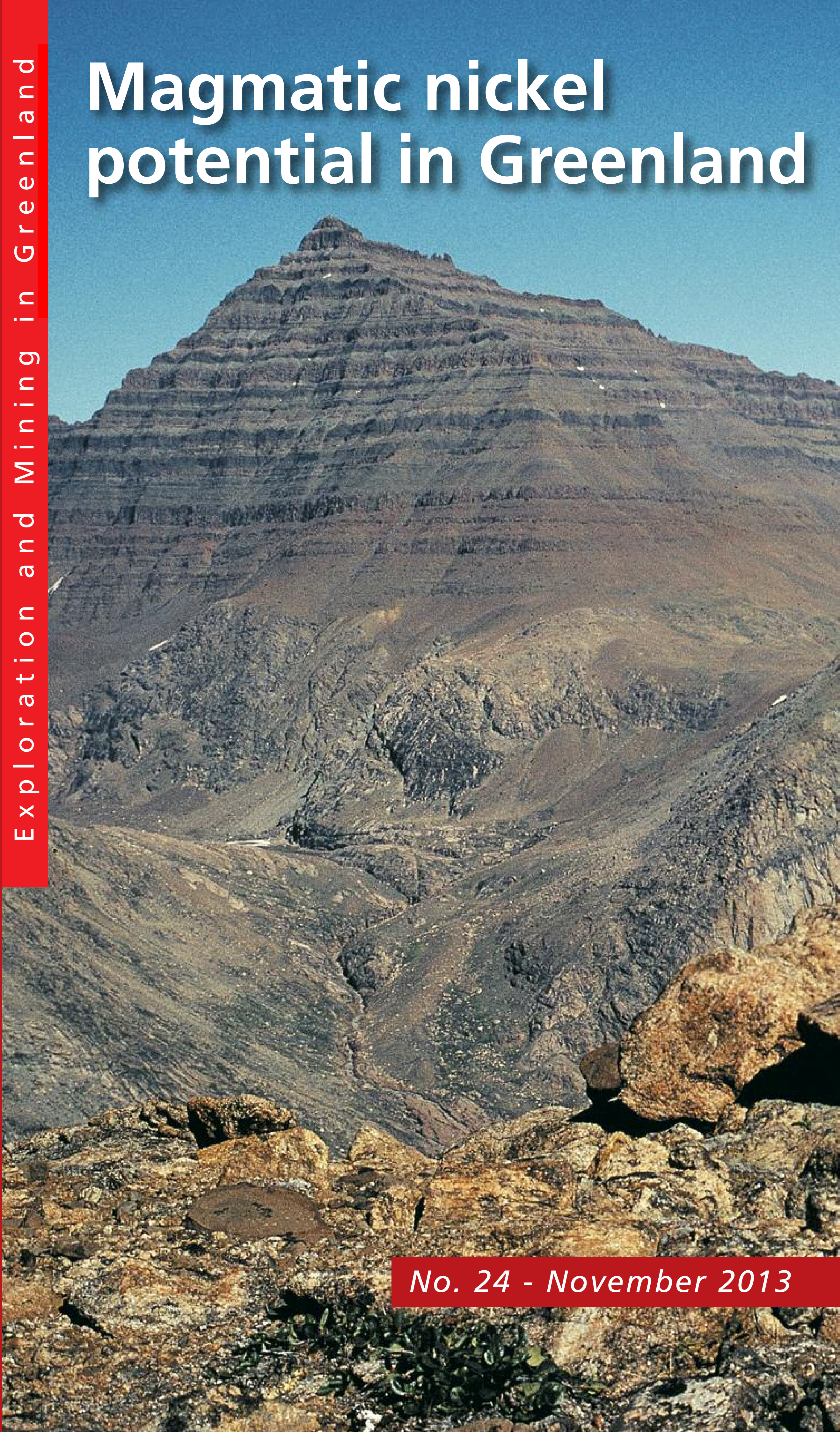
GEOLOGY AND ORE

Exploration and Mining in Greenland

Magmatic nickel potential in Greenland



No. 24 - November 2013

Magmatic nickel potential in Greenland

A workshop on the 'Assessment of the nickel potential in Greenland' was arranged by the Geological Survey of Denmark and Greenland (GEUS) and the former Bureau of Minerals and Petroleum (BMP) on 27–29 November 2012. The purpose of the workshop was to assess magmatic komatiite-hosted, conduit- and contact-type nickel deposits, and also to assess the possible presence of undiscovered nickel deposits in Greenland in the uppermost part of the Earth's crust and to rank the most prospective areas. The procedures for the assessment and ranking of the individual tracts were designed to comply, as much as possible, with the 'Global Mineral Resource Assessment Project' (GMRAP) procedures defined by the U.S. Geological Survey (USGS).

Picrite lavas of the Vaigat Formation, Nuussuaq, central West Greenland. The formation consists of olivine-rich mainly picritic lavas with a thickness of up to more than 5 km and an average thickness of 1 km. Their extent is 22,000 km2. In parts the formation is crustally contaminated. Photo: L. M. Larsen

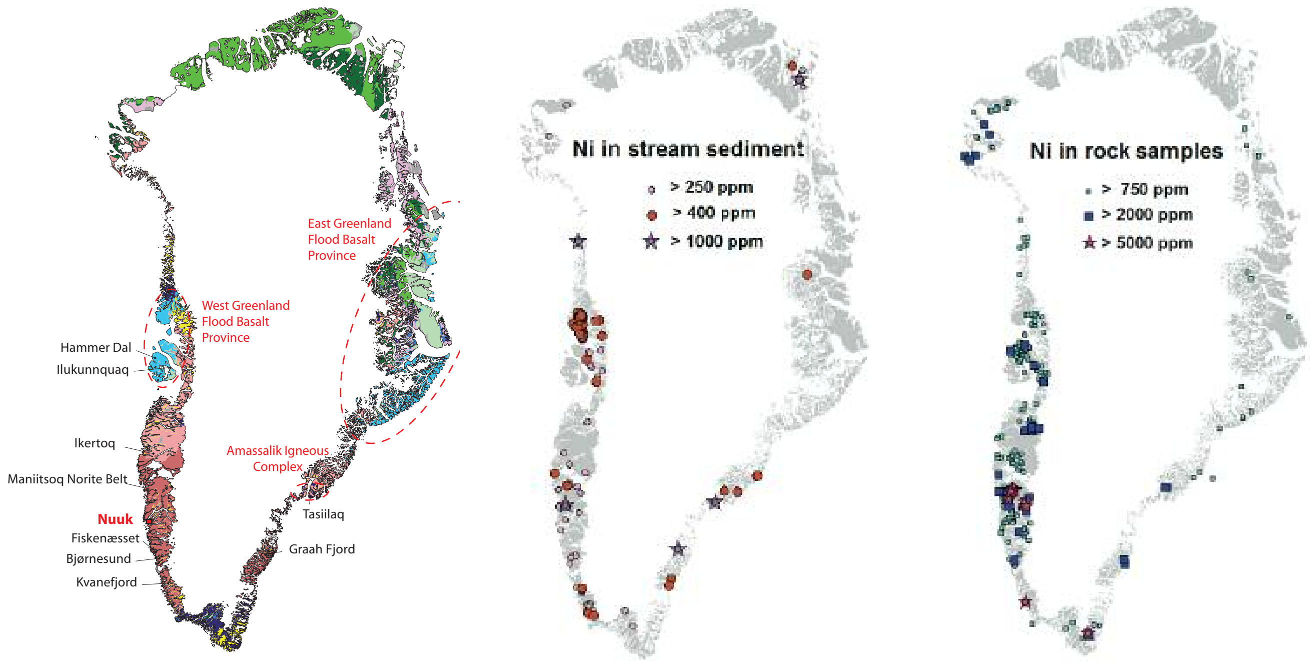
This edition of Geology and Ore highlights some of the results from the workshop, including descriptions of the most important nickel provinces in Greenland, their known mineralisations and the resulting potential for undiscovered nickel deposits within these provinces. A more comprehensive GEUS survey report documenting the results from the workshop has been published in the GEUS report series (Rosa *et al.* 2013).

The methodology applied

The evaluation of the potential for undiscovered magmatic nickel deposits in Greenland was carried out according to the standardised process utilised in the GMRAP. In this process, an assessment panel of experts discuss all available knowledge and data for a specific area (tract) and assess the possibility of finding new undiscovered deposits within this tract. The assessment panel constituted nineteen geologists from the USGS, GEUS, the former BMP, University of Aarhus and private exploration companies; each with specific knowledge on aspects of Greenlandic geology and/or expertise in nickel deposits. Each tract was defined from the surface to 1 km depth (1.5 km for the conduit-type). The members of the assessment team made their individual estimates (bids) of the number of deposits of a specific size and grade they believed could be found and mined in a specific tract. A panel discussion of the bids led to a consensus bid, which was used as input to a statistical simulation. The result was a grade-tonnage estimate (prediction) of how much undiscovered ore and metal could be found within a tract under the best circumstances. The consensus bids and predicted number of undiscovered nickel deposits per tract are shown on page 5, 8 and 10.

Deposit type	Tonnage ore metric tons	Nickel grade per cent	Copper grade per cent	Number of deposits
Komatiite -hosted Peridotite -subtype	2.8	3.14	low	51
Komatiite -hosted Dunite -subtype	148	0.69	low	7
Contact-type	62	1.00	0.64	55
Contact-type	206	0.19	0.26	37

Worldwide summary statistics for the mean tonnage and grade for the komatiite-hosted, conduit and contact nickel deposits. Based on data from Barnes (2006), Schulz et al. (2010) and Zientek (2012). Data extracted from Zientek's (2012) workshop presentation (see Rosa et al. 2013).



Left: *Simplified geological map indicating main lithostratigraphic environments and favorable nickel tract localities in Greenland.* **Middle and right:** *Stream sediment and rock sample localities with nickel values higher than 250 ppm. From Steenfelt's (2012) workshop presentation (see Rosa et al. 2013).*

Types of nickel mineralisation

It was agreed before the workshop to use the following three deposit types as they account for most of the world's known reserves of nickel:

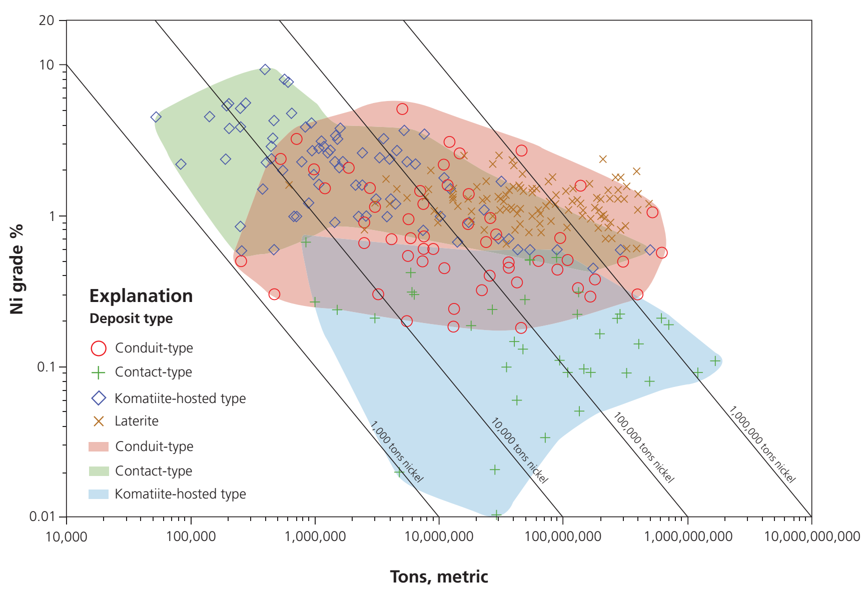
- Komatiite-hosted deposits
- Conduit-type deposits
- Contact-type deposits

Descriptive characteristics of the three known deposit types (referred to as a mineral deposit model) were used together with a broader-scaled mineralising system approach to set up the targeting-elements that should be evaluated.

Each type of nickel mineralisation is associated with a grade/tonnage model that is obtained through a compilation of global grade and tonnage data from known deposits that have been formed through the same genetic process and can be mined and processed using similar methods. The grade/tonnage models are used as input for the estimation of undiscovered nickel deposits for the different tract and deposit models.

Komatiite-hosted deposits

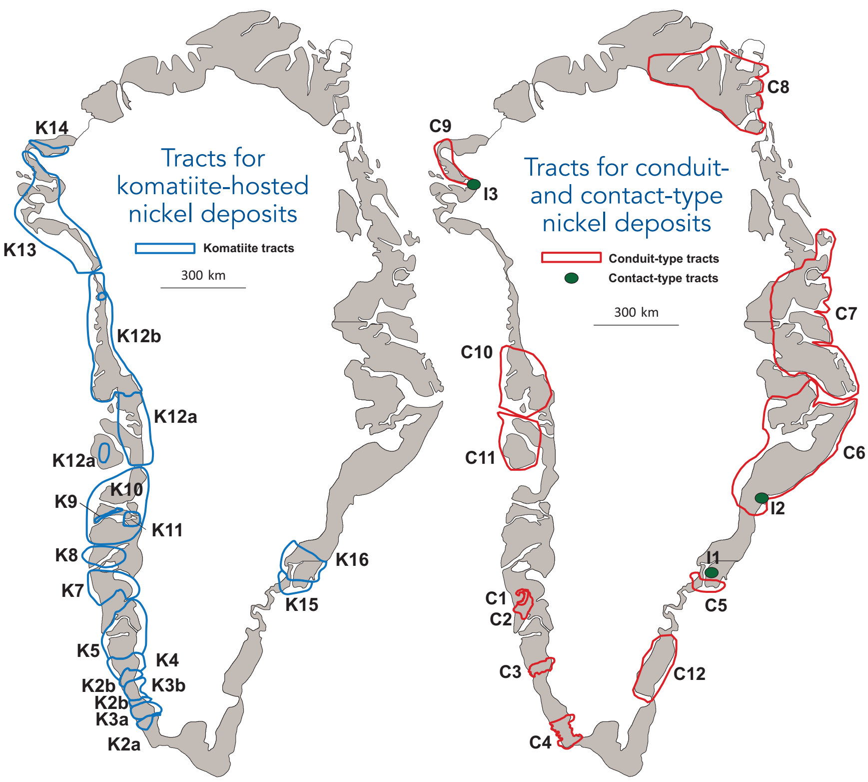
This type corresponds to the more extrusive settings of the magmatic continuum and is therefore hosted by extrusive volcanic rocks. Traditionally, this type has been divided into two subtypes, according to their host-rock and corresponding facies of the volcanic flow system. Subtype 1 (or peridotite-type) deposits, related to komatiite lava flows, in more distal settings of the volcanic flow-system, and type 2 (or dunite-type) deposits, related to dunite bodies, in more proximal settings. Komatiite-hosted magmatic nickel deposits tend to be of higher grade, yet lower tonnage, and are typified by the Kambalda deposits of Western Australia.



Grade and tonnage for the different assessed mineral deposit types. Modified from Zientek's (2012) workshop presentation (see Rosa et al. 2013).

Scale	Source	Active Pathway	S saturation (chemical)	Trap (physical)
District	**Critial** • High degree partial melts • Major metallogenic epoch	• Lithospheric architecture • Paleocraton margins		
Camp		• Synvolcanic crustal architecture	• Magmatic sulphides • Chalcophile enrichment	• Olivine-rich cumulate
Prospect	**Less relevant**			• Channels and channel size • Amygdaloidal flows • Structural complexity

Targeting elements for komatiite-hosted, nickel-copper sulphide mineral systems. The relative importance of targeting elements at various scales is denoted by box colour: red = critical, green = less relevant. Especially the elements in the district and camp scale are relevant for the assessed tract sizes. S = sulphur. Modified from McCauig et al. (2010).



The areas (tracts) used for the nickel assessment workshop.
More information about the individual tracts can be found in the tables included on page 5, 8, 10.

Conduit-type deposits

This deposit type typically has grades and tonnages that are intermediate between the komatiite-hosted type (high grade, low tonnage) and the contact-type deposits (low grade, high tonnage). Most of the global nickel production can be accounted for by this type. It includes deposits with the largest total nickel resource, among the magmatic nickel deposits, with giants such as Norilsk and Pechenga (Russia), Jinchuan (China) and Voisey's Bay (Canada). The deposits of Sudbury (Canada) can also be considered to belong to this type; although a unique meteorite, impact-related melt sheet has been proposed to be related to their emplacement (Naldrett 2004). For this reason, the Sudbury-type is not part of the grade/tonnage model for the conduit-type.

This deposit type is associated with hypabyssal dykes or sills that are associated with large volumes of mafic magmatism (such as a continental flood basalt province). This style of mineralisation is also called conduit-type, a genetic name indicating that these deposits form in conduits in large magmatic systems. Since the amount of metal in the deposits cannot be derived from the limited volume of mafic melt in the associated intrusion this implies that some type of open system, with a large throughput of energy and matter, was present. The presence of such an open system can be recognised by the existence of bulk compositions which are not those of liquids and by the evidence for excess heat (thermal erosion and wide contact metamorphism aureoles). This means that nickel is effectively scavenged from streaming magma, through sulphide immiscibility driven by the assimilation with crustal sulphur.

Contact-type deposits

In contrast to the komatiite-hosted deposits, contact-type nickel deposits tend to be of lower grade but higher tonnage. These deposits also have important PGE contents, and are mined mostly for these elements. This type corresponds to the

Summary of consensus bids from the nickel assessment workshop on the number of undiscovered komatiite-hosted nickel deposits in Greenland.

Name	Tract no.	Areal extent [km^2]	Consensus bid on number of undiscovered nickel deposits at different confidence levels					Statistical calculation of:			Rank
			N90	N50	N10	N5	N1	Number of unknown deposits	Deposit density	Mean estimate of undiscovered nickel resources [metric tons]	
Taartoq	K2a	380	0	0	0	2	2	0.15	0.00034	9,200	5
Bjørnesund & Kvanefjord	K2b	560	0	0	1	2	3	0.41	0.00073	22,000	3
Paamiut S	K3a	932	0	0	0	1	2	0.11	0.00011	6,200	8
Paamiut N	K3b	220	0	0	0	0	2	0.06	0.00027	4,300	14
Fiskenæsset	K4	463	0	0	0	0	1	0.03	0.000065	2,100	15
Nuuk - Akia	K5	2535	0	0	2	3	4	0.71	0.00028	43,000	2
Maniitsoq E	K7	886	0	0	0	1	2	0.11	0.00012	5,900	11
Ikertoq	K8	263	0	1	3	3	5	1.40	0.00532	79,000	1
Nordre Strømfjord	K9	169	0	0	0	1	2	0.11	0.00062	6,000	10
Sisimiut – Illulissat	K10	2796	0	0	0	1	2	0.11	0.000038	6,800	7
Inner Nordre Strømfjord	K11	75	0	0	0	0	1	0.03	0.00040	2,100	14
Eqi – Disko - Kullorsuaq	K12a	960	0	0	0	1	2	0.11	0.00011	6,800	6
Karrat Group	K12b	20	0	0	0	1	2	0.11	0.00580	6,100	9
Melville Bugt	K13	734	0	0	0	0	1	0.03	0.000041	1,800	16
Inglefield Land	K14	137	0	0	0	1	2	0.11	0.00077	5,400	13
Tasiilaq contact halo	K15	1040	0	0	1	1	3	0.36	0.00034	21,000	4
Tasiilaq North	K16	1550	0	0	0	1	2	0.11	0.000068	5,700	12

N90, N50, N10, N05, N01 = Confidence levels; a measure of how reliable a statistical result is, expressed as a percentage that indicates the probability of the result being correct. A confidence level of 10% (N10) means that there is a probability of 10% that the result is reliable.

intrusive settings of the magmatic continuum and is therefore hosted by plutonic rocks. The plutonic rocks are mafic to ultramafic and typically magmatically layered. Immiscible sulphide, which collects nickel, as well as other chalcophile elements such as copper and PGE, is formed as the result of fractional crystallisation, magma mixing, assimilation of sulphur or contamination leading to increase in silica content. The nickel-copper-PGE-enriched sulphides subsequently form disseminated, net-textured and massive sulphide concentrations, hosted by igneous rocks and country rocks, near the lower part or the margin of the layered intrusion. Irregular distribution of the sulphide concentrations in this deposit type makes it hard to establish volumes that are large enough to be mined and for this reason only the Platinum reef in the Bushveld complex has been mined to date. In order to identify intrusions with a potential for nickel prior to the workshop, a stepwise filtering of an existing database of intrusions in Greenland was carried out. Since the workshop was focused on nickel, intrusions with

Detailed saw-channel sampling of the dunite-dominated ultramafic sills at Ikertoq in West Greenland. Photo: 21st North.

Typical weathered rusty boulder with disseminated and net-veined Ni-Cu-Co sulphides as they appear within dunite-dominated ultramafic sills at Ikertoq in West Greenland. Photo: 21st North.

potential for copper over nickel, and likewise PGE over nickel (stratiform, reef-like mineralisation), were filtered out during the evaluation. Step 1 in the filtering extracted all mafic and ultramafic intrusive complexes with peridotites, norites, mafic gabbros and Mg-rich diorites (because Ni and Pt are lost during fractionation) and the individual intrusions were assigned a size-classification of 0–10 km^2, 10–100 km^2 and >100 km^2 based on their judged/known extent. All steps involved in the filtering of the intrusions in Greenland are described in the GEUS report from the assessment workshop. As very large intrusive complexes are needed to provide the right settings for the contact-type nickel mineralisation style, the assessment panel found it most reasonable to only focus on very large intrusions/complexes in Greenland and a threshold value of >500 km^2 on the areal extent was arbitrarily chosen by the panel.

Undiscovered komatiite-hosted nickel deposits

Supracrustal (undifferentiated), mafic and ultramafic rock units were extracted from the 1:500 000 scale geological map of Greenland. Based on the characteristics of komatiite-hosted nickel deposits and the associated mineralising system, these rock units were used as a first proxy for permissive geology for this type of mineralisation. Units within similar geological settings and with similar level of investigation and exploration were then grouped together into *tract groups*. The groups were used to define the tracts that were believed to be permissive for komatiite-hosted nickel mineralisation. A total of 21 initial tract groups were identified in this way. In total 24,656 km^2 were defined as being permissive for komatiite-hosted nickel. During the course of the workshop the panel decided to split three of the initial tract groups into two groups. Furthermore, seven of the proposed tracts were not assessed due to time limitations and limited potential. As a result, a total of 17 tract groups were assessed for undiscovered komatiite-hosted nickel deposits. The consensus bids on the number of undiscovered komatiite-hosted nickel deposits are summarised in the table below.

The ***Ikertoq K8 tract*** in central West Greenland was found to be the area in Greenland that according to the assessment had the highest number of undiscovered komatiite-hosted nickel deposits. This was probably largely attributed to the presence of known nickel prospects in the area and the presence of additional geophysical anomalies. The Ikertoq K8 tract straddles the foreland of the Palaeoproterozoic Nagssugtoqidan orogeny in which Archaean supracrustal, mafic and ultramafic rock units were reworked. To the south the tract is bounded by the non-reworked North Atlantic craton.

The ***Nuuk – Akia K5*** tract was assessed as to have the second highest number of undiscovered komatiite-hosted nickel deposits. It is a large tract that includes several continuous belts of supracrustal (undifferentiated), mafic and ultramafic rock units. The tract includes several terrane boundaries, which in some cases can be followed for 150 km, and also contains many well-known ultramafic rock units with komatiites as well as exhalative sulphides. While some of the ultramafic rocks are Neoarchaean, deemed to be a favourable period for komatiitic nickel mineralisation, pentlandite occurrences in the area are actually related to Mesoarchaean, gabbroic, mafic granulites and serpentine schist. Gold mineralisations are also well-known from this tract.

The ***Bjørnesund & Kvanefjord K2b*** tract defines another area that was ranked relative high for its potential to contain undiscovered komatiite-hosted nickel deposits. The tract represents mapped ultramafic rocks and amphibolites but no metasedimentary rocks are known in the Bjørnesund and Kvanefjord areas. Spinifex textures in ultramafic rocks are reported from Kvanefjord. Although there are acid volcanic rocks, no exhalative massive sulphides have been documented, so the potential for the ultramafic magmas to have reached sulphur saturation from this source is limited. Several gold showings and one showing with pentlandite mineralisation have been reported from the Bjørnesund area.

Sampling of nickel-copper sulphide mineralisation hosted within a metasedimentary sequence, associated with dioritic and ultramafic rocks at Tasiilaq, South-East Greenland. Photo: NunaMinerals A/S

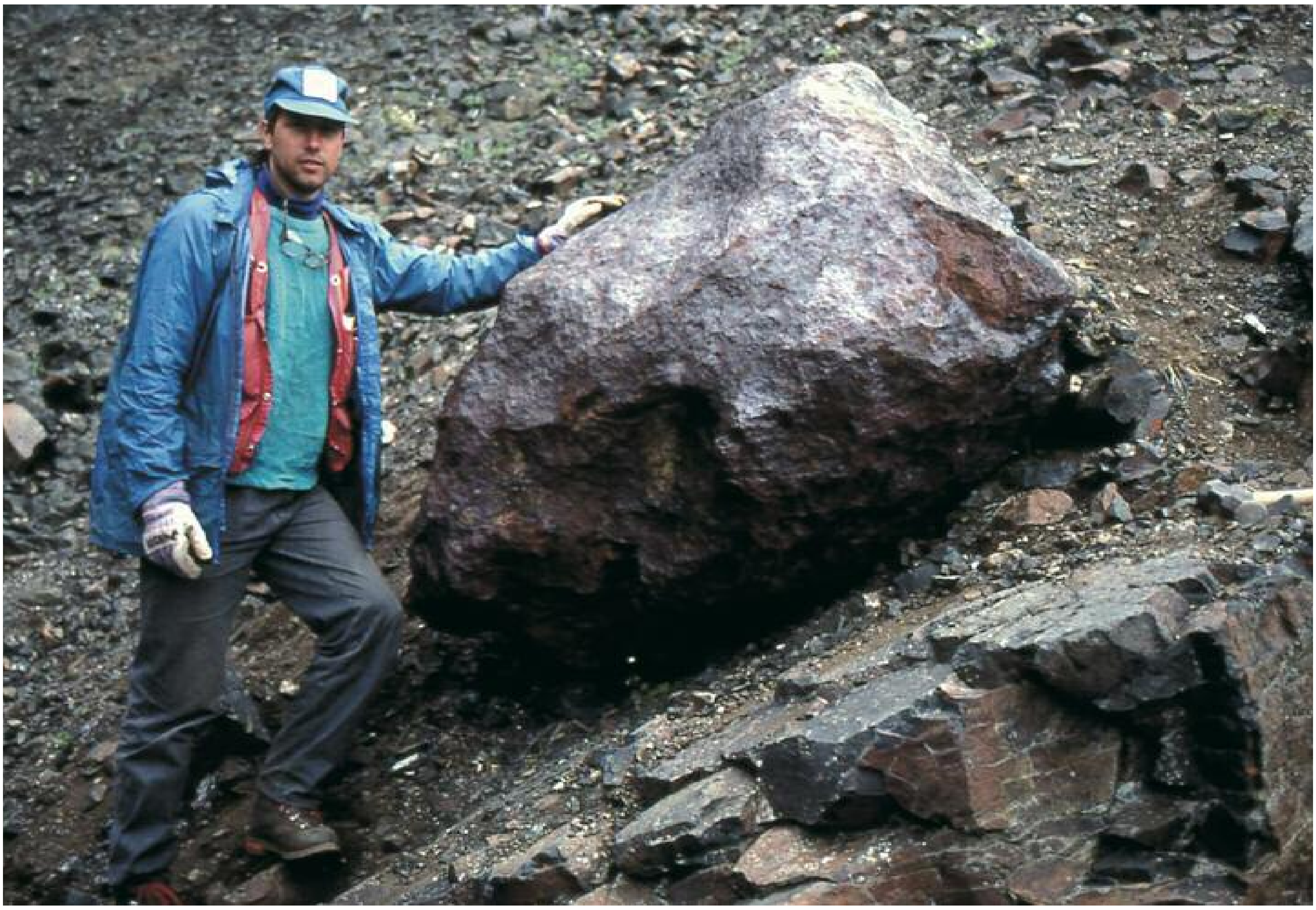
Undiscovered conduit-type nickel deposits

The assessment panel found that the target parameters for the conduit-type nickel mineralisation were present in many parts of Greenland. Several regions hold evidence for large magmatic systems that in many cases are associated with widespread swarms of dykes and sills. A total of 12 tracts were assessed during the workshop for their potential for undiscovered conduit-type nickel deposits.

Three regions in Greenland are well-known for their presence of flood-basalts and related major magmatic activity including numerous dyke and sill systems. The northernmost of these regions, ***tract C8***, is defined by the ***Zig-Zag Dal*** basalts and the presumed contemporaneous ***Midsommersø dolerites***. These were emplaced during rifting in the Independence Fjord Basin. The tholeiitic flood basalt sequence is *c.* 1,350 m thick and extends over an area of *c.* 10,000 km^2. The overall variation of Ni-MgO in samples from the basalts points towards an olivine control, however, a few more primitive samples from the lowermost part of the Zig-Zag Dal basalts are present and might indicate that nickel was removed via an immiscible sulphide liquid. Tract C8 was ranked number 11 among the tracts for undiscovered conduit-type nickel deposits. The tract has seen very little exploration.

The ***tracts C6 and C7*** cover the ***East Greenland Flood Basalt Province*** (EGFBP) and associated intrusions (including numerous sill and dyke systems) that are related to the Palaeogene volcanic-rifting and opening of the North Atlantic. The flood basalt sequence is up to *c.* 7 km thick and consists of more than 260 flows that cover an area of more than 65,000 km^2. More than sixty layered gabbro intrusions have been recorded in the province. The plutonic suite ranges from ultramafic to felsic, from depleted basaltic to highly alkaline, and from upper crustal intrusion to sub-volcanic centres and breccia pipes with related epithermal vein systems. The magmas were sulphur undersaturated and for most samples it seems that nickel is controlled by olivine fractionation. Only the so-called Urbjerget lavas depart from the olivine line of control on a Ni-MgO diagram which may suggest that nickel may have been lost to sulphides in these rocks. The province was split into two tracts. The reason for this is that the lavas and associated dykes/sills to the south were emplaced into a narrow and rather shallow sedimentary basin (tract C6), while those to the north were emplaced into a more extensive and deeper sedimentary basin (tract C7). Also the level of investigation and exploration for nickel is different from north to south, with the northern tract C7 having a higher level. Tracts C6 and C7 were ranked numbers 7 and 8 among the potential tracts for undiscovered nickel deposits.

The ***West Greenland Flood Basalt Province*** (WGFBP) constituted the last tracts, tracts ***C10 and C11***, that are directly related to known flood basalt regimes in Greenland. WGFBP is considered to be an analogue of the Siberian Traps in Russia to which the giant Norilsk nickel



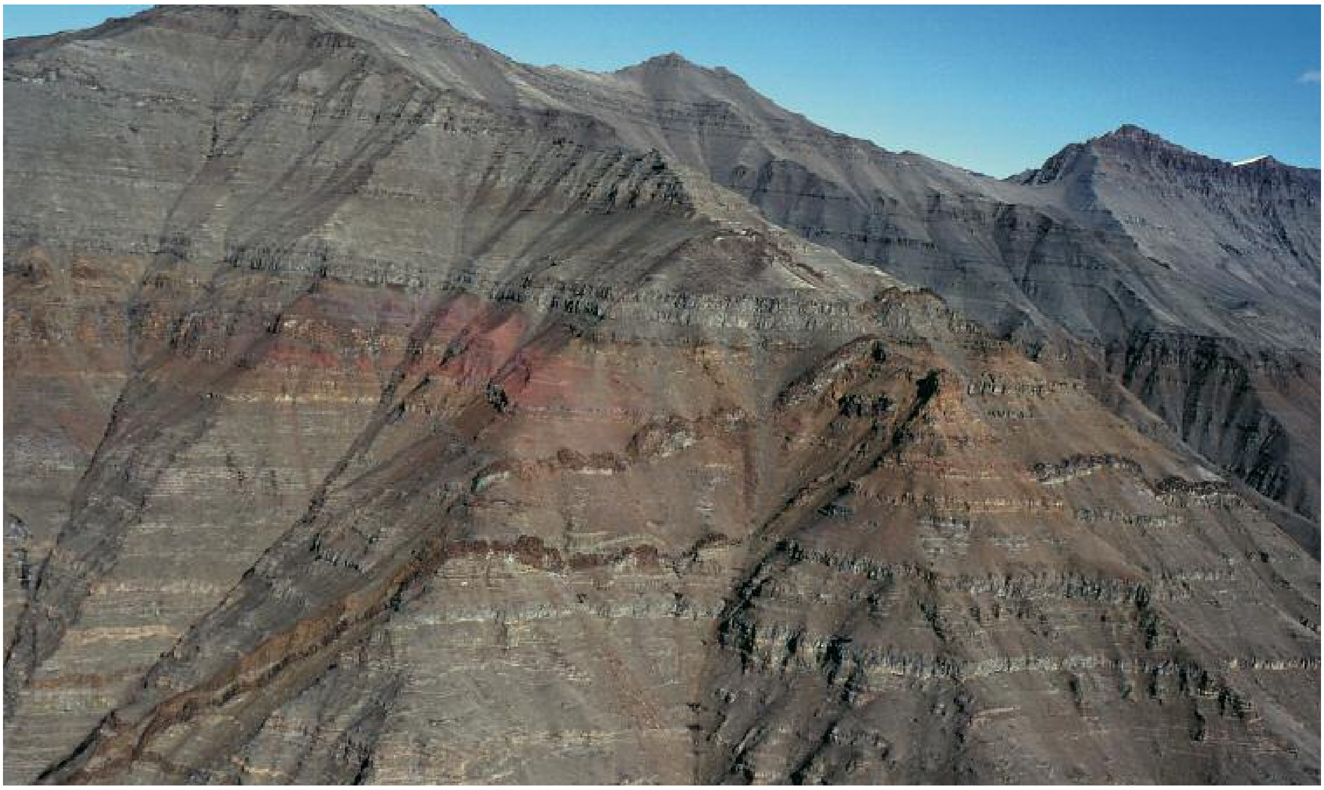
A 10 tons boulder of iron found by Falconbridge in 1993 on western Disko Island. Photo: A. K. Pedersen.

Summary of consensus bids from the nickel assessment workshop on the number of undiscovered conduit-type nickel deposits in Greenland.

Name	Tract no.	Areal extent [km²]	Consensus bid on number of undiscovered nickel deposits at different confidence levels					Statistical calculation of:					Rank
			N90	N50	N10	N5	N1	Number of unknown deposits	Deposit density	Mean estimate of undiscovered resources [metric tons]: Nickel	Copper	PGE	
Maniitsoq Norite Belt	C1	50*	0	1	2	3	5	1.10	0.25	490,000	270,000	19	1
Fiskefjord	C2	420*	0	0	0	1	1	0.07	0.00018	27,000	15,000	1	10
Fiskenæsset	C3	350*	0	0	0	1	2	0.11	0.0003	46,000	26,000	1	6
Gardar dykes (oldest)	C4	6,570	0	0	0	1	2	0.11	0.000016	43,000	23,000	2	4
Tasiilaq AIC	C5	250*	0	0	1	2	3	0.41	0.0017	160,000	90,000	7	3
S. of Scoresbysund	C6	50,970	0	0	0	1	2	0.11	0.0000021	43,000	24,000	2	7
N. of Scoresbysund	C7	2,510	0	0	0	1	2	0.11	0.000042	40,000	22,000	1	8
Zig Zag Dal	C8	4,400	0	0	0	0	1	0.03	0.0000 068	12,000	7,800		11
Inglefield Land	C9	460*	0	0	0	1	1	0.07	0.00016	32,000	18,000	1	9
N. WG Basalt Prov.	C10	10,730	0	0	1	2	3	0.41	0.000038	160,000	88,000	7	4
S. WG Basalt Prov.	C11	10,880	0	1	2	3	5	1.10	0.0001	460,000	250,000	18	2
Skjoldungen	C12	270*	0	0	1	1	2	0.33	0.0012	130,000	73,000	5	5

N90, N50, N10, N05, N01 = Confidence levels; a measure of how reliable a statistical result is, expressed as a percentage that indicates the probability of the result being correct. A confidence level of 10% (N10) means that there is a probability of 10% that the result is reliable.

An asterisk (*) marks that the areal extent of the tract corresponds to the mapped rock units. The areal extent for those not marked with an asterisk corresponds to the entire area judged by the assessment panel to comprise the rock units and settings that are permissive for conduit-type



An eruption site for Kûgánguaq Member on Disko Island. Contaminated basalt forms basaltic ignimbrite, possibly by interaction with natural gas. Photo: A. K. Pedersen.

deposit is related. WGFBP is related to the initial phase of continental break-up and initiation of sea-floor spreading of the Labrador Sea in the early Palaeogene. The basalts vary in thickness from 4 to 10 km and cover at least 68,000 km^2. They were deposited on a substrate of 6–8 km thick sediments in a Cretaceous-Paleocene subsiding basin and a Precambrian basement of the continental interior. The WGFBP is especially noted for its presence of native iron-bearing basalts and large volumes of high-temperature picrites and olivine basalts. The picrites probably are the largest volumes of MgO-rich lavas known globally. Both basaltic and picritic parts of the lavas have been documented to be contaminated by sedimentary rocks and to have reached sulphur saturation. The lower part of the lava succession (members of the Vaigat Formation) is of significant volume and has undergone crustal contamination. These magmas ascended along known focused magma conduits distributed along the N–S Kuugannguaq-Qunnilik fault system. These conduits have native iron and Fe-Ni-Cu-Co-sulphide occurrences.

In the 1930s, 28 tons of massive nickel sulphide was extracted from the Ilukunnguaq dyke located on the northeast part of the island of Disko. Since then several exploration companies have actively explored for nickel in the area. Lately, magnetelluric and electromagnetic geophysical surveys have identified large and strong conductive bodies in the northwestern part of tract C10. Tract C10 was ranked number 5, while tract C11 was ranked number 2 among all assessed tracts for conduit-type nickel deposits. The consensus bid on tract C11 resulted in one conduit-type nickel deposit at a 50% confidence level. Again, although the rock types and settings are similar, different levels in knowledge, exploration and data make it appropriate to subdivide the basalt province into different tracts. Tract C10 is the northern part of WGFBP, which comprises lesser volumes of picritic lavas and no known occurrences of native iron or nickel. Tract C11 contains large volumes of picritic lavas, occurrences of native iron and nickel, well-established pathways for ascending magmas and strong, however deep-seated, EM anomalies.

Tract C1 is defined by the distribution of the norite and leucogabbroic rock units that are mapped as belonging to the ***Maniitsoq Norite Belt*** which lately has been suggested surrounding a large Archaean impact structure that triggered fracturing and magma ascension that were active for a long period. There are evidences for crustal accumulation, and iron-sulphide-bearing amphibolite layers are locally associated with the intrusives and may have provided a source for sulphur saturation. Exploration in the areas on numerous rust zones was initiated in the 1950s and 1960s and several nickel-sulphide showings were identified. The

Nickel exploration and drilling in the Maniitsoq Norite Belt in 2012. Photo: North American Nickel Inc.

initial work was only followed up by shallow drilling. Later, in 1995, fixed-wing airborne electromagnetic surveys were carried out with limited follow-up. In 2011 helicopter-borne TEM and magnetic surveys were carried out. During these sur veys many new conductive bodies were identified, and subsequent drilling has resulted in very encouraging results with several new nickel occurrences. Tract C1 is ranked number 1 among all assessed tracts for conduit-type nickel deposits. Consensus bid on tract C1 resulted, at a 50% confidence level, in one conduit-type nickel deposit.

Summary of assessment results including consensus bids on undiscovered contact-hosted nickel deposits in Greenland and statistically derived estimations.

Location	Tract no.	Areal extent [km²]	Consensus bid on number of undiscovered nickel deposits at different confidence levels					Statistic calculation of:				Rank
			N90	N50	N10	N5	N1	Number of deposits	Deposit density	Mean estimate of undiscovered resources [metric tons] Nickel	Copper	
Innartivaq (Tasiilaq)	I1	>500	0	0	0	1	2	0.11	0.000021	26,000	53,000	1
Kap Edvard Holm	I2	>500	0	0	0	1	2	0.11	0.000021	26,000	53,000	1
Qaqujârssuaq	I3	>500	0	0	0	0	1	0.03	0.000006	8,100	20,000	2

N90, N50, N10, N05, N01 = Confidence levels; a measure of how reliable a statistical result is, expressed as a percentage that indicates the probability of the result being correct. A confidence level of 10% (N10) means that there is a probability of 10% that the result is reliable.

Coarse-grained pyrrhotite-pyrite-pentlandite-chalcopyrite mineralisation from Imiak Hill. Photo: North American Nickel Inc.

Massive sulphide sample from diamond drill hole MQ-13-026 at the Imiak Hill occurrence, part of the Maniitsoq Norite Belt. The sample, which comes from 158.5 metres down the hole assayed 5.26% Ni, 1.78% Cu and 0.18% Co. Photo: North American Nickel Inc.

Undiscovered contact-type nickel deposits

This type of mineralisation is characterised by being associated with very large mafic and ultramafic complexes. Subsequently, the assessment panel found it appropriate only to focus on this type of complexes and a threshold value of 500 km^2. Only three complexes were found to meet these criteria.

Tract I1 constitutes the Archaean ***Innartivaq gabbro-diorite-tonalite-granite intrusive complex*** north of Tasiilaq, South-East Greenland. The complex is presumed to be emplaced early in the Proterozoic evolution of the Nagssugtoqidian orogeny in South-East Greenland. Minor sulphide occurrences, including pentlandite mineralisation, have been found in small gabbroic bodies within the complex. The complex is hosted north of a supposed Palaeoproterozoic crustal boundary. The complex has not been investigated.

Tract I2 the Palaeogene ***Kap Edvard Holm complex***, South-East Greenland, covers *c.* 800 km^2 and constitutes a large layered, tholeiitic gabbro complex that subsequently was intruded by syenite, granite and wehrlite that reflect multiple magma pulses injected over an extended time period. The complex is hosted by Precambrian gneisses, near a supposed crustal triple-junction. There is evidence for crustal contamination, including sulphur-rich sediments. Exploration in the complex has identified a *c.* 40 km long gold and platinum anomalous zone.

Tract I3 hosts the Archaean ***Qaqujârssuaq complex***, south of Thule, North-West Greenland. The complex covers more than 1,000 km^2 and is mostly made of anorthosite but also contains gabbro and leucogabbro. The complex is intruded into gneisses, iron formations and metasedimentary rocks. The complex is very poorly known and has not seen any exploration.

Concluding remarks

Greenland comprises geological environments that are highly prosperous for nickel mineralising processes. Considering the historically limited exploration activities that have been carried out in many parts of Greenland and the limited amount of data and information that are available, the assessment still resulted in an estimate of undiscovered nickel deposits and an associated nickel endowment that can be considered significant and warrants further opportunities and exploration. When the few historical exploration campaigns that have been directed towards nickel mineralising systems in Greenland, *e.g.* those on the West Greenland Flood Basalt Province and those within the Maniitsoq Norite Belt, are taken into consideration, it is worth noticing that each new campaign has resulted in new targets for nickel. This is mainly due to technical advancements in geological models and the available geophysical methods. Recent and on-going exploration campaigns have thus resulted in identification of new nickel deposits that might represent larger nickel districts. The assessment of undiscovered

Drill rig and casings used in connection with Vismand Exploration Inc.'s drill programme on Nuussuaq in 2007. The aim was to locate nickel-enriched, deeper-lying, lava conduits that connect to successions of contaminated flood basalts.

nickel deposits also concluded that numerous tracts are highly prosperous for nickel, but more investigations and data are needed to increase the certainty with which to evaluate the favourability of these tracts. Greenland is especially enriched in geological environments favourable for hosting conduit-type nickel deposits. However, environments for komatiite-hosted nickel deposits are also present, although to a lesser degree.

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Front cover photograph
In the inner parts of the Scoresby Sund area(70°N) the lowest units of the plateau basalts rest directly on gneisses from the Caledonian fold belt. The basalt succession shown is about 800 m thick.

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