



North and East Greenland in focus of new exploration

The North and East Greenland ice-free country may be hiding a potential for mineral resources of world class character amongst a number of commodities. This statement is supported by the huge amount of accumulated knowledge about showings, prospects, deposits, geological environments and exploration conditions, which is the result of nearly 50 years of exploration and investigation. The information originates from large campaigns carried

out by companies with Greenland expertise like Northern Mining Company, Platinova Resources, Nuna Minerals, GEUS and a number of national and foreign universities - and is now available in the archives of GEUS.

Moving from north to south in East Greenland known major prospects are the Citronen Fjord (zinc-lead) in Palaeozoic North Greenland; Ymer Island (gold, antimony, tungsten) in Caledonian North-East Greenland; the former mine near Mestersvig (lead, zinc) in Palaeozoic-Mesozoic East Greenland;



Handling of ore and waste in high arctic Greenland, Mestersvig, East Greenland, 1956.

Standard terms for a Prospecting Licence

Minerals covered:	All minerals except hydrocarbons and radioactive elements.
Licence area:	Land areas only.
Licences period:	Five years at a time.
Non-exclusive:	The licence is non-exclusive.

Standard terms for an Exploration Licence

Minerals covered:	All minerals except hydrocarbons and radioactive elements.
Licence area:	Land areas only.
Licences period:	Five years, with the possibility of extensions up to a maximum of 16 years.
Exclusive:	The licence is exclusive.
Commitments:	Annual expenses commitments are calculated as the sum of two components:

Year	Cost* per licence	Cost* per km ²
1-2	123,400 DKK	1,234 DKK
3-5	246,800 DKK	6,170 DKK
6-10	493,600 DKK	12,340 DKK

* All prices are indexed

Special Exploration licences:

Granted in North and East Greenland for a period of three years and have a total annual exploration commitment of DKK 617 per km².

Standard terms for a Production Licence

Licence area:	Any licensee, who has delineated viable mineral deposits, is entitled to be granted a production licence.
Exclusive:	The licence is exclusive.
Licence period:	Valid for 30 years, extendable to 50 years.

Further information: Please visit the Bureau of Minerals and Petroleum's website www.bmp.gl

Milne Land (zircon, rutile, monazite) in fossil placers of the Mesozoic central East Greenland. Palaeogene intrusions with well-known mineralisations are numerous in central and southern East Greenland: Malmbjerg (molybdenum); Flammefjeld (molybdenum, silver); Skaergaard and Kap Edvard Holm (gold, PGEs). Concluding this journey South-East Greenland is known for several mineral indications in Palaeoproterozoic environments around Tasiilaq (copper, nickel, PGEs).

Large areas in North and East Greenland attractive to licensees

Greenland is actively encouraging mineral activities in North and East Greenland. A favourable three-year exploration licence, with reduced exploration commitments, is available for areas of over 1,000 km² in North and East Greenland. The total annual exploration commitment for this special exploration licence is DKK 617 (USD 80) per km². The licence is exclusive and the licence period is 3 years. In the licence period the licensee is entitled to be granted an exploration licence on regular terms. It is normally granted for five years and may be



In winter the ice-covered fjords serve as field airstrips, Citronen Fjord, North Greenland, 1995. Photo F. van der Stijl.

extended to a maximum of 16 years. Exploration commitments are expressed as expenditure obligations, which are based on the size of the licence area, and the time for which it has been held. These commitments increase with both area and time. Any exploration licensee, who delineates a viable mineral deposit, is entitled to be granted a production licence. The transition between these two licence types is described in the standard terms for exploration licences.

Logistics in East Greenland

Although East Greenland is a remote place, logistics is not an insurmountable problem. International accessibility is possible via both West Greenland and Iceland. In summer time there are daily flights from Iceland to Kulusuk and two flights a week to Constable Point in the central part of East Greenland. Helicopter charter is possible through Air Greenland and the Icelandic company Air Alpha. Air Alpha is servicing Mestersvig, Danmarkshavn and Daneborg on an all year basis.

During the summer five cargo ships from Royal Arctic Line A/S call at Tasiilaq with supplies from Denmark. The shipping season is very short for the northern part of East Greenland due to drifting pack ice. Only one cargo ship goes further north than Illoqqortoormiut (Scoresbysund) each summer.

Three companies are currently active in mineral exploration in North and East Greenland. The targets for the exploration activities are zinc/lead and PGE's. Although the operations are situated in the remote eastern part of Greenland, the harsh conditions have provided some operational advantages. In winter the ice-covered fjords serve as a supplement to the many recognised field airstrips in the central and northern parts of East Greenland.

East Greenland Case 1: Palaeogene intrusions could hide 'elephants' among known 'large tonnage-low grade' magmatic deposits

Mafic, felsic and carbonatite related intrusions are a part of the igneous suite in East Greenland, described in a comprehensive compilation of data, which is about to be released by GEUS. Despite the significant amount of geological investigation and exploration in East Greenland many of the recorded 69 intrusions and intrusives are only known in little detail. Even the main lithological variation and the age of many complexes are not well established and entire subprovinces are only known from reconnaissance investigations.

Exploration has hitherto been limited to a small number of intrusions and complexes. Two large deposits with 'elephant' potential have been studi-

ed in detail. The Skaergaard palladium deposit (18 km of drill cores) is the type locality of stratiform "Skaergaard-type" mineralisation in mafic intrusions and complexes of





False colour 'quicklook' of HyMapTM data west of Mestersvig, July 2000. Grey and brown colours are sediments, bright red colours are vegetation and ice-blue colours are glaciers. Size of field: 10 x 2.3 km.

continental rift environments. In several of other mafic intrusions along the East Greenland volcanic rifted margin sub-economic PGE mineralisations have been recorded.

The East Greenland volcanic rifted margin developed during the opening of the North Atlantic under the influence of the ancestral Icelandic mantle plume. The magmatic activity is recorded from 61 to 13 Ma. The more than 6 km thick flood basalts of the Blossville Coast formed mainly during the early stages of the magmatism



Shipping of ore concentrate from the Mestersvig harbour (Nyhavn) in 1956.

around 61 to 54 Ma. Intrusive complexes were emplaced between c. 55 to 25 Ma. Mafic intrusions are mainly emplaced between 55 and 50 Ma, whereas felsic intrusions formed over an at least 25 Ma long period after the onset of seafloor spreading in the North Atlantic.

The Malmbjerg porphyry molybdenum deposit is, as other molybdenum and vein mineralisations along the coast of East Greenland often compared to classic porphyry mineralisation of continental rifting environments. Along the East Greenland volcanic rifted margin the porphyry-type mineralisations are related to the post-rifting felsic magmatism. The felsic magmatism resulted from variable degrees of interaction between volatile and alkali enriched mafic melts and crustal material.

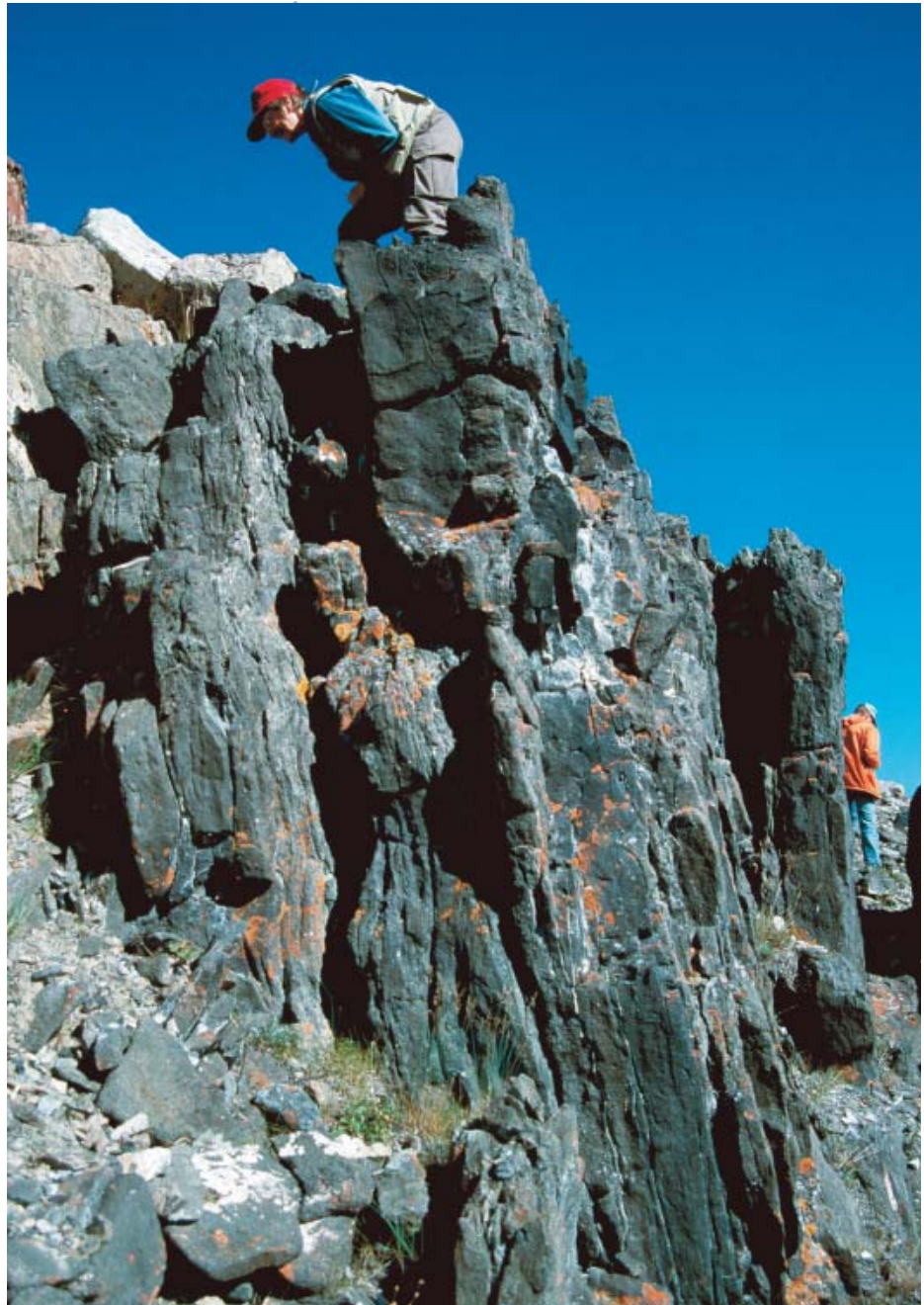
In the compilation report mentioned above the Palaeogene magmatic intrusions and complexes in East Greenland are described from north to south as 'data sheets'. The intrusions and complexes are not evenly distributed along the volcanic rifted margin. Clusters of intrusions and complexes are often referred to as 'centres' or 'districts'. The data sheets for the 69 intrusions and complexes of Palaeogene age are treated individually thus is making it convenient for explorationists to compare and use the information.

T.F.D. Nielsen (in press): Palaeogene intrusions and magmatic complexes in East Greenland, 66° to 75°N

**East Greenland Case 2:
Is a lead-zinc mine from
the past a reason for re-
newed exploration near
Blyklippen Mine, Mesters-
vig (1956-63)?**

The lead mine at Mestersvig lasted seven years with underground operations from three levels where a total of 540 000 tons of ore were removed with an ore grade average of 9.3% lead and 9.9% zinc. The ore mill and necessary installations were established at the lower underground level. When the mine was closed it was estimated that the total ore reserve was exhausted. The mine area was located about 12 km inland from the harbour, and the ore concentrate was transported by trucks on dirt roads in a short but hectic period of two months during the arctic summers. A gravel airstrip of 1650 m (5400 ft) was constructed close to the harbour area making all-year air connection with up to Hercules (C-130) size aircraft possible. Although the mining town has been largely removed since the closure, the airstrip is still navigable.

Nearly half a century has passed without active mining in the Mestersvig area; however, the place has demonstrated its suitability to host practical operations like an underground mine. The mine was barely economically viable but the technological challenge was met and the operation turned out to be a success. On top of that achievement, the established infrastructure made an intense regional exploration possible, which at the termination of the campaign in 1984 had revealed a number of prospects of a variety of commodities. More lead and zinc were reported along with deposits and showings of molybdenum, gold, tungsten, titanium and barium to mention just a few. Renewed exploration with modern methods developed through the intervening 20 years will no doubt substantially enlarge the rich potential of the area. Results from airborne hyperspectral measurements carried out on selected areas in 2000 are soon to be released from GEUS – with new information on possible extensions of the potential reserves in the old mine area, as one of the interesting indications.



Outcrop of the contact zone of a 20 m wide kimberlitic dyke near Kangerlussuaq airport. This dyke is one of the largest known kimberlitic dykes in the world!

**Diamond exploration in West
Greenland continues with new
views on distribution of kimberlitic
dyke rocks – broad analytical cam-
paign planned to be next step**

The GEUS initiative on mapping the kimberlitic rocks in West Greenland (MINEX 22) was continued in 2002 with fieldwork in the region of Sisimiut-Kangerlussuaq. Results from the 2001 campaign has just been released in an article published in the *Geology of Greenland Survey Bulletin 191* (see later paragraph). More reports on the distribution and magnetic signature of kimberlitic dykes are due for presentation at the 8th International Kimberlite Conference in Victoria, B.C. in June 2003. The



joint BMP and GEUS compilation of released company data from earlier diamond exploration (announced in MINEX 22) will be ready during spring 2003 and ready for distribution at the Victoria kimberlite conference. GEUS and BMP continue to give attention to the work on kimberlitic rocks and a broad analytical program will be a part of the 2003 campaign.

S.M. Jensen, H. Hansen, K. Secher, A. Steenfelt, F. Schjøth & T.M. Rasmussen 2002: Kimberlites and other ultramafic alkaline rocks in the Sisimiut–Kangerlussuaq region, southern West Greenland. Geology of Greenland Survey Bulletin 191, 57–66.

The Nalunaq gold mine – likely to be a reality in Greenland mining history

In a press release (18 November 2002) Crew Development Corporation (Crew), President and CEO Jan A. Vestrum, announces that the company is in the final stages of planning the commencement of production from the Nalunaq Gold Mine. Nalunaq has an existing stockpile containing approximately 28,000 oz of gold. Mine construction is expected to start in the first half of 2003, and the economics of the operation are considered to be



The aircraft used for the hyperspectral survey 2002 in Kangerlussuaq airport, West Greenland.

robust. The average annual production is projected to be 90,000 oz at a cash operating cost of USD \$168 per oz, based on an average ore production of 350 tonnes per day. Assuming all the necessary permits are received as anticipated, Nalunaq should start production during 2003.

Drilling and exploration at the Sarfartoq niobium deposit to continue 2003

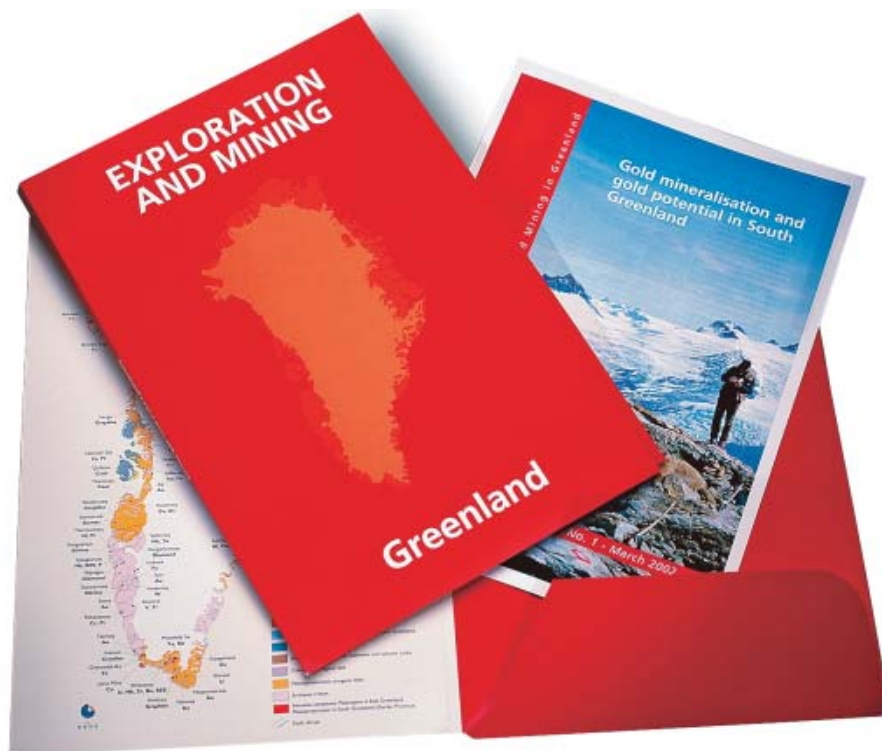
In July 2002, New Millennium N.L. embarked on an extensive exploration programme at its Sarfartoq tenement. The geological program was a success it is stated by the company. The Sarfartoq site was mapped in detail and two additional pyrochlore occurrences labelled SU 2 and SU 2.5 were identified, located in close proximity to the main occurrence SU 1. Systematic geological mapping and rock chip sampling of SU 2 and SU 2.5 has highlighted significant extensions to the pyrochlore occurrences. The rock chip assays have, according to the company, returned values of 38.8% and 48.0% Nb₂O₅ at SU 2 and SU 2.5 respectively. The other known pyrochlore occurrence at SU 25 was increased in size and significant rock chip assays returned values of 16.2% Nb₂O₅. The additional deposits are located in close proximity to the main occurrence (SU 1). The SU 2 occurrence is significant and has a strike length of 200 m as reported in the Directors' report of the 2002 Annual Report from the company.

Whilst the drilling program in 2002 was not as successful as hoped for, due to mechanical commissioning problems, the drilling will commence in the first week of June 2003 as soon as the water line starts to flow.

HyperGreen 2002 – fieldwork and first results

During the summer of 2002, HyVista carried out a new hyperspectral survey in central West Greenland under a contract with BMP. GEUS manages the project and handles the supporting fieldwork, in which also partners from Finland and Germany participated. The survey operations

were based in Kangerlussuaq and were primarily directed towards the kimberlite province in the area. Due to unusually bad weather during the campaign, the flying had to be done where and when cloud cover allowed it, and as a consequence, the subsequent processing of the strongly segmented data have been difficult and time consuming. However, the first results are now emerging. The data are expected to be released in March 2003 at the PDAC in Toronto where examples of data and their interpretation will be presented. The project also encompassed spectral measurements on the ground and in the laboratory. It is the plan to present some of the more interesting scientific results at the 8th International Kimberlite Conference in Victoria, B.C. in June 2003.



Useful reading... 'Review of Greenland activities 2001' just from the printing office

The annual Review of Greenland activities is a special bulletin. It contains articles on activities carried out in 2001 written in a style that enables other than professionals to get an all-round impression of recent georesearch.



Geology of Greenland Survey Bulletin 191, 2002: Review of Greenland activities 2001, 161 pages.

New formats of information material introduced – the series “Geology & Ore” and Fact Sheets display current topics related to ‘Greenland exploration and mining’

New publication series with favourite subjects from the world of ‘Greenland exploration and mining’ have been presented to the public at the PDAC show in Toronto this spring, and in Australia at the D&D. A constant request for condensed reviews and assessments within the framework of economic geology in Greenland has for some time been put forward to GEUS and BMP. To meet some of these requests a new suite of publications has been initiated. ‘Geology & Ore’ is a publication introducing a compilation of knowledge and data to non-scientific readers, and ‘Fact Sheets’ are data sheets only presenting headlines of a theme. The topics in the publications will also be subjects for general exhibition material at conferences and trade shows e.g. with scientific accounts and power point presentations. Further publications are planned for spring 2003 and by the end of 2002 the following themes have been issued:

Geology & Ore No.1: Gold mineralisation and gold potential in South Greenland, 12 pages

Fact Sheet No.1: Gold mineralisation and gold potential in South Greenland, 2 pages

Fact Sheet No.2: Early mining activities in South Greenland, 2 pages

Fact Sheet No.3: Deposits of speciality metals in South Greenland, 2 pages



Mail to:

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Paper of the year – Greenland economic geology highlighted in IMM award

GEUS researcher from the Department of Economic Geology, geochemist Agnete Steenfelt, has been awarded the Wardell-Armstrong Prize 2000 for the best paper published in The Institution of Mining and Metallurgy, Transactions Section B, Applied Earth Science in 2000. The paper was one of a series of papers on Greenland accumulated in a special volume of the series: "Exploration in Greenland - discoveries of the 1990s".

The awarded paper: 'Geochemical signatures of gold provinces in South Greenland', examines the locations of many gold occurrences in South Greenland in relation to regional geochemical distribution patterns as recorded by stream sediment data. The spatial relationships of selected elements are used to demonstrate coinciding anomalies of As, Sb, Au, Cs and Sc used as a prospectivity criterion for epigenetic gold mineralisation in the Ketilidian orogen. Concluding the paper a multi-stage model for the gold mineralisation is proposed, according to which a first-stage concentration of gold and pathfinder elements in the Palaeoproterozoic Ketilidian sedimentary basin was followed by late-stage remobilization of these elements as a result of late- to post- granite magmatism of Ketilidian age.

Agnete Steenfelt 2000: Geochemical signatures of gold provinces in South Greenland. Transactions of the Institution of Mining and Metallurgy, Section B, Applied Earth Science vol. 109, 14-22.

GEUS now a part of the new 'centre of excellence': GEOCENTER COPENHAGEN

In May and June 2002 GEUS moved from the premises at Thoravej to the newly established 'Geocenter Copenhagen',



'Geocenter Copenhagen', new premises for GEUS from May 2002.

hagen', located at Øster Voldgade not far from the old city of Copenhagen. 'Geocenter Copenhagen' is a formalised co-operation between five independent institutions: Geological Survey of Denmark and Greenland (GEUS), Danish Lithosphere Centre (DLC), and the University of Copenhagen institutions: Geological Institute, Geographical Institute and Geological Museum. The aim of the Geocenter is to become a focus of geoscientific research, education, consulting and publishing at high international levels. To all our users from the national and the international world the closer co-operation is believed to be an advantage. Please note that although the postal address has been changed, all telephone/fax numbers and e-mail addresses remain the same.

GEUS, Øster Voldgade 10, DK 1350-Copenhagen K, Denmark; www.geus.dk.

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GEOLOGICAL SURVEY OF DENMARK AND GREENLAND (GEUS)

Øster Voldgade 10 · DK-1350 Copenhagen K · Denmark

Tel: +45 38 14 20 00 · Fax: +45 38 14 20 50 · e-mail: minex@geus.dk · homepage: www.geus.dk

BUREAU OF MINERALS AND PETROLEUM (BMP)

Government of Greenland · P.O. Box 930 · DK-3900 Nuuk · Greenland

Tel: +299 34 68 00 · Fax: +299 32 43 02 · e-mail: bmp@gh.gl · homepage: www.bmp.gl

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