DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2010/29

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GEUS

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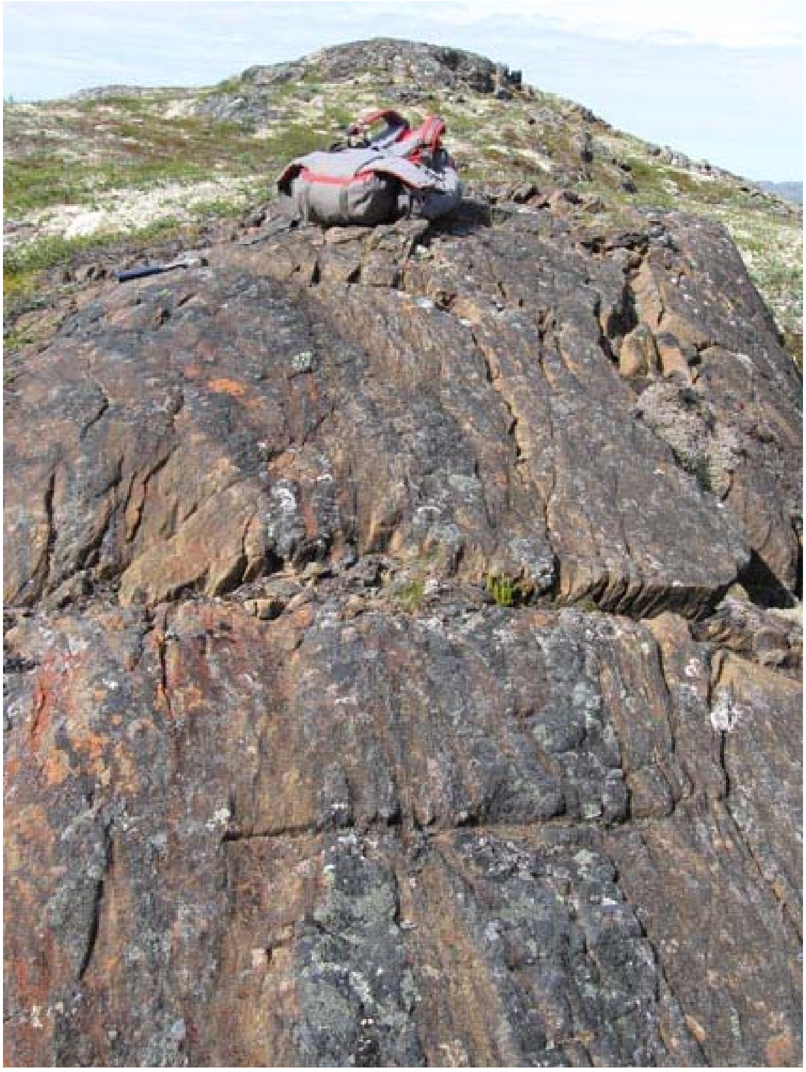


Figure 1. ***Olivine-rich peridotite with hornblendite veins***

Summary

The Fiskenaesset anorthosite complex was emplaced ~2970 Ma ago as multiple sills of magma and crystal mush into oceanic crust (tholeiitic basalts and gabbros), forming an association of ~550 m thick anorthosite, leucogabbro, gabbro and peridotite layers. The complex has a present strike length of ~200 km. It has been partly broken up during multiple deformations, and suffered amphibolite- to granulite facies metamorphism. Chromite-rich bands are common throughout the complex; sulphide-rich layers are generally rare.

The first traces of platinum group elements (PGE) were discovered in a chromitite banded bronzitite by Martin Ghisler in the late 1960'ies and prompted prospecting for PGE by a Canadian company (Platinomino A/S) in the subsequent decade, but without encouraging results. During a campaign undertaken by GEUS in 1991 new PGE occurrences were discovered, but due to those days low price level of PGE the results did not attract attention.

In 2007, a joint project between Bureau of Minerals and Petroleum (BMP), Nuuk and GEUS with the purpose of re-evaluating the PGE potential of the Fiskenaesset anorthosite complex was initiated and field work has been carried out in 2008 and 2009. The project revealed elevated PGE contents in different parts of the complex. The part of the intrusive complex sampled in 1991 was reinvestigated in greater detail, and several profiles were sampled. The profiles revealed PGE's in small but significant amounts throughout the ultrabasic rocks with a significant enrichment in a ~5 m thick reef, named Ghisler Reef, grading 690 ppb Pt, Pd and Au over 5 m with best values within the Reef of 2 ppm Pt, Pd and Au with 20 ppb Rh over 1 m. The PGE-bearing unit can be traced with intervals for ~5 km and an exposed thickness up to 50 m.

Ghisler Reef displays an unusual geochemical signature with near perfect correlation of Pt, Pd, Au and Cu with Bi. This geochemical signature is in good accordance with the observed presence of PGE-Bi bearing minerals such as froodite $PdBi_2$, sobolevskite (Pd, Pt) Bi, insizwaite $PtBi_2$, maslovite PtTeBi, michenerite (Pd, Pt) TeBi, keithconnite Pd_{1-x} (Te, Bi), unnamed $Cu_3Pt_3Bi_4S_{10}$, electrum AuAg, native Ag, parkerite $Ni_3Bi_2S_2$ and native Bi. Ghisler Reef has low contents of sulphur.

The association of PGE with bismuth is seen in deposits such as Sudbury, Great Dyke and Monchegorsk intrusion on Kola Peninsula.

The discovery of ultrabasic rocks highly enriched in PGE has opened up parts of the 200 km long Fiskenaesset anorthosite complex for finding economic PGE deposits.

Investigations were also conducted on the complex' rock units in the Sinarsuk area, as well on selected ultrabasics not forming part of the complex, but no encouraging geochemical data have been returned.

1. Introduction

1.1. Background for renewed activities on the Fiskenaesset anorthosite complex

GEUS and the Bureau of Minerals and Petroleum (BMP) in 2007 decided to include a re-evaluation study of the Platinum Group Element (PGE) potential of the Fiskenaesset anorthosite complex as part of the ongoing regional mineral resource evaluation of West Greenland. Funding of the two-year project has been equally provided by BMP and GEUS. This report concludes the project.

A two-fold approach was agreed to by BMP and GEUS:

1. A geochemical approach aimed at tracing a potential extension of the bronzitite-hosted PGE anomaly and/or locating unknown PGE anomalies.
2. A detailed geochemical study of the anorthosite complex and adjoining rocks aiming at establishing the geological setting of the intrusive complex in relation to the amphibolites into which the complex intruded.

1. Work carried out by Platinomino A/S in 1969-72 showed that visual inspection through traversing the complex with regular intervals was not successful in finding the continuation of a PGE-bearing bronzitite found on central Qeqertarssuatsiaq (see Fig. 2). It was thus decided to make detailed sampling along a profile over the complex across a PGE-bearing bronzitite on central Qeqertarssuatsiaq as well as to undertake a similar sampling traverse across the complex in the inland area, around Sinarsuk. All collected samples should be analysed for major and trace elements characterize the rock units involved as well as to detect anomalous pattern of trace elements in the vicinity of the bronzitite.

