



***Development of Metallurgical Flowsheet  
Kvanefjeld Multi-Element Project***



**GREENLAND**  
MINERALS AND ENERGY LTD

*“Specialty Metals for a Greener World”*

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Information in this presentation that relates to mineral resource estimation reflects information compiled by Mr Robert Spiers and Arnold van der Heyden. Resource estimation was undertaken by Mr Spiers who with Mr van der Heyden are full time employees of Hellman and Schofield Pty Ltd. Mr Spiers is a Member of the Australian Institute of Geoscientists (AIG) and Mr van der Heyden is a member of the Australian Institute of Mining and Metallurgy (AusIMM). Mr Spiers and Mr van der Heyden have sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which they are undertaking to qualify as Competent Persons as defined in the 2004 Edition of the "Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves". Mr Spiers and Mr van der Heyden consent to the reporting of this information in the form and context in which it appears.





# Presentation Overview

- ***Company and Project Background***
- ***Geology/Mineralogy***
- ***Metallurgical Research***
- ***Flowsheet Development***
- ***Current Status and Summary***



# Greenland Minerals and Energy Ltd

- **ASX listed mineral exploration and development company**
- **Head quartered in Perth, Australia**
- **Offices in London, Copenhagen and Nuuk (Greenland)**
- **Operations base – Narsaq, Greenland**

## **Key Personnel**

### **Michael Hutchinson – Executive Chairman**

- *Former Chairman and CEO of Metallgesellschaft Ltd, and longstanding Director of the London Metals Exchange (LME)*

### **Roderick McIllree - Managing Director**

- *Geologist, resource analyst, corporate experience in international capital markets*

### **Lars-Emil Johansen - Chairman of Greenlandic subsidiary**

- *Prime Minister of Greenland 1991-1997*



# Kvanefjeld Multi-element Project

***Rare earth metals and uranium recognised as strategically important commodities for the future:***

## ***Rare Earth Elements:***

- *Specialty metals with unique chemical and physical properties*
- *Essential in many new technologies and consumer products*
  - *Hybrid cars, wind turbines, laptops, ipods, flat screens, oil refining, catalytic converters, medical and military applications*
- *Imminent short supply as China reduces exports*

## ***Uranium:***

- *World power crisis, climate change and the nuclear renaissance*
- *Crucial base load energy supply for the future – clean and efficient*





# Greenland

## An Emerging Mineral Province

### *Politically stable democracy:*

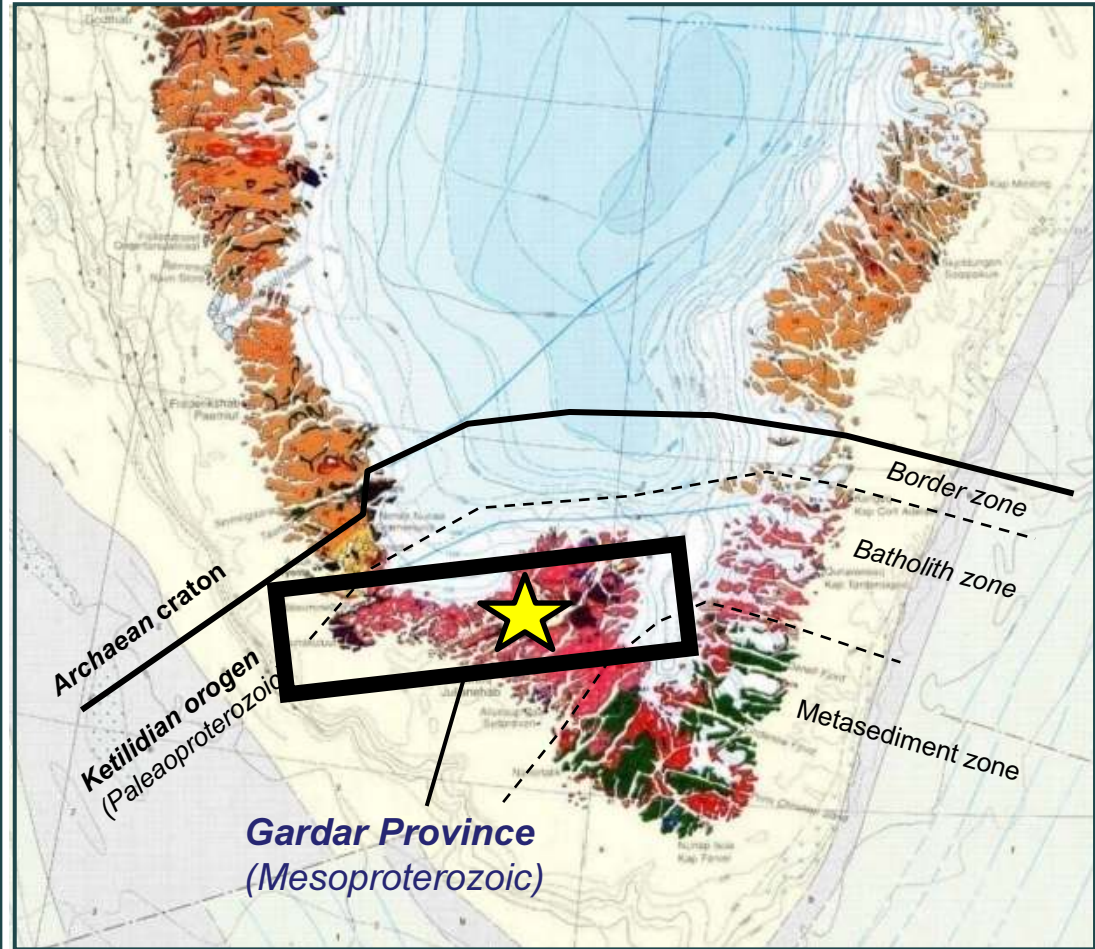
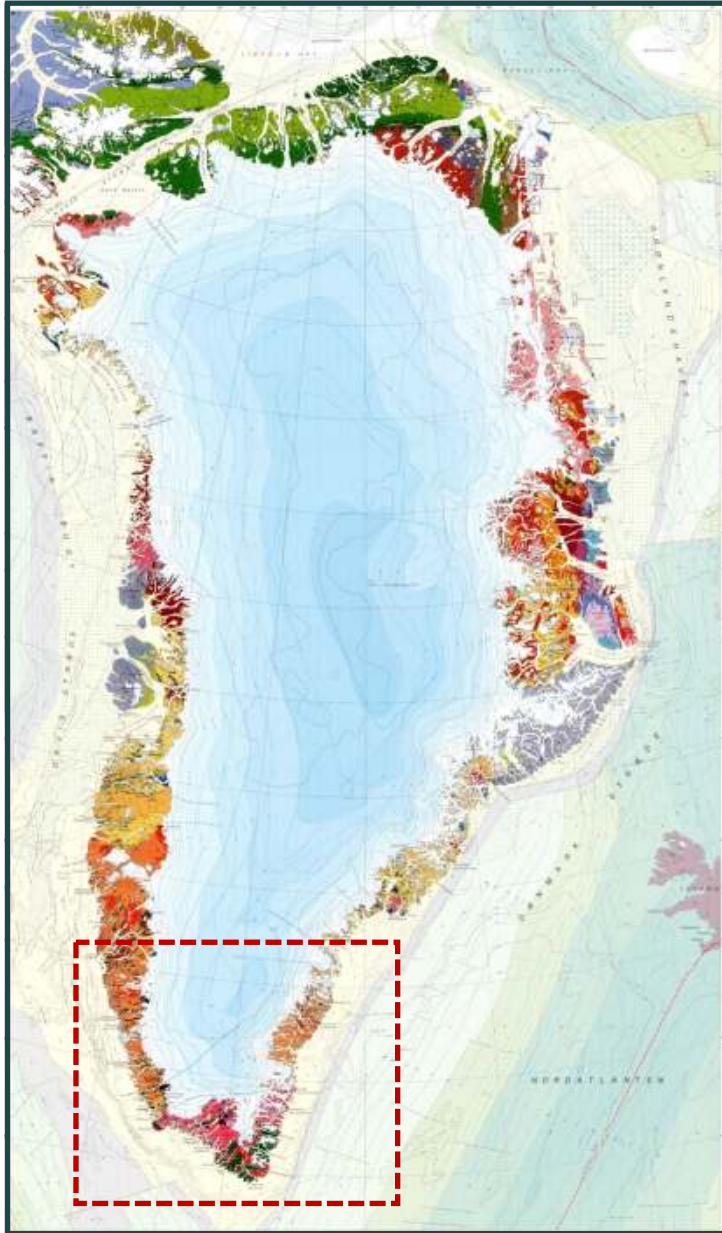
- *Autonomous constituent country within Kingdom of Denmark*
- *Increasing independence with transition from **Home Rule** to **Self Rule***
- *Pro-mining government – increased independence is dependant on establishing strong minerals and hydrocarbon industries*

