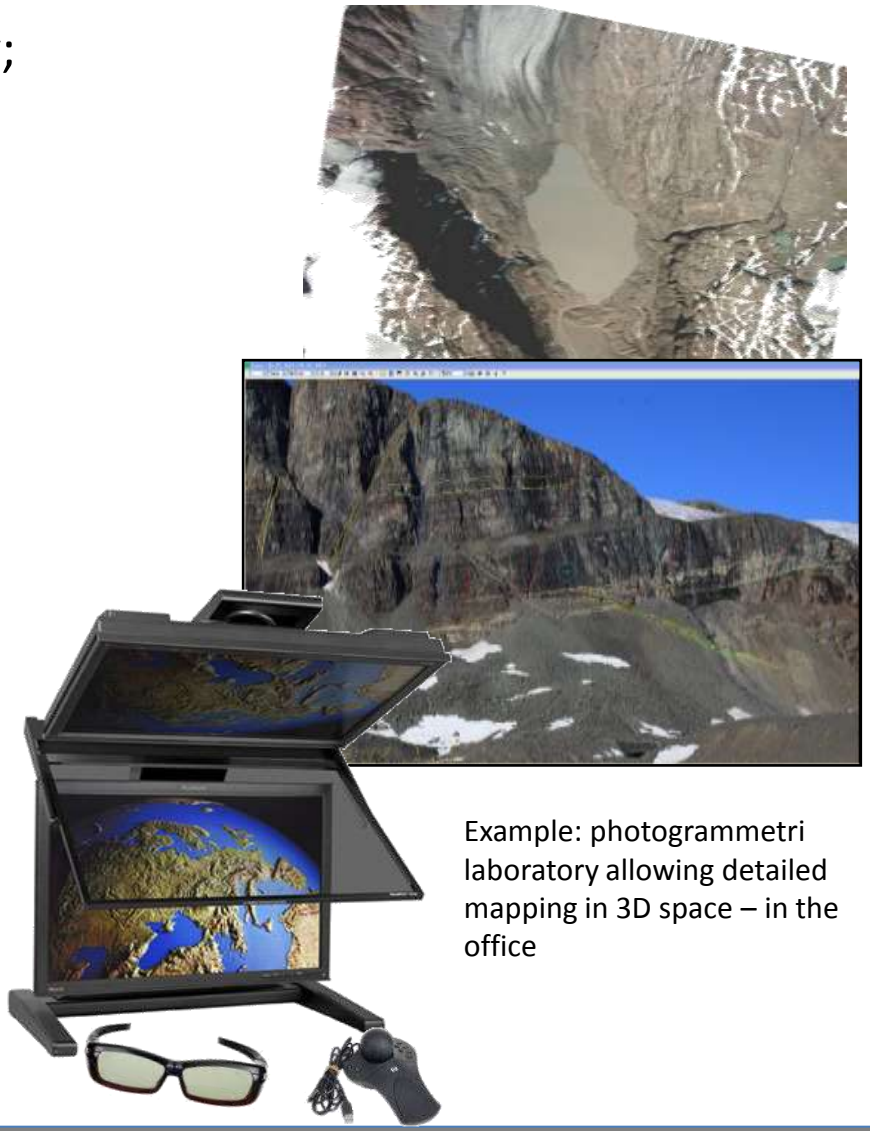
…the opportunities of the Arctic – and Greenland:

Not only a place of future resources…

- Pristine environment; base line, environmental studies
- A natural geological laboratory – unconcealed and unmatched outcrops; impacts on our understanding elsewhere
- Challenging conditions and environments imply innovative solutions, clean and green tech., efficient and effective solutions, technologies at

Exploration and technology for the Arctic: exploration

- Take advantages of the natural laboratory; the good exposure – learn about what's under cover elsewhere…
- Defining critical minerals; opportunities for new sources of materials/resources
- 3D geological database and techniques for the Arctic – for the rest of the world
- Warm and hot springs – geothermal systems for raw materials and energy
- Surface processes in the Arctic – remote sensing signal
- Geophysical and remote sensing techniques for the Arctic: dealing with snow/ice, lichen/moss vegetation, extreme topography, sun angle etc.



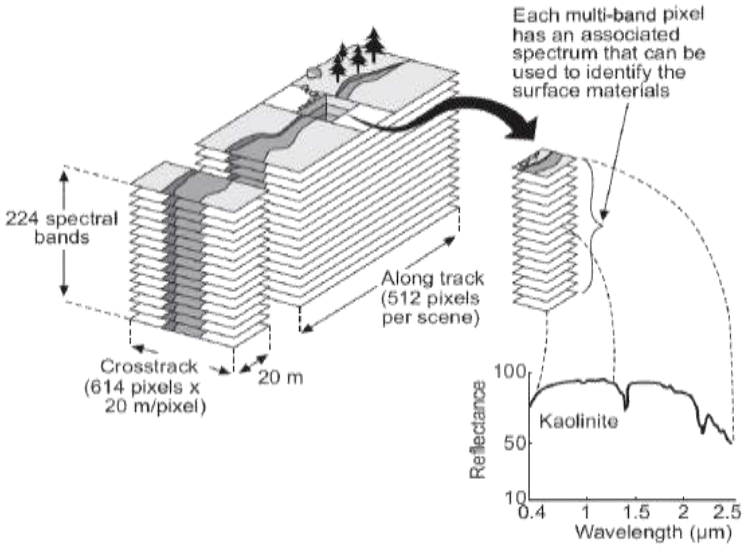
Example: photogrammetri laboratory allowing detailed mapping in 3D space – in the office

Example: Mineral Exploration using Hyperspectral Remote Sensing

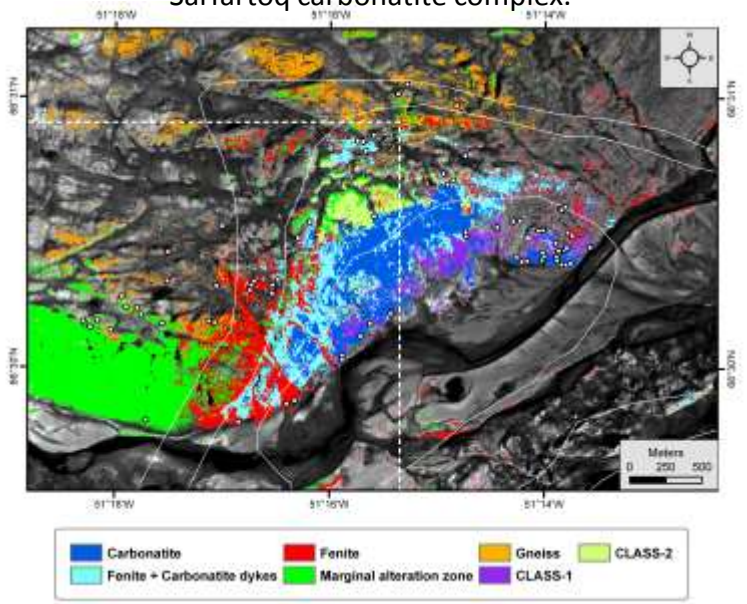
- Excellent tool for mineral exploration
- Mapping difficult accessible regions – data acquisition by satellites/aircrafts/ drones
- Special Arctic considerations: clean atmosphere, vegetation, sun angle, snow/ice, etc.

Basics of hyperspectral remote sensing:

- A large number of minerals display absorption features in reflectance spectra
- Measuring the reflected light it is possible to quantitatively map the surface distribution of minerals

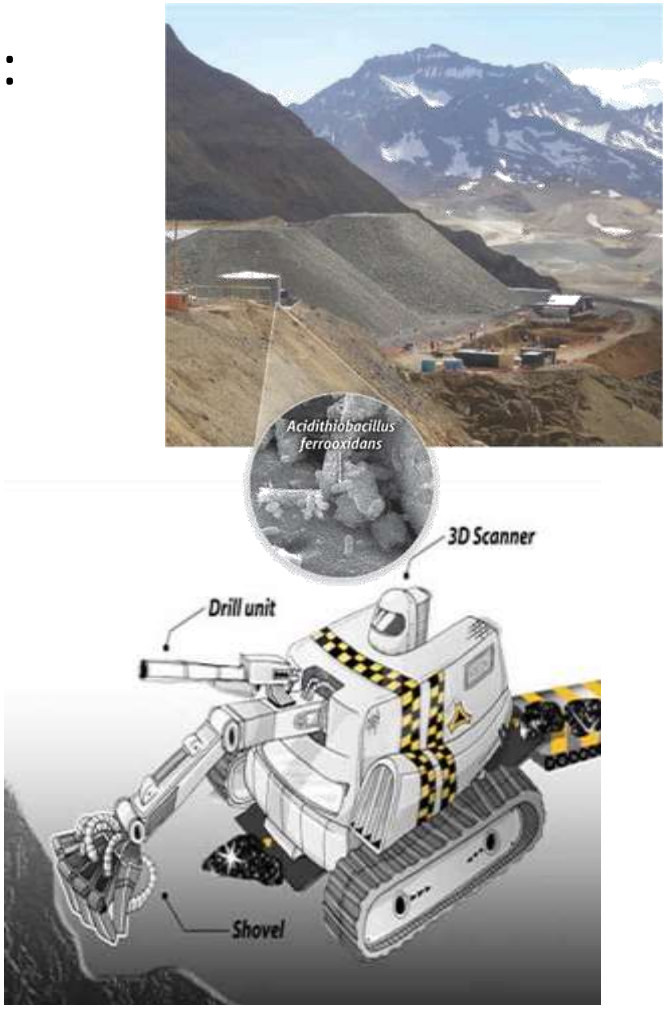


Lithological Classification of Sarfartoq carbonatite complex.



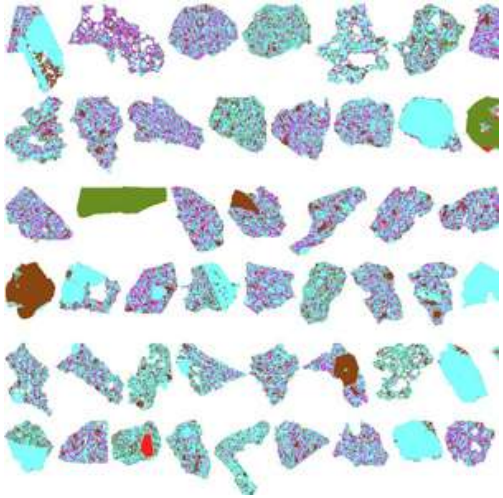
Exploitation and technology for the Arctic: processing and production

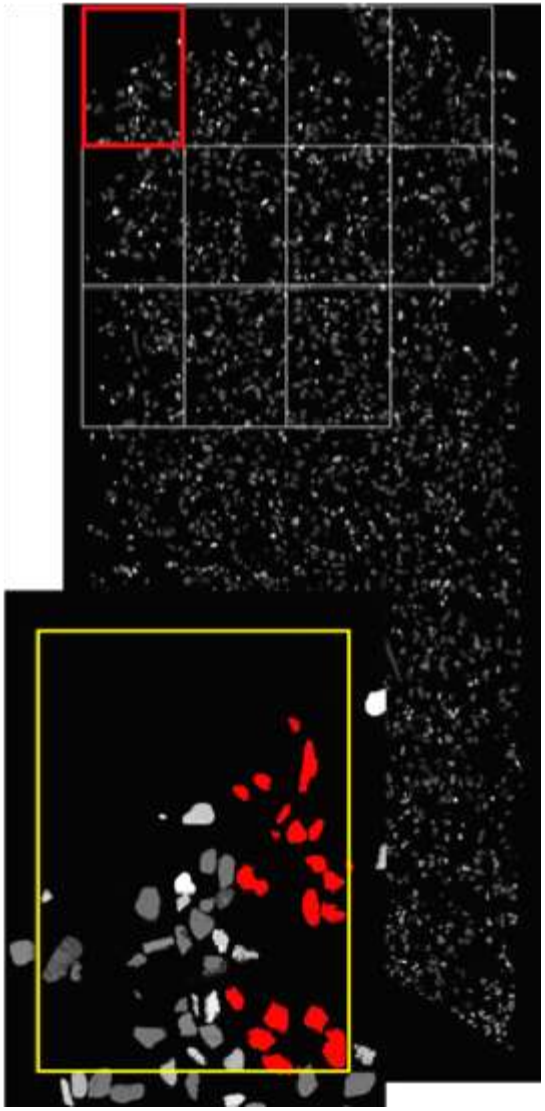
- Bioleaching under harsh climate; natural laboratory
- Pristine baseline studies
- Online environmental control and remediation
- Automatization in mining production; fare-remote control, robots
- Green technology solutions for mining and energy in Arctic
- Efficient transportation
- Improving recovery: automative online analysis of middling products during processing
- Characterization of recycling material



Exploitation and technology for the Arctic: product

- Heavy mineral sands or aggregate characterization
- Fingerprinting Arctic raw materials; certification of production
- New sources of minerals/metals
- Implications for society and economy
- Setting the standards





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the end...