2. Very little research on the Fiskenaesset complex has been carried out for several decades. It was therefore suggested to conduct detailed geological investigations in selected areas followed by geochemical investigations of the major rock types within the complex in order to place the anorthosite complex and host rocks in a modern geological context.

1.2 Previous work on the PGE’s in the Fiskenaesset anorthosite complex

The first exploration for PGE in the Fiskenaesset anorthosite complex was carried out by Platinomino A/S in 1969 to 1972. On central Qeqertarssuatsiaq (see Fig. 2) a chromitite banded bronzitite was sampled. It returned interesting PGE values (Table 1). During the following years, the exploration activities of Platinomino A/S were intensified and traverses were run across the complex with intervals of about 500 m. This systematic work did, however, not reveal any further significant PGE occurrences, even though a number of anomalous values up to 4 ppm PGE were localized.

On northern Qeqertarssuatsiaq, an approximately five km long and hundred metres wide belt of ultrabasic rocks, anorthosites and gabbros are outcropping. This belt continues across the fjord towards east in the Itise area. One part of this belt has been mapped in detail by Platinomino A/S. The belt was also sampled, but returned low PGE values only. However, the samples from the Itise area revealed prospective PGE values. Further scattered PGE discoveries were made by Platinomino A/S (Table 1). Accordingly, the Platinomino A/S exploration ceased in 1972.

In 1991, GEUS (at that time GGU) carried out field campaign in the Fiskenaesset area, focussing on PGE in the complex. During the campaign a combined chip and channel sample of part of the slightly rusty ultrabasic rocks on northern Qeqertarssuatsiaq was collected over a width of 26 m. The samples were analysed for trace elements and returned elevated Pd and Pt values (Table 2) (Appel 1993).

In 1991, three grab samples and two chip samples were collected from the Itise area at the plateau a few hundred metres above sea level, and returned elevated PGE values (Table 2). However, in 1993 it was concluded that the PGE contents were not of sufficient interest to warrant further investigations.

Table 1. *PGE contents in ultrabasic rocks discovered by A/S Platinomino (1960'ies)*

Sample No	Locality	Pt ppm	Pd ppm	Au ppm	Ag ppm	Rh ppm	Rock type
130009	Central Qeqertarssuatsiaq	0.6	0.3	0.3	0.54		Bronzitite
130049	Itise	0.39	1.98	0.24	2.7	0.03	Ultrabasite
130043	Itise	0.24	1.62	0.24	2.7		Ultrabasite
130061	North Qeqertarssuatsiaq		0.36		3.6		Ultrabasite
130065	North Qeqertarssuatsiaq	0.09	0.51	0.15	1.8		Ultrabasite
130125	North of Sarfaq		0.18	1.2			

Table 2. *Analytical results from the GGU 1991 campaign in Fiskenaesset area (Appel, 1993). n.d.= not detected*

Loc.	Sample	Ag_ppm	Au_ppb	Cu_ppm	Ni_ppm	Pd_ppb	Pt_ppb	Channel (m)	Chip (m)
Qeq-N	393870	0.2	2	11	806	7		1.8	
Qeq-N	393871	n.d.	1	48	555	15	7	1.3	
Qeq-N	393872	0.2	8	114	1,000	2	n.d.	2.5	
Qeq-N	393873	0.6	52	1,876	643	750	160		2
Qeq-N	393874	n.d.	22	1,086	1,104	420	110		3
Qeq-N	393875	0.2	24	1,221	665	360	88		2
Qeq-N	393876	n.d.	21	1,097	495	300	60		2
Qeq-N	393877	0.5	84	1,799	518	850	100		2
Qeq-N	393878	0.5	42	1,310	286	430	90		2
Qeq-N	393879	n.d.	8	821	365	150	20	2.5	
Qeq-N	393880	n.d.	6	389	134	10	80	2.5	
Qeq-N	393881	n.d.	10	427	161	86	10	1	
Qeq-N	393882	n.d.	14	798	499	360	67	1.8	
Itise	393914	n.d.	10	n.d.	340	7	n.d.	Grab	
Itise	393915	n.d.	4	833	784	33	11	Chip	1.5
Itise	393917	0.2	8	1,110	101	361	68	Chip	1
Itise	393918	n.d.	6	129	210	9	5	Grab	
Itise	393919	0.9	14	209	740	20	6	Grab	

1.4. Field work carried out in 2008 and 2009

Bureau of Minerals and Petroleum and GEUS financed field work in the Fiskenaesset area in 2008 and 2009. The field work was helicopter- and boat supported and served from the Fiskenaesset as base in 2008 and a base in the fiord (Camp Midgaard) in 2009.

One team headed by Ali Polat from University of Windsor worked on Qeqertarssuatsiaq, Sinarsuk and Majorqap Qava in 2008 and same places together with Itise in 2009. Another team headed by Per Kalvig worked together with Ali Polat in 2008 and 2009 in Qeqertarssuatsiaq, Itise and Sinarsuk. Per Kalvigs team also worked on a few other parts of ultramafics in the Fiskenaesset complex. However, his work was hampered by large amounts of snow.

Detailed channel and chip sampling along a number of profiles at Qeqertarssuatsiaq and Itise was made by Ole Dahl, hired in for the field work in 2009. He also carried out detailed mapping of the profiles.

1.4.1 Location map

The map below (fig. 2) is part of the Geological map of Greenland 1:500 000 Frederikshåb Isblink – Søndre Strømfjord (Sheet 2), published by GEUS 1998.