### *Extremely prospective:*

- *Diverse geology exposed around coastal fringe*
- *Underexplored, yet strong geological survey, quality service providers*
- *High potential for world-class ore bodies near surface*



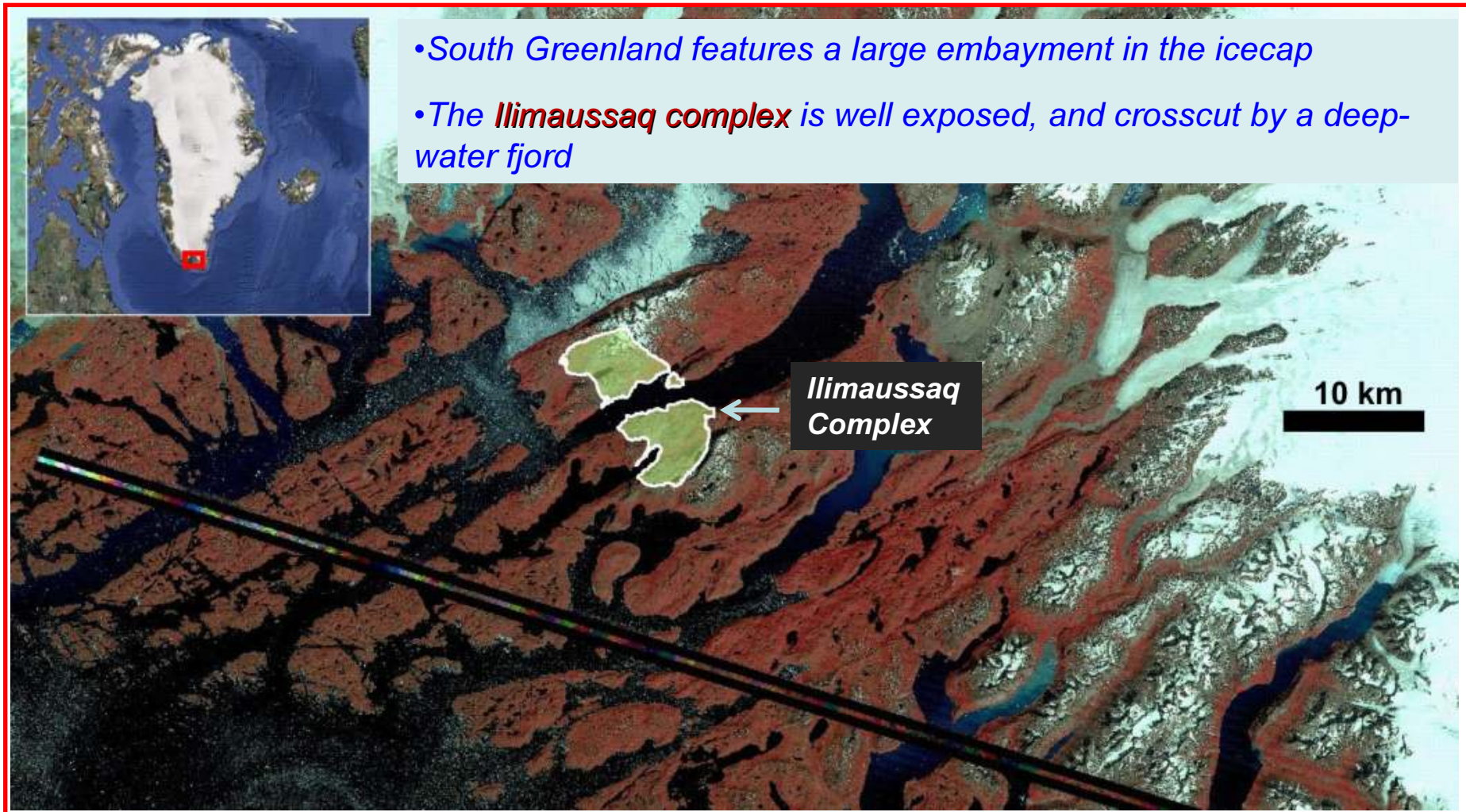
# Greenland Geology



**Gardar Province** – Alkaline intrusions emplaced in a continental rift setting (*e.g. Ilimaussaq Complex*)



# Ilimaussaq Intrusive Complex

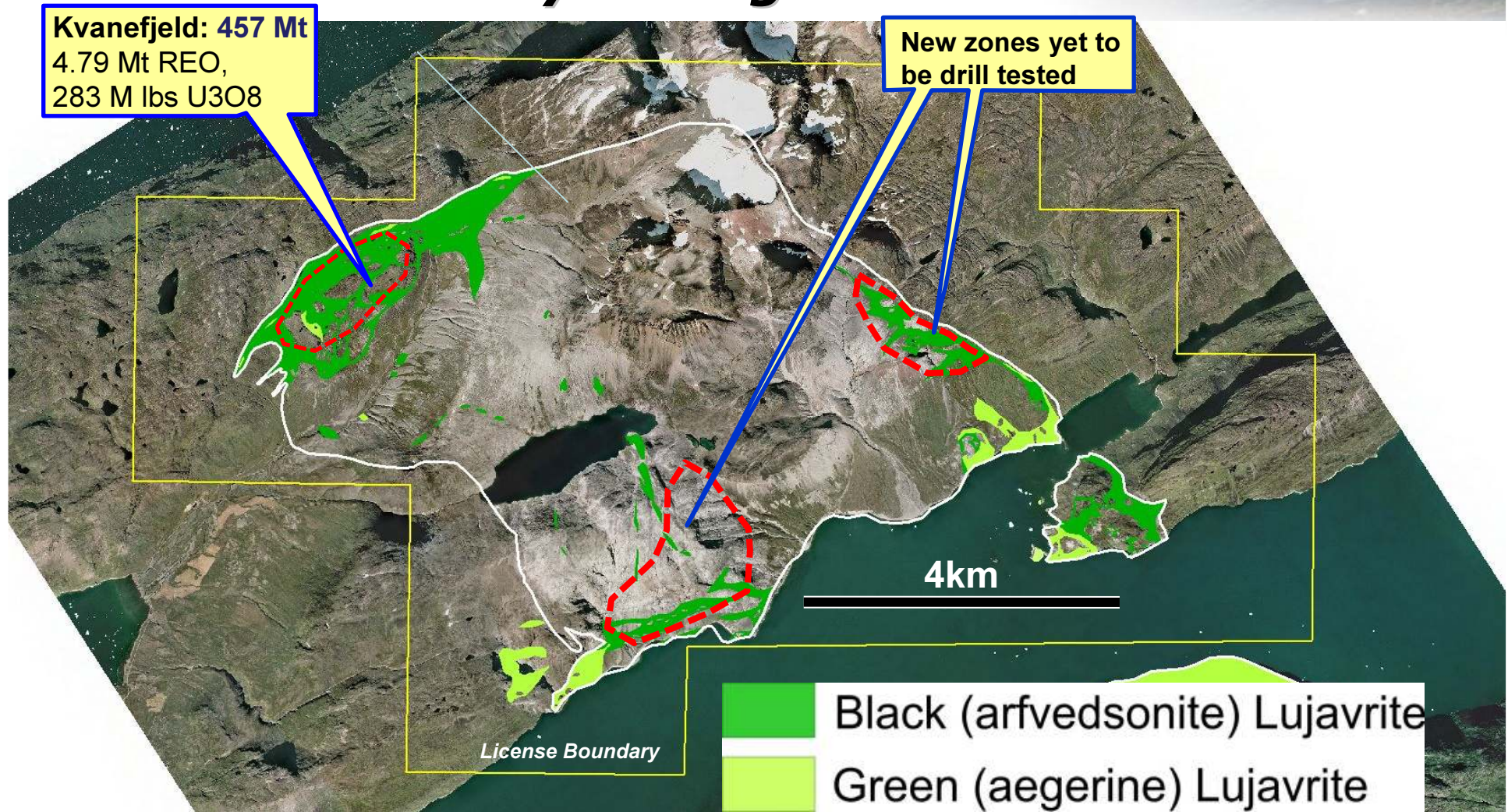


False-colour image over south Greenland



# Ilimaussaq Intrusive Complex

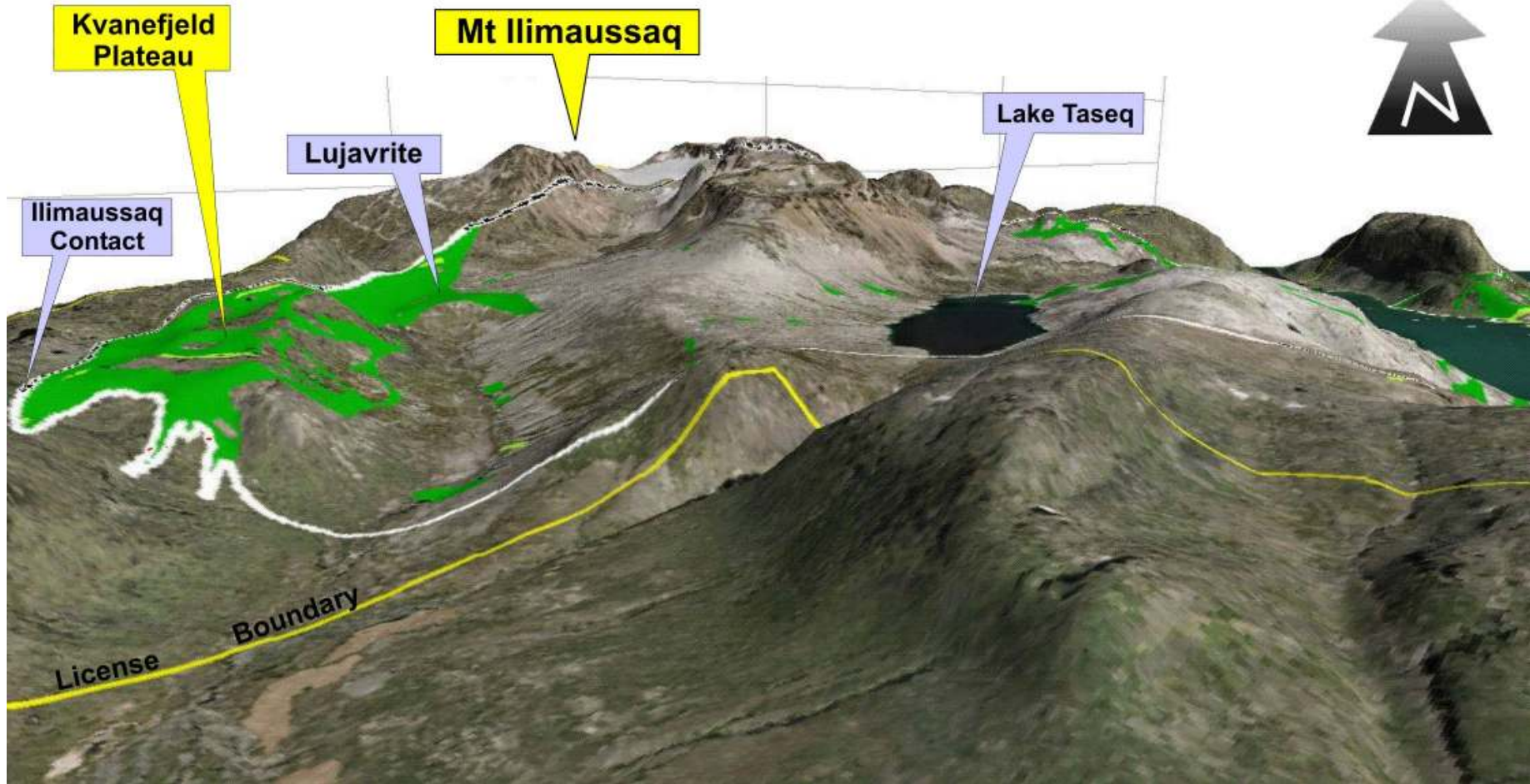
## Key Geological Units





# The Kvanefjeld Deposit

## Geography



# Kvanefjeld - Resources

At U <sub>3</sub> O <sub>8</sub> % cutoff grades <sup>1</sup>	Tonnes (million)	U <sub>3</sub> O <sub>8</sub> %	U <sub>3</sub> O <sub>8</sub> lb/t	TREO% <sup>2</sup>	Zn%	Resource category
0.015	365	0.028	0.62	1.06	0.22	Indicated
	92	0.027	0.59	1.12	0.22	Inferred
	<b>457</b>	<b>0.028</b>	<b>0.62</b>	<b>1.07</b>	<b>0.22</b>	<b>TOTAL</b>
0.020	276	0.032	0.70	1.13	0.23	Indicated
	63	0.031	0.69	1.21	0.24	Inferred
	<b>339</b>	<b>0.032</b>	<b>0.70</b>	<b>1.14</b>	<b>0.23</b>	<b>TOTAL</b>
0.025	207	0.035	0.77	1.20	0.23	Indicated
	43	0.036	0.78	1.31	0.25	Inferred
	<b>250</b>	<b>0.035</b>	<b>0.77</b>	<b>1.22</b>	<b>0.24</b>	<b>TOTAL</b>

1) Uranium cut-off grades used owing to greater assay coverage; 2) TREO = rare earth elements plus yttrium

**457 Mt Resource containing:**

**4.9 Mt TREO @ 1.07%,**

**0.99 Mt Zn @ 0.22% Zn**

**282 Mlbs U<sub>3</sub>O<sub>8</sub> @ 280 ppm U<sub>3</sub>O<sub>8</sub>**

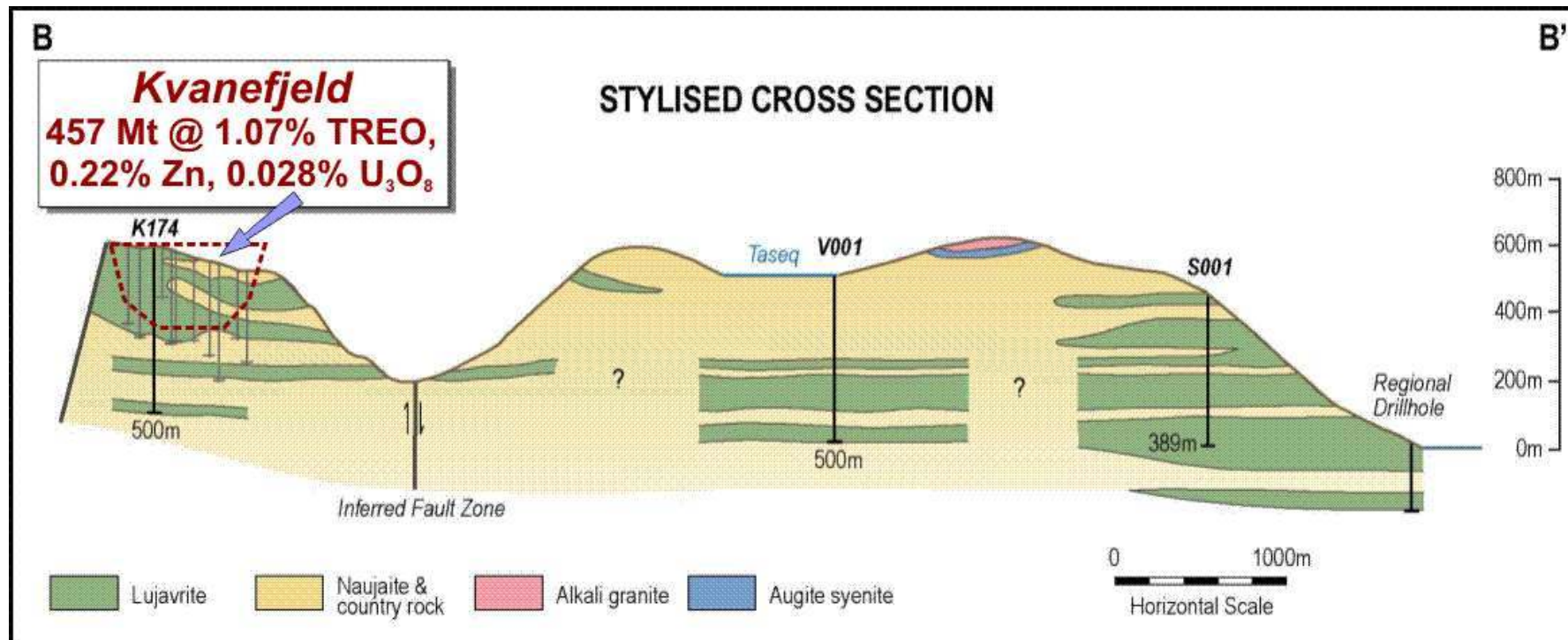
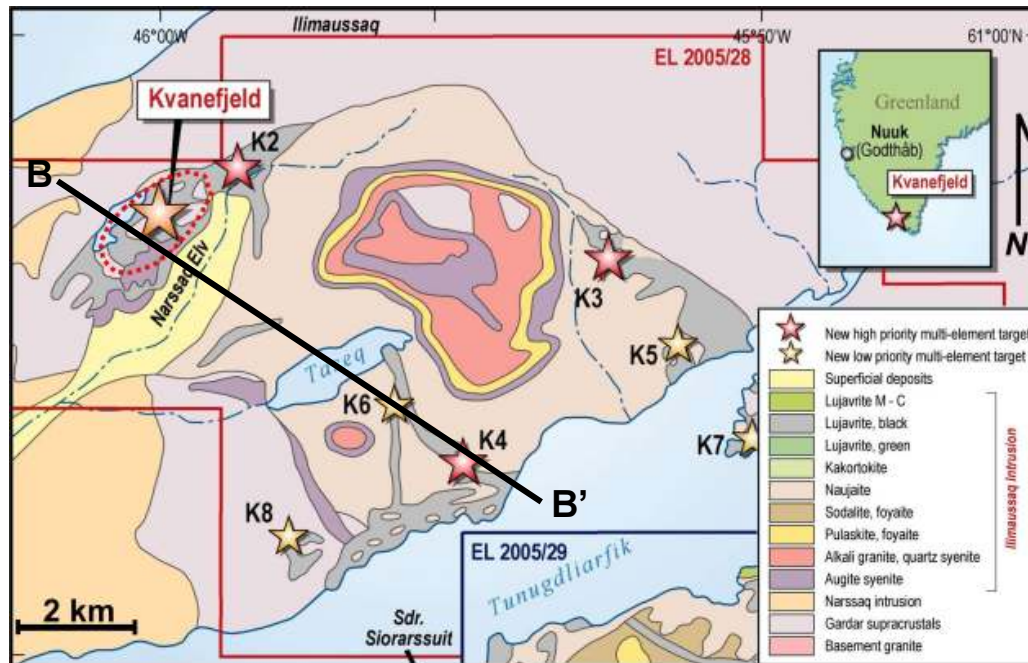
**JORC – Compliant, 79% Indicated, 21% Inferred**



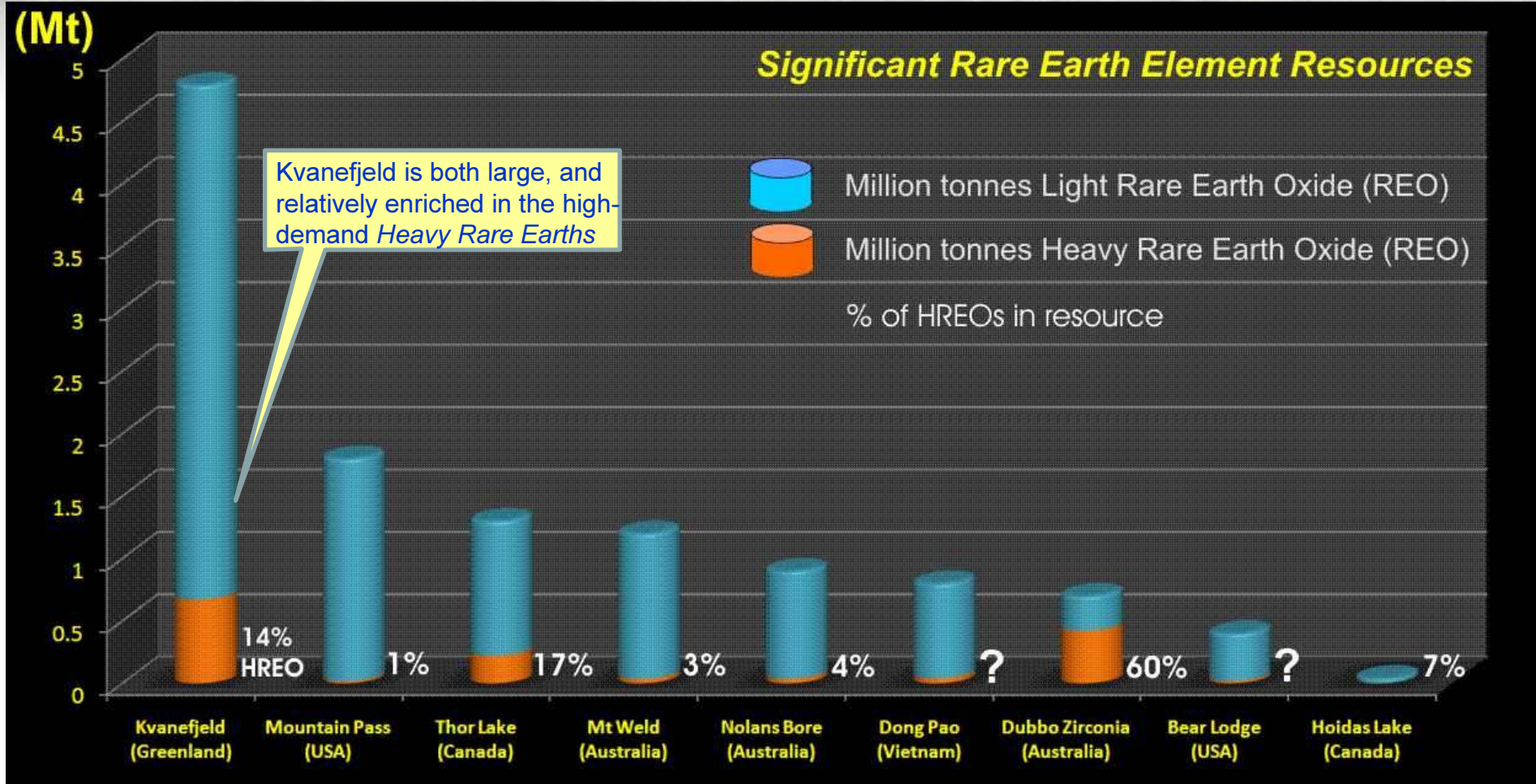
# Ilimaussaq Complex Resource Potential

Regional drill holes demonstrate huge potential for new multi-element deposits

Lujavrite – host to multi-element ores, occurs throughout the northern Ilimaussaq Complex at varying depths



# The Global Significance of the Kvanefjeld Resource

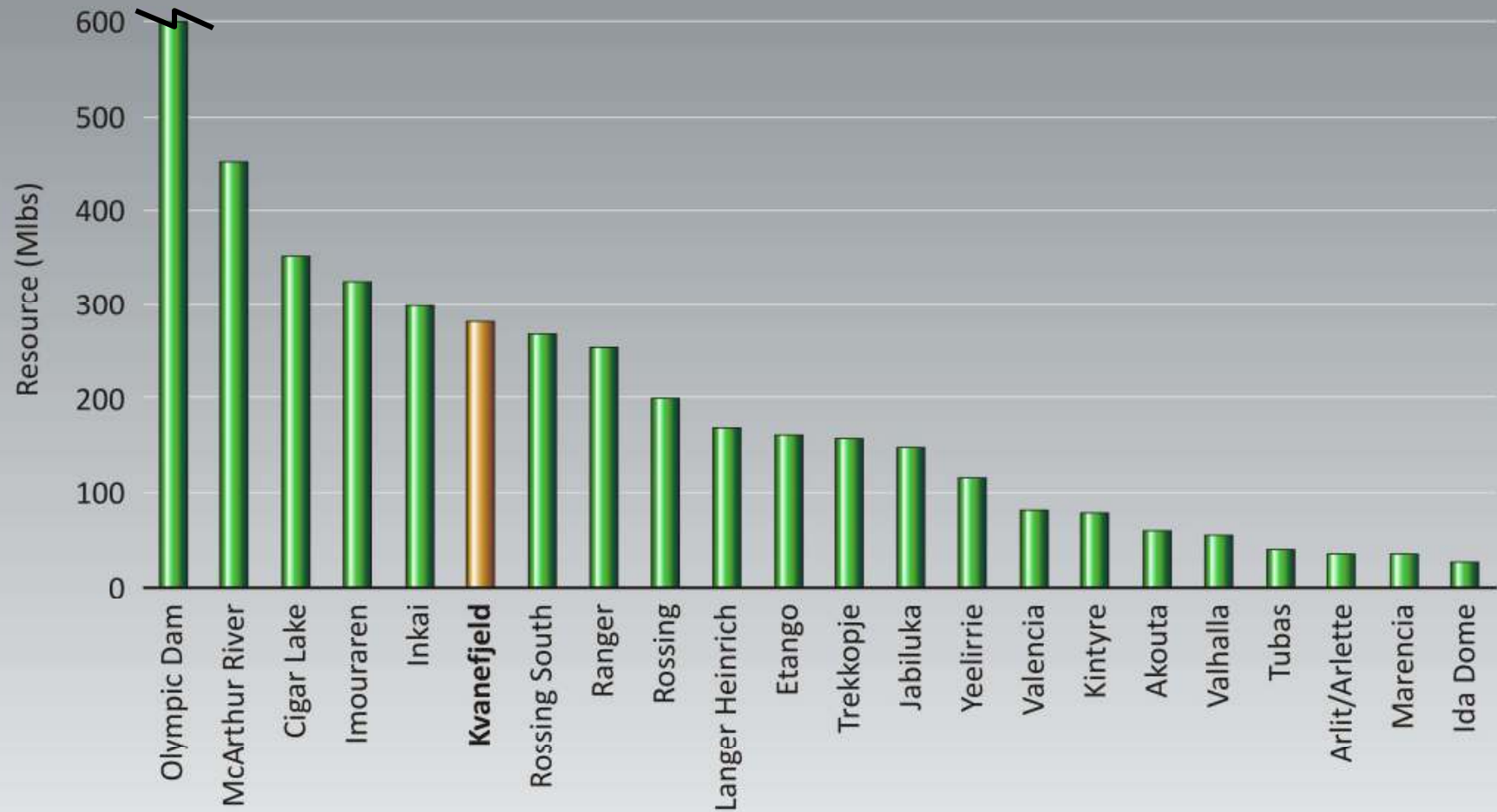


Known REE resources that are compliant by either the Australian JORC code, or Canadian National Instrument 43-101 standards. China also contains very significant REE resources but compliant figures are uncertain (Source IMCOA).



# Uranium Deposits Ranked by Size

Resource rankings of major global uranium deposits



# Kvanefjeld: Mineralogy

## Rare Minerals Found in Lujavrites at Kvanefjeld

<i>Mineral Name</i>	<i>Chemical Formula</i>
<i>Steenstrupine</i>	$\text{Na}_{14}\text{Ce}_6\text{Mn}_2\text{Fe}_2(\text{Zr, Th})(\text{Si}_6\text{O}_{18})_2(\text{PO}_4)_7(\text{OH})_2\cdot 3\text{H}_2\text{O}$
<i>Vitusite</i>	$\text{Na}_3(\text{Ce, La, Nd})(\text{PO}_4)_2$
<i>Cerite</i>	$\text{Ce}_9\text{Fe}(\text{SiO}_4)_6(\text{SiO}_3)(\text{OH})_4$
<i>Monazite</i>	$(\text{Ce, La, Nd, Th})\text{PO}_4$
<i>Eudialyte</i>	$\text{Na}_{15}\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Si}(\text{Si}_{25}\text{O}_{73})(\text{O, OH, H}_2\text{O})_3(\text{OH, Cl})_2$
<i>Uranothorite</i>	$(\text{Th, U}), \text{SiO}_4$
<i>Kapustinite</i>	$\text{Na}_{5.5}\text{Mn}_{0.25}\text{ZrSi}_6\text{O}_{16}(\text{OH})_2(\text{OH})_2$
<i>Catapleiite</i>	$\text{Na}_2\text{ZrSi}_3\text{O}_9\cdot 2\text{H}_2\text{O}$
<i>Britholite</i>	$(\text{Ce, Ca})_5(\text{SiO}_4)_3(\text{PO}_4)(\text{OH, F})$
<i>Naujakasite</i>	$\text{Na}_6(\text{Fe, Mn})\text{Al}_4\text{Si}_8\text{O}_{26}$
<i>Ussingite</i>	$\text{NaAlSi}_3\text{O}_8\text{NaOH}$
<i>Sodalite</i>	$\text{Na}_4\text{Al}_3\text{Si}_3\text{O}_{12}\text{Cl}$
<i>Villaumite</i>	$\text{NaF}$





# Metallurgical Research - Historical

- **Early test work 60's-70's**
  - *Ore beneficiation – flotation, magnetic separation*
  - *Sulphation roast batch testwork and pilot plant*
- **Carbonate Leach Route**
  - *Batch testwork, variability testing and mineralogy*
  - *Piloting at Lurgi (Lunen) - 1979*
  - *Piloting at Riso – 1981-82*
- **Riso 1883 Study**
  - *Geological Resource, Mining, Processing, Engineering, Environmental, Infrastructure, Hydropower, Socio-economic Studies*





# Metallurgical Research – 2008

- **T1 – AMDEL**
  - *Water leaching, Atmospheric leach -various lixivants, Heavy Liquid Separation, Mineralogy Studies*
  
- **T2 – AMDEL**
  - *Beneficiation –Flotation, Gravity, and Magnetic Separation*
  
- **T3 – SGS Lakefield Oretest**
  - *Beneficiation – Flotation, Sulphation roast-water digestion and Neutralisation/Precipitation*





# Metallurgical Research – 2009

- **T4 – SGS Lakefield Oretest**
  - *Beneficiation - flotation, Sulphation roast-water digestion, diagnostic leaches, REE Flotation from CPL Residues, acid leach REE concentrates, filtration/thickening tests*
  
- **T4 – CSIRO**
  - *Carbonate pressure leach variability tests*
  
- **ANSTO**
  - *Review of test work, development of flowsheet options for recovery of REE carbonate concentrate*





# Pre-Feasibility Study 2009

- **Resource definition and mine plans**
  - Coffey Mining, Hellman and Schofield
- **Metallurgy and process development**
  - AMEC Minproc, ANSTO, SGS Lakefield, CSIRO
- **Environmental baseline and EIA**
  - Coffey Environments, Orbicon (Denmark)
- **Infrastructure**
  - NIRAS (Denmark)
- **Marketing – product pricing**
  - BCC Research, IMCOA, World Nuclear Association





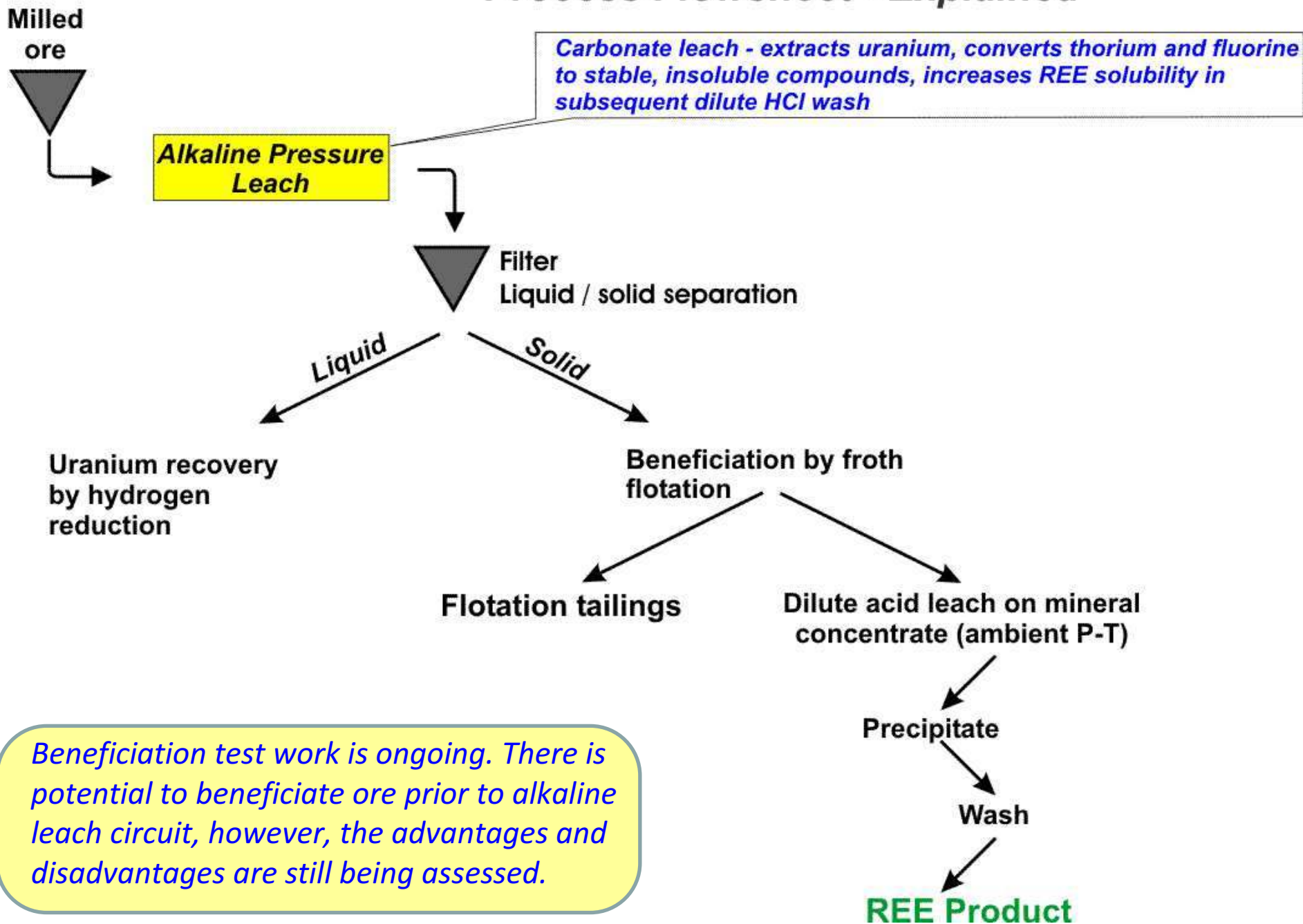
# Pre-Feasibility Study 2009

- **Initial priority:** demonstrate that REEs and uranium can be extracted economically from what is a “**new ore type**”
- Danish studies demonstrated uranium extraction via alkaline pressure leach – this concept has been refined and updated by **AMEC Minproc**
- **ANSTO** – driving REE extraction studies; developed conceptual circuit
- New process flow sheet developed to generate a **RE product** and **uranium oxide**





# Process Flowsheet - Explained



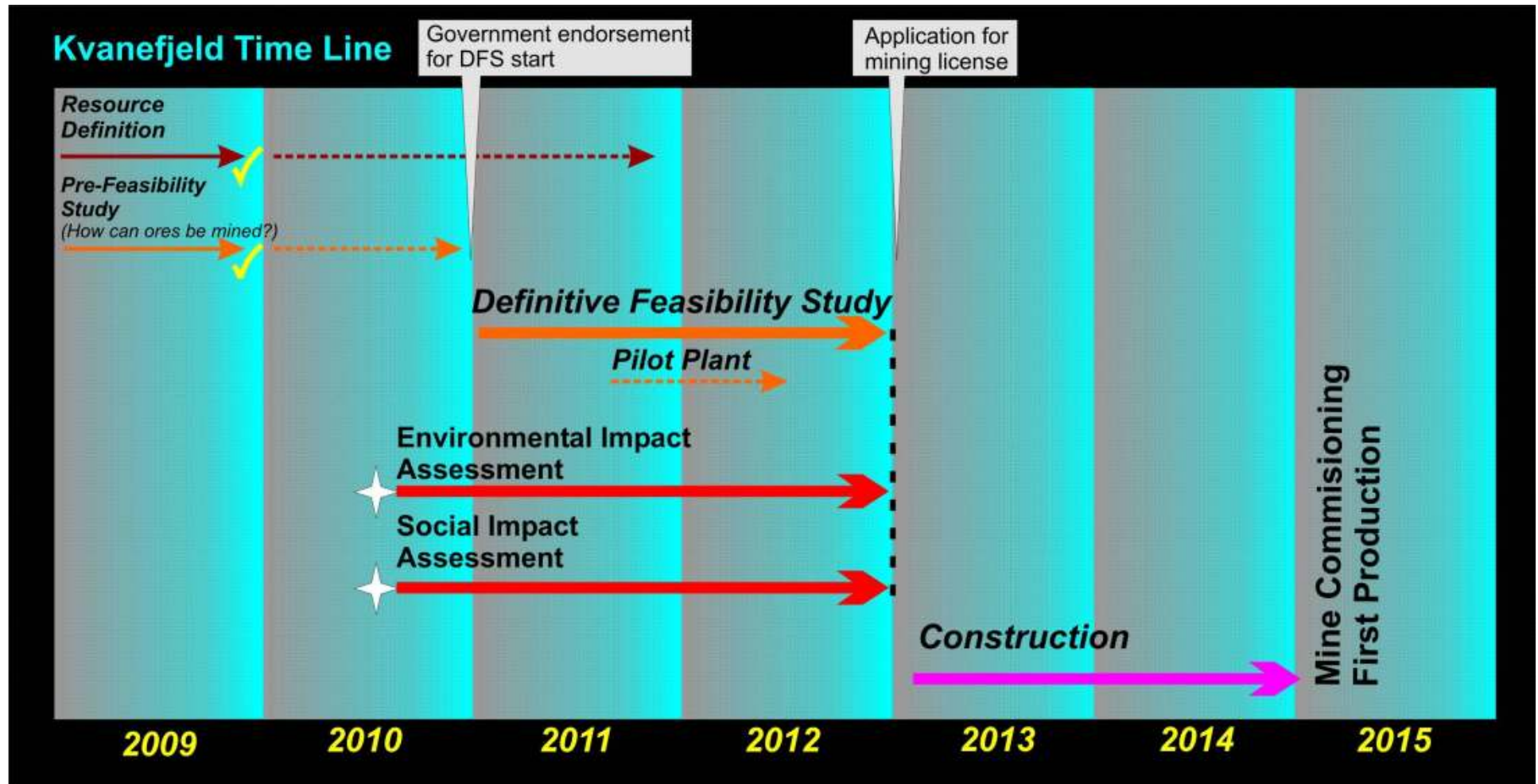


# Next Phase of Development

- **Beneficiation Studies – improve head grades**
- **Improve rare earth recoveries – currently only 34%**
- **Investigate zinc recoveries – extra product, reduce CPL costs**
- **Improve mine schedule – reduce dilution to improve grades**
- **Convert Inferred to Indicated Resources – add to mine life**
- **Define New Resources – increase both grade and mine life**



# Kvanefjeld Project Time Line





# Summary

- *Building the foundations of a **world-class mining operation** in southern Greenland*
- *Pre-feasibility study outcomes indicate potential for Kvanefjeld to become an **economically robust, large-scale producer** of RE concentrate and uranium oxide*
- *Resource is already 457 Mt, with scope to define **new large tonnage multi-element zones**, with the possibility of **improved grades***
- *Strong local **community support**, government review on uranium stance underway*





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