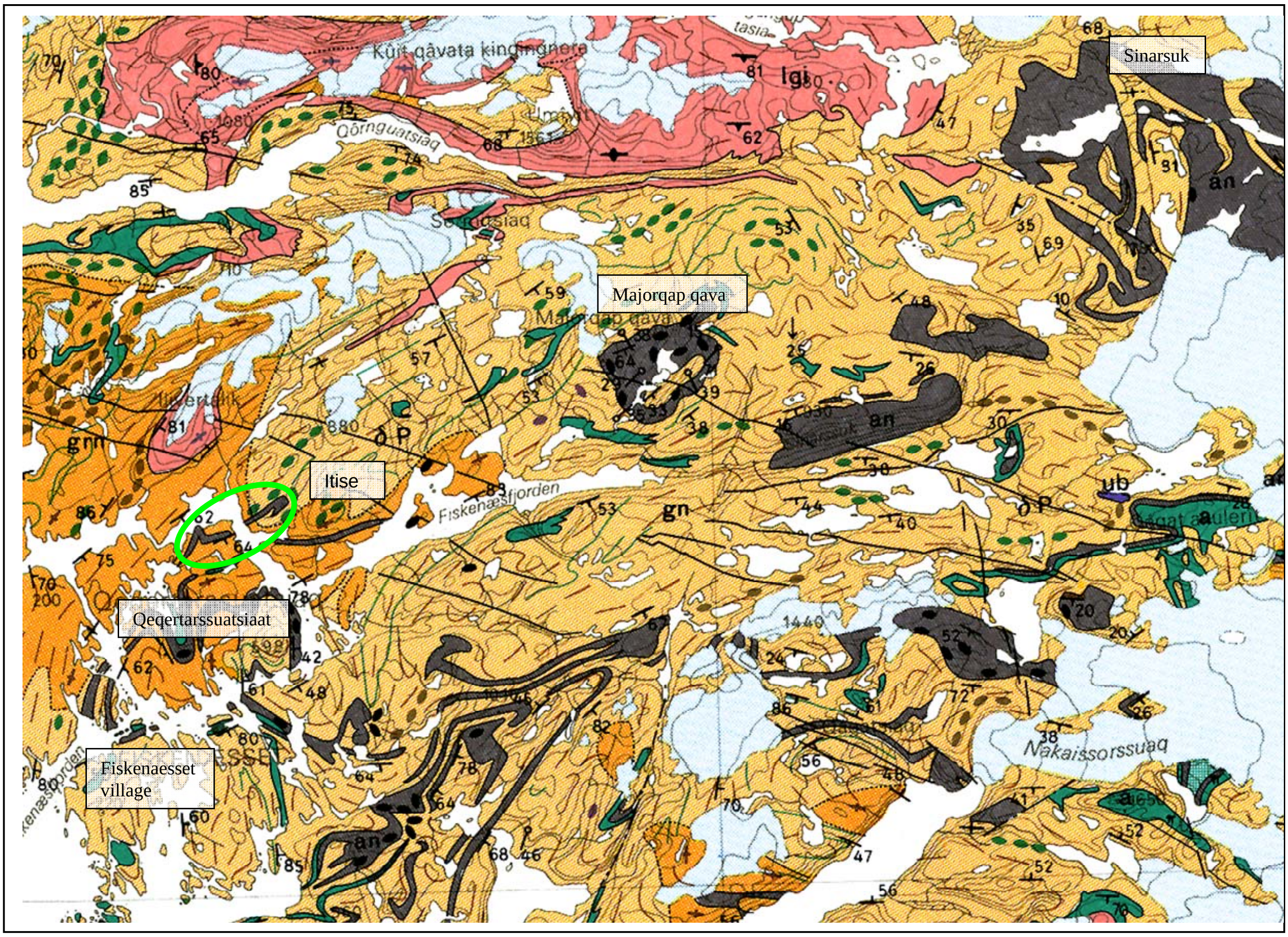
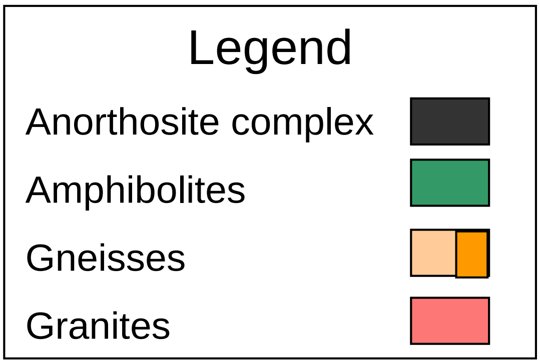


Figure 2. *Index map showing distribution of the anorthosite complex and target areas; the green circle indicates the Qeqertarssuatsiaat area and the Itise area. Legend equivalent to the GGU 1:500 000 map.*



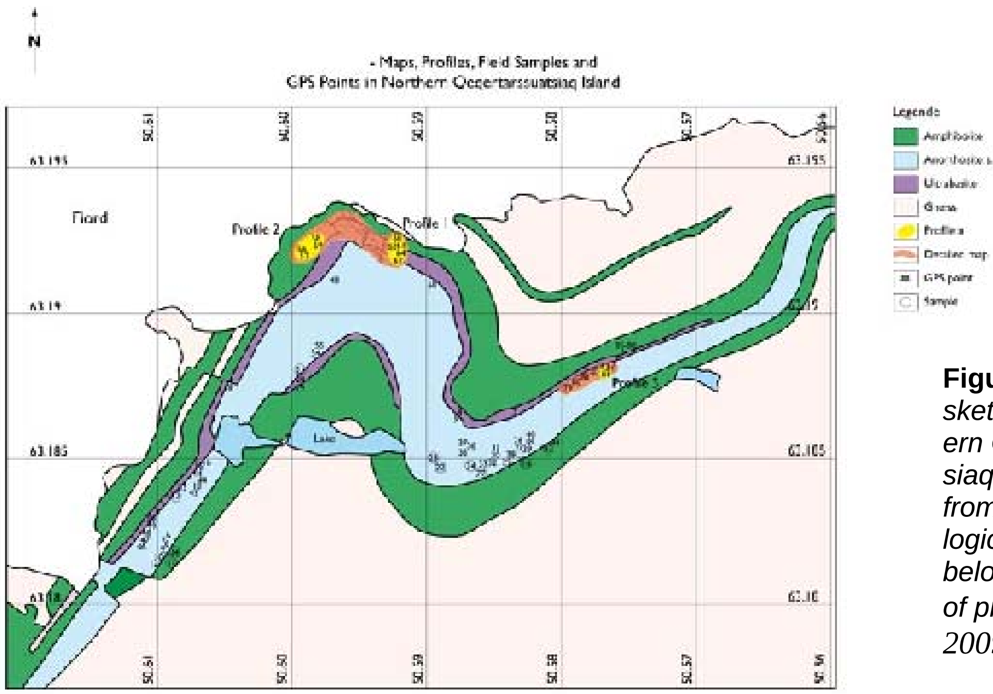


Figure 3. *Geological sketch map of northern Qeqertarssuatsiaq slightly updated from published geologic maps (see text below) with location of profiles sampled in 2009.*

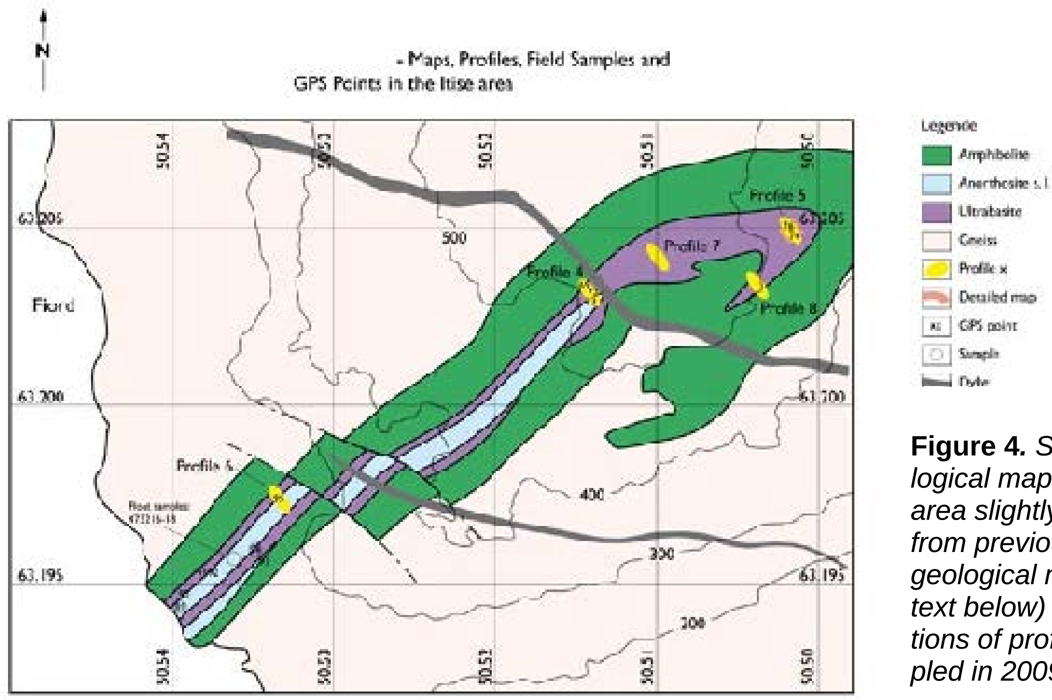


Figure 4. *Sketch geological map of the Itise area slightly updated from previous published geological maps (see text below) with locations of profiles sampled in 2009*

1. 5 Logistics

The Fiskenaesset anorthosite complex outcrops from the coastal area all the way inland until the outcrops disappear under the Inland Ice. The PGE mineralization described in this report is situated in the coastal region 15 km, measured in a straight line from the Fiskenaesset village, and immediately adjacent to a deep fiord, which is ice-free most of the year. The Davis Strait outside this part of the Greenland is generally ice free all year around.

Fig. 5 a and b*: The two photos above are from the ultrabasic rocks on Qeqertarssuatsiaq (a, to the left) and Itise (b, to the right). The deep Fiskenaesfjord is next to the PGE mineralization.*

2. Geological setting

The Fiskenaesset anorthosite complex consists of sheet-like bodies that are concordant with the adjacent orthogneisses and amphibolites (Myers, 1985). Single layers range in width from 2 km to less than a metre and as trains of inclusions in the orthogneisses, and extend in outcrop for up to at least 50 km. Throughout the whole Fiskenaesset region, exposed layers of the complex (see Fig 2) have a total strike-length of at least 200 km, often the same layer being refolded or thrusted several times (Kalsbeek and Myers, 1973; Myers, 1985). Three phases of isoclinal to tight folding gave rise to spectacular km-scale fold interference patterns.

The complex and the gneisses have been variably affected by granulite facies metamorphism and retrogressed in high-amphibolite facies. According to Riciputi et al. (1990), peak metamorphic conditions reached about 780°C and 8.9 kbar (30 km depth) in the region. The presence of fragments of folded amphibolites, metamorphosed anorthosites, gabbros and leucogabbros in the gneisses suggest that the Fiskenaesset complex had already been metamorphosed and deformed prior to the intrusion of the protoliths of the engulfing gneisses (Myers 1976; Polat et al., 2009). Given the fact that all rocks in the Fiskenaesset complex belt have been metamorphosed, the prefix ‘meta’ will be taken implicitly.

In spite of deformation and metamorphism, many parts of the Fiskenaesset complex retain the igneous stratigraphy, cumulate texture, grading and channel deposits. The gross igneous stratigraphy of the Fiskenaesset complex, and its duplication by the first phase of isoclinal folding, was first identified by Windley (1971) on the island of Qeqertarssuatsiaq situated in Fiskenæsfjord (Windley et al. 1973). This lead first to the recognition that similar stratigraphy (although better developed and more complete at Majorqap qâva) was present throughout all layers of the Fiskenaesset complex from the coast to the inland ice (e.g., Walton 1973; Myers 1975), and later to the final revision and definition of the stratigraphy of the whole complex throughout the Fiskenaesset region (Myers 1985).

The main stratigraphic units are from bottom to top: Lower Gabbro, Ultrabasic rock, Lower Leucogabbro, Middle Gabbro, Upper Leucogabbro, Anorthosite, Upper Gabbro (Myers 1985). Chromitite layers that are up to 20 m thick (Ghisler & Windley 1967; Ghisler 1976) are concentrated in the anorthosite and at the top of the Upper Leucogabbro unit (Myers 1985). Thin layers of chromitite also occur in the ultrabasic rocks in other stratigraphic positions.

On the island of Qeqertarssuatsiaq, contacts between the Fiskenaesset Complex and the surrounding orthogneisses are strongly deformed. These contacts often display multiple phases of folding and shearing. Contacts between the anorthosites, gabbros, leucogabbro, and ultrabasic rocks are also mostly deformed. The boundary between the basaltic amphibolites and intrusive members of the complex (e.g., anorthosites, leucogabbros, gabbros, ultrabasic rocks) are sheared and display metasomatic alteration. Like the anorthosites, leucogabbros and gabbros, the amphibolites display well-developed foliation and polyphase deformation. No primary magmatic textures or structures have been preserved in the amphibolites on Qeqertarssuatsiaq.

The ultrabasic rocks occur mainly as tectonic lenses, sills or magmatic differentiates ranging in thickness from several tens of centimetres to several tens of metres. Olivine- and orthopyroxene-rich rocks tend to occur as 1-3 m thick bands within the anorthosite and leucogabbro layers. The anorthosites and leucogabbros are the dominant rock types in the complex. These units have variable thicknesses, ranging from several metres to several hundreds of metres. Primary magmatic structures, such as cumulate layers, are locally preserved in low-strain areas. The size of plagioclase crystals in cumulate texture ranges from a few millimetres to several centimetres. Interstitial minerals between cumulus plagioclase are dominated mostly by amphiboles (hornblende) and pyroxene. Chromite bands occur frequently in the Fiskenaesset complex. They can be massive to semi massive, up to 5 m thick. Frequently, however, they appear as augen chromitite with up to 60% chromite and 40% plagioclase. Similar field relationships between different members of the complex are also seen in other parts of the complex. Igneous layering characterized by 0.5 to 4 m thick dunite-peridotite-pyroxenite-gabbro-leucogabbro-anorthosite intercalation are better preserved in the Majorqap qâva and Sinarsuk areas (see Fig. 2).

The broad geological outline of the Fiskenaesset complex can be seen on the following three geological maps in scale 1:100.000:

Grædefjorden 63 V1 Syd
Sinarsuk 63 V2 Syd
Bjørnesund 62 V1 Nord

3. The Fiskenaesset anorthosite complex in a modern geologic context

The field work and following laboratory work carried out during the project has given a wealth of information, which helps placing the complex in a modern geologic context. Below is the abstract from a paper published in Precambrian Research in 2009.

Polat, A., Appel, P.W.U., Fryer, B., Windley, B., Frei, R., Samson, E. M. & Huang, H. 2009: Trace element systematics of the Neoarchean Fiskenaesset anorthosite complex and associated meta-volcanic rocks, SW. Greenland: Evidence for a magmatic arc origin. Precambrian Research ***175****, 87-115.*

Abstract:
New major and high-precision ICP-MS trace element data on the Neoarchean (ca. 2970 Ma) layered Fiskenaesset Complex and associated volcanic rocks, southern West Greenland, provide new constraints on the petrogenesis and geodynamic setting of the complex. The complex appears to have been emplaced as multiple sills of magma and crystal mush into oceanic crust (tholeiitic basalts and gabbros), forming an association of ca. 550m thick anorthosite, leucogabbro, gabbro, and peridotite layers. The Fiskenaesset Complex and the associated volcanic rocks were intruded by Neoarchean tonalite, trondhjemite, and granodiorite (TTG) sheets during thrusting that was followed by several phases of isoclinal folding. Despite the intense deformation and amphibolite to granulite facies metamorphism, primary cumulate textures and igneous layering are locally well preserved throughout the complex. The presence of calcic plagioclase (An75-95) and igneous amphibole in anorthosites, gabbros and leucogabbros, and hornblendite veins in peridotites suggests a hydrous magma source(s).

The major and trace element compositions of tholeiitic basalts (amphibolites) suggest that they are petrogenetically related to the Fiskenaesset Complex by fractional crystallization. The trace element systematics of the least-altered anorthosites, gabbros, leucogabbros, peridotites, tholeiitic basalts, and calc-alkaline high-magnesian andesites (HMA) is collectively consistent with a supra-subduction zone geodynamic setting. On the log-transformed tectonic discrimination diagram, including La/Th, Sm/Th, Yb/Th, and Nb/Th ratios, tholeiitic basalts display a trend projecting from mid-ocean ridge basalt (MORB) field to island arc basalt (IAB) field. This trend is interpreted as reflecting a transition from the Neoarchean depleted upper mantle to a subarc mantle wedge following the initiation of intra-oceanic subduction and arc migration. Collectively, on the basis of field relationships, petrographic features, and geochemical characteristics, the Fiskenaesset Complex is interpreted as a fragment of a Neoarchean oceanic island arc.

On the basis of REE patterns, anorthosites are divisible into four major groups: (1) Group 1 displays moderately depleted to slightly enriched LREE and HREE patterns; (2) Group 2 possesses strongly enriched LREE and moderately depleted HREE patterns; (3) Group 3 has strongly enriched LREE and depleted HREE patterns; and (4) Group 4 (garnet anorthosite) exhibits concave-upward REE patterns; that appear to have resulted from contamination of anorthositic magma by basaltic rocks or magma. The different REE patterns in Group 1, 2, and 3 anorthosites are interpreted to reflect various depths of partial melting and variably enriched (in incompatible elements) source compositions. The majority of anorthosites and leucogabbros were derived from depths above the garnet stability field.

A manuscript entitled:
Geochemistry of differentiated sills in the Archean (~2970 Ma) Fiskenæsset anorthosite complex, SW Greenland: Implications for parental magma compositions and regional-scale evolutionary trends.
By: Polat, A., Fryer, B., Appel, P.W.U., Kalvig, P., Kerrich, R., Dilek, Y. & Yang, Y. has been submitted to Lithos April 2010

Further analytical work is in progress on the samples collected during the two field seasons. The results of these investigations will be published at a later stage.

4. Exploring for PGE mineralization in the Fiskenaesset complex

4.1 Geochemical exploration approach

The exploration concept of Platinomino A/S in the late sixties was to run traverses across the Fiskenaesset complex with a distance of 500 m, based on the assumption that a PGE ore body had to be more than 500 m long to possess any economic potential. The same approach has proven successful on other major intrusive bodies, e.g. Stillwater. The basic idea was that the PGE mineralization was supposed to be associated with small amounts of visible sulphides. However, only scattered elevated PGE values were found as the result of this fieldwork. They were all associated with 1-5% sulphides (pyrrhotite, chalcopyrite, pyrite and pentlandite).

The strategy applied by GEUS in 2008 was based on the fact that PGE-bearing rocks cannot be identified visually and not necessarily can be expected to be followed by sulphides; thus a geochemical approach was adopted for two main areas: the central part of Qeatertarssuatsiaq and the easternmost area of the complex, the Sinarsuk area. Two geochemical profiles were grab sampled, covering the main rock types of the complex; this approach also allowed subsequent detailed studies. The profiles sampled in 2008 are numbered Profile 1 (2008) and Profile 2 (2008) in order to distinguish the profile numbers from the profiles sampled in 2009.

- Profile 1 (2008) on the central part of Qeqertarssuatsiaq. The complex was sampled, along a c. 730 m horizontal distance perpendicular to strike, along an approximately NW-SE traverse. The sample interval was 5 -10 m. A total of 125 samples were collected of which 116 have been analysed for Pd, Pt and Au, and major elements. The profile crossed the bronzitite discovered in 1960'ies.
- Profile 2 (2008) in the north-eastern part of the intrusion in Sinarsuk from 2008. The complex was sampled along a 1,875 m horizontal distance perpendicular to strike. The section included the gneiss, ultrabasic rock, leucogabbro, gabbro, and anorthosite units. The sample interval varied from 5-40 m depending on homogeneity. A total of 151 samples were collected, of which 110 have been analysed for Pd, Pt and Au. No bronzitite has been identified along the line.

4.1.1 Results of the geochemical approach

Profile 1 (2008) – Qeqertarssuatsiaq: A total of 116 samples have been analysed for major elements, Pt, Pd and Au (Fire Assay-ICP-MS). Pt+Pd-values >8ppb Pt were observed mainly in association with the mafic to ultrabasic rocks, on four different sections of the traverse; peak values are 57 and 13 ppb for Pd and Pt respectively were associated with ultrabasic rocks.

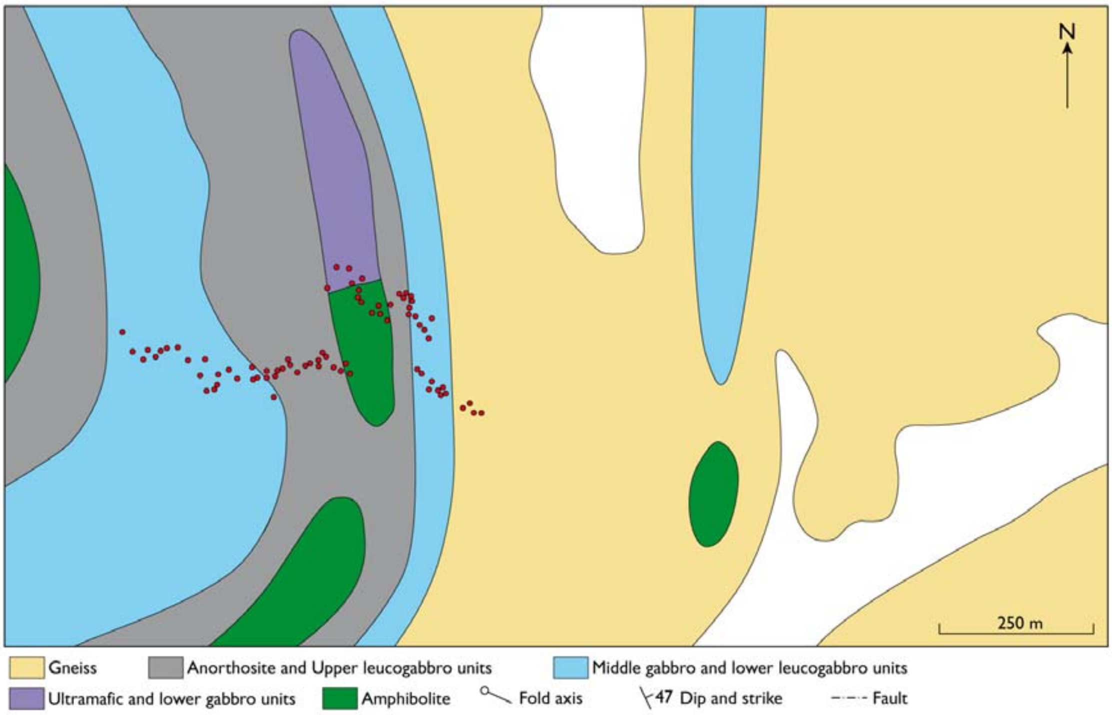


Figure 6. *Profile 1 (2008) – Qeqertarsuatsiaaq. The figure shows the geology based on the 1:100 000 geological map, Fiskenaesset; legend according to the same map. Red dots represent samples collected along the profile. The profile is off-set in order to sample perpendicular to strike.*

Profile 2 (2008) – Sinarsuk: A total of 110 samples representing the 1,875 m long profile sampled across a suite of anorthosite, ultrabasic rocks, leucogabbros, amphibolites, and gneisses were analysed for Pd, Pt, and Au, and revealed only slightly elevated PGE values, confined by the ultrabasic rocks in particular; but also the hornblendite shows slightly elevated PGE-values.

The peak value of the Sinarsuk area is found in an ultrabasic rock belonging to the complex, located east of Lange Sø, revealing 48 ppb Pd and 17 ppb Pt.

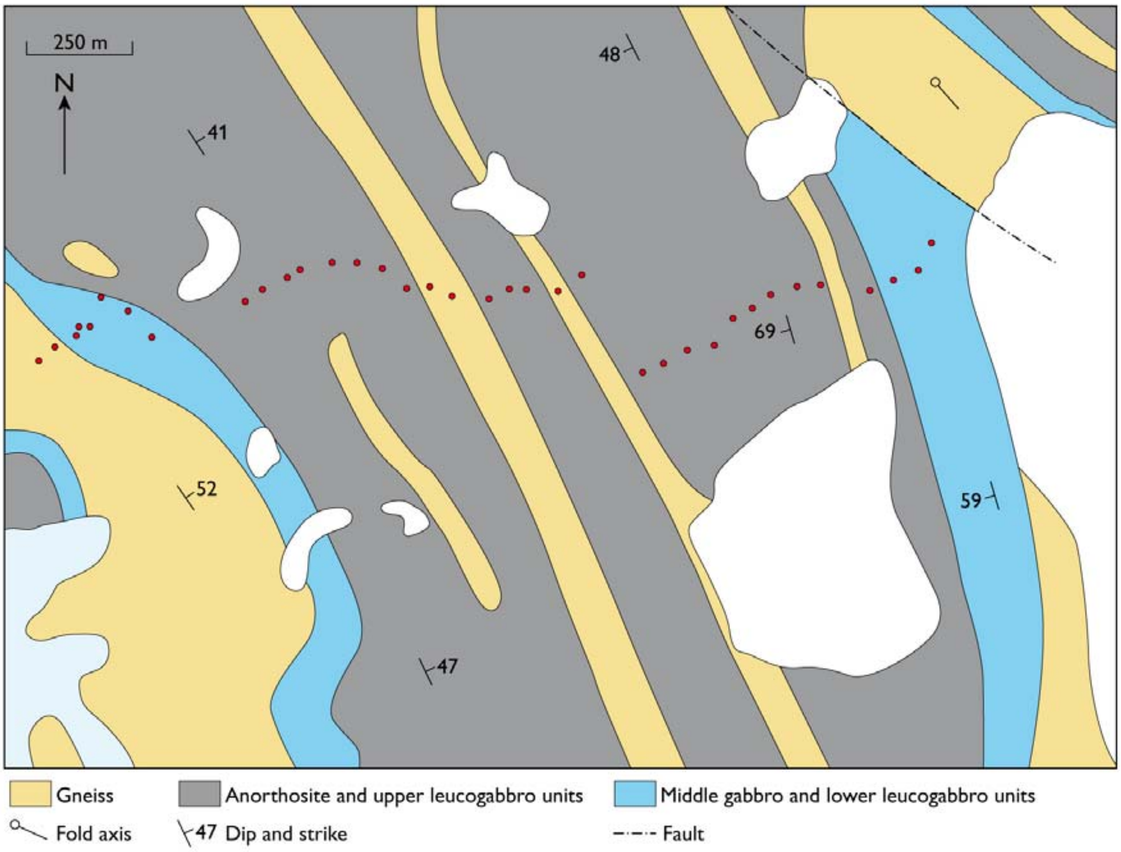


Figure 7. *Profile 2 (2008) – Sinarsuk: The geology based on the 1:100 000 geological map, Sinarssut; legend according to the same map. Red dots represent selected samples collected along the profile; samples are also collected in between the dots. The profile is offset, several times in order to sample perpendicular to strike.*

The geochemistry of two traverses show that the ultrabasic rocks make up the most prospective parts of the complex, though slightly elevated Pt and Pd values also are observed in the other rock unites belonging to the complex. Statistics on the 254 samples are shown in table 3.

Table 3. *The average and maximum content of Pt and Pd along Profile 2 (2008), sampled in the ultrabasic-, leuco-gabbro- and anorthosite rocks*.

	Ultrabasic rock	**Leucogabbro**	**Anorthosite**
Pt (ppb) Average/Max	6 / 21	4 / 13	3 / 11
Pd (ppb) Average/Max	7 / 57	3 / 18	2 / 7

The geochemical investigation at central Qeqertarssuatsiaq did not reveal a geochemical signature in the wall rocks of the bronzitite, which could betray the presence of a PGE mineralization. It can be considered that the sampling was too widely spaced and therefore did not catch a potential continuation of the PGE mineralization.

The geochemical work along the profile in the Sinarsuk area did reveal low, but interesting Pt and Pd anomalies, and further detailed geochemical work in that area may pinpoint areas with PGE mineralization.

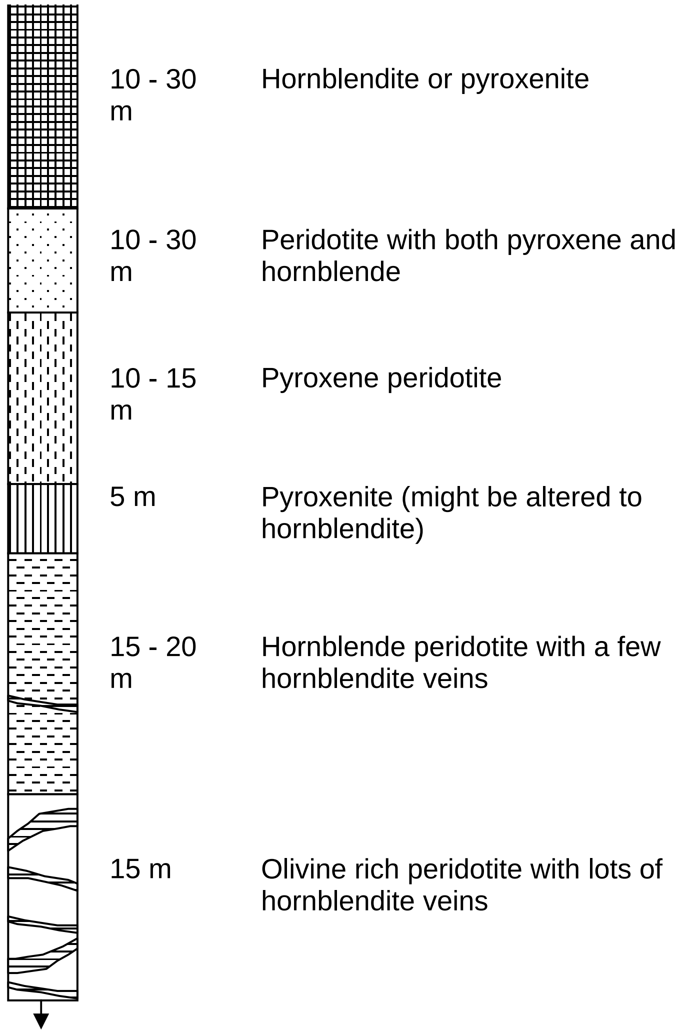
4.2 Follow up work on known PGE mineralization

The profiles sampled in 2009 are numbered Profile 1 to Profile 8.

4.2.1 Detailed mapping on northern Qeqertarssuatsiaq

The area on northern Qeqertarssuatsiaq consists of a package of ultrabasic rocks together with anorthosite and gabbroanorthosite; parts of the ultrabasic rocks host PGE mineralization. During field work in 1991 PGE-bearing rocks were discovered in a profile across a sequence ot ultramafic rocks. Field work in 2009 comprised sampling and detailed mapping along three profiles on Qeqertarssuatsiaq (Profile 1-3) and five profiles on Itise (Profiles 4-8).

Figure 8. *Simplified overall stratigraphy for the ultrabasic rock profiles*



The rocks are generally coarse-grained and often difficult to distinguish in the field. The main rock types identified in the field are pyroxenite, peridotite and hornblendite with small amounts of dunite. Discordant hornblendite veins are abundant especially in some of the peridotite layers.

4.2.2 Sampling across a PGE mineralised ultrabasic unit on northern Qeqertarssuatsiaq and Itise

Seven profiles were sampled across the ultrabasic rocks on Qeqertarssuatsiaq and Itise (Figs. 3 & 4). The degree of exposure did not allow a complete sampling across the entire width of the ultrabasic rocks. The areas sampled along profiles on Qeqertarssuatsiaq and Profile 5 on Itise was mapped in detail (see appendix A); the profiles 4, 6, 7 and 8, all from Itise, were sampled and described but not mapped. The choice of sampling technique has been based on practicalities, though where ever possible channel sampling by use of a rock saw was given priority. Table 4 provides an overview of the profiles, sampling technique applied and details on the samples. The ultrabasic rocks were named based of their olivine content. The most frequent rocks observed on the profiles were peridotite with varying amounts of hornblende and pyroxene; dunite was mainly observed around Profile 1 and 5.

Table 4. *Overview of the geochemical profiles with regard to samples and sampling technique applied. (Qeq = Qeqertarssuatsiaq. Chp = chip, Cha = channel)*

Profile	**Pr. 1**	**Pr. 2**	**Pr. 3**	**Pr. 4**	**Pr. 5**	**Pr. 6**	**Pr. 7**	**Pr. 8**
Location	Qeq	Qeq	Qeq	Itise	Itise	Itise	Itise	Itise
Type of sampling	Chp/ Cha	Chp/ Cha	Cha	Cha	Chp/ Cha	Chp	Grab	Grab
Samples	47	35	16	9	19	8	59	11
Length of profile (m)	62	46	20	10	32	9	61	41
Geological mapping	Yes	Yes	Yes	no	Yes	no	no	no
Profile described	Yes	Yes	Yes	Yes	Yes	Yes	no	no
Ghisler Reef exposed	Yes	No	No	?	?	?	?	?
Sample no.	475301-47	476901-35	476950-65	499601-09	499667-50	475370-77	495232-96	497301-11
Peak values Pd / Pt (ppb)	1480 /401	92/17	64/16	28/17	23/9	42/10	836 / 234	32 / 12

4.2.3 Geochemistry along profiles on Qeqertarssuatsiaq

Profile 1, Qeqertarssuatsiaq
The profile is ~60 m long (Table 5). The analytical results are shown in Appendix B. Selected results from a c. 25 m long part of profile is shown in Table 6. It should be emphasized that although scattered malachite staining is visible on the surface of the ultrabasic rocks, the sulphur contents are generally very low (<0.5%).

The distributions of Pd, Pt, Au, Cu and Bi in this profile are strongly correlated (see table 6 and Figure 8); no correlation was observed for e.g. Ni and Co with respect to PGE and Au. Pd, Pt and Au are present in small amounts through most of the profile, but significantly enrichments (690 ppb Pt+Pd+Au) are found over a ~5 m wide zone in the southern end of the profile (marked in yellow in tables 5 and 6); a peak value of 2 ppm Pt+Pd+Au with 20 ppb Rh over one meter is also detected. This section of the PGE-rich ultrabasic rocks is named the Ghisler Reef (Martin Ghisler, former Director of GEUS, who has for more than 40 years been mostly engaged in and has encouraged the investigation of the economic potential of the Fiskenaesset complex, the chromite deposits and sulphides/PGE (Ghisler, 1976)). Ghisler Reef is marked with yellow in the tables below. The co-variation of PGE and Bi is also betrayed by the appearance of PGE-Bi minerals as described in the chapter mineralogical investigations.

Table 5. *Description of rock types in profile Qeqartarssuatsiaq. The green colour denotes the part of the belt with PGE contents. The yellow colour denotes Ghisler Reef.*

From	To	Description of rock types in profile 1
-0.3	0	NO SAMPLE. Probably olivine rich pyroxene peridotite with cross cutting hornblendite veins.
0	3.3	Mainly olivine rich pyroxene peridotite with lots of cross cutting hornblendite veins.
3.3	5.8	Pyroxene bearing dunite.
5.8	10	Mainly olivine rich pyroxene peridotite with lots of cross cutting hornblendite veins. Serpentinized olivine from 9 to 10 m.
10	20	Mainly hornblende peridotite with a few cross cutting hornblendite veins. Sometimes overgrown by orange algae. Only very limited outcrop.
20	25	GAP. Probably hornblende peridotite with a few cross cutting hornblendite veins.
25	28.5	Mainly hornblende peridotite with a few cross cutting hornblendite veins. Sometimes overgrown by orange algae.
28.5	33	Massive olivine rich pyroxenite, dark green rock with dark grey and reddish striations. 20 – 60 % olivine, 30 – 80 % pyroxene, < 10 % hornblende.
33	36.4	Massive pyroxene peridotite, dark green rock with dark grey and reddish striations.
36.4	37	Hornblende pyroxene peridotite. 20 – 25 % hornblende, orange algae.
37	43.4	Pyroxene peridotite with zones of olivine rich pyroxenite. Erodes in lumps, grey green rock with some banding. Very rusty, areas with malachite staining and sulphide weathering. Orange algae.
43.4	47	Mainly pyroxene peridotite. Similar in appearance to 25 – 28.5 m interval. Orange algae. Still erodes in lumps.
47	50.5	Hornblende pyroxene peridotite. Darker due to higher amphibole content. Still some orange algae. Does no longer erode in lumps.
50.5	51.5	Pyroxene hornblende peridotite. A 1 m bench with 2 distinct 5 cm pyroxene bands in olivine matrix.
51.5	52.5	Hornblendite (50 – 90 % hornblende). Not as massive. Still dark with pyroxene hornblende bands, rusty patches.
52.5	53.4	NO SAMPLE. Looks like hornblendite.
53.4	54	Pyroxene hornblendite (10 – 30 % pyroxene).
54	56.8	Hornblendite (70 – 95 % hornblende). Darker, massive, rich in hornblende, some pyroxene, no sulphides.
56.8	57.6	Hornblendite. Not as massive. Still dark with pyroxene hornblende bands, rusty patches. 20 – 30 % olivine.
57.6	58	Hornblendite. 0.4 m hornblende band, green brown appearance in outcrop
58	59	Hornblendite, rich in olivine (ca. 40 %). Not as massive. Still dark with pyroxene hornblende bands, rusty patches.

Table 6. *Selected element distribution along part of profile 1. The green colour denotes the part of the belt with PGE contents. The yellow colour denotes Ghisler Reef. (n.a. = not analysed).*

Table 6	**Cu**	**Ni**	**Co**	**Bi**	**S**	**Au**	**Pt**	**Pd**	**Rh**	**Length**
Pr. 1	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppb**	**ppb**	**ppb**	**ppb**	**metres**
475327	864	396	24	0.7	0.26	7	30	132	n.a.	1.0
475328	996	464	28	0.8	0.36	9	24	136	n.a.	1.0
475329	686	471	52	0.7	0.18	9	46	196	n.a.	2.0
475330	1712	762	91	1.4	0.40	47	83	493	9	1.0
475331	1088	257	26	0.8	0.16	19	60	264	n.a.	1.0
475332	940	368	41	0.2	0.19	21	48	236	n.a.	1.0
475333	837	656	71	0.3	0.21	22	48	219	n.a.	1.0
475334	655	407	50	0.2	0.19	9	45	238	n.a.	1.2
475335	1063	685	90	0.3	0.30	13	58	325	n.a.	1.2
475336	1136	491	78	0.5	0.11	9	24	115	n.a.	1.0
475337	572	747	90	0.2	0.15	11	34	157	n.a.	1.6
475338	342	612	66	<0.1	0.12	4	19	90	n.a.	1.5
475339	566	826	96	0.2	0.21	23	318	211	n.a.	1.5
475340	503	735	74	0.3	0.19	9	45	199	n.a.	1.5
475341	526	467	54	0.9	0.18	17	48	205	n.a.	1.0
475342	2592	836	74	5.4	0.48	116	401	1480	20	1.0
475343	30	731	97	<0.1	<0.05	54	76	41	n.a.	1.1
475344	49	368	48	<0.1	<0.05	<2	24	31	n.a.	1.5
475345	30	438	53	<0.1	<0.05	4	14	14	n.a.	0.8

Profiles 2 and 3, Qeqertarssuatsiaq

The chip- and channel sampled profiles (Table 7- 10) show low but elevated contents of PGE and Au (see complete assay results in Appendix B), but no trace of Ghisler Reef. The absence of the Ghisler Reef is assumed to be due to the fact that this particular horizon is not outcropping on these two profiles and is thus not represented by the samples.

Table 7. *Selected element distribution along profile 2*

	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Length
Pr. 2	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppb**	**ppb**	**ppb**	**m**
476901	39	1689	107	<0.1	<0.05	2.2	9	130	1.00
476902	42	1323	108	<0.1	<0.05	1.1	<3	8	1.00
476903	36	1366	105	<0.1	<0.05	1.0	3	10	1,00
476904	35	1230	92	<0.1	<0.05	1.7	<3	13	1,00
476905	220	1135	87	0.7	<0.05	8.1	4	22	1.00
476906	85	608	53	0.3	<0.05	3.6	7	33	1.00
476907	100	947	72	0.1	<0.05	2.1	17	92	1.00
476908	68	812	67	0.3	<0.05	3.0	<3	25	1.00
476909	60	617	46	0.1	<0.05	1.5	5	6	1.00
476910	98	987	72	0.2	<0.05	1.6	6	5	1.50
476911	55	410	40	<0.1	<0.05	1.4	8	22	1.00
476912	61	117	12	<0.1	<0.05	0.9	5	5	1.00
476913	81	230	20	<0.1	<0.05	1.2	6	7	1.00
476914	107	483	40	<0.1	<0.05	0.8	16	15	1.00
476915	89	688	51	<0.1	<005	1.0	8	12	1.00
476916	125	479	43	0.1	<0,05	3.7	6	7	1.00
476917	59	583	45	<0.1	<0,05	2.4	9	13	1.00
476918	50	877	63	<0.1	<0,05	1.2	6	8	1.00
476919	49	990	75	<0.1	<0,05	1.2	17	12	1.00
476920	63	110	10	<0.1	<0.05	1.0	11	13	1.00
476921	80	157	12	<0.1	<0.05	<0.5	6	10	1.00
476922	72	216	22	0.1	<0.05	0.9	4	10	1.00
476923	56	332	40	0.2	<0.05	1.5	9	13	1.00
476924	51	242	25	<0.1	<0.05	0.9	7	11	1.00
476925	91	282	29	<0.1	<0.05	1.1	8	7	1.00
476926	82	319	36	0.2	<0.05	3.0	9	8	1.00
476927	67	304	32	0.1	<0.05	1.9	9	8	1.00
476928	81	318	36	0.2	<0.05	2.2	7	5	1.00
476929	102	318	37	0.4	<0.05	5.5	6	6	1.00
476930	72	492	56	0.2	<0.05	0.7	7	7	1.00
476931	22	531	57	<0.1	<0.05	<0.5	13	12	1.00
476932	49	703	59	0.1	<0.05	<0.5	<3	13	1.00
476933	73	728	64	0.4	<0.05	1.1	<3	8	1.00
476934	36	449	40	<0.1	<0.05	<0.5	7	10	1.00
476935	28	612	60	<0.1	<0.05	<0.5	5	10	1.00

Table 8. *Description of rock types along profile 2*

From	To	Description Profile 2
0	10	NO SAMPLE. Probably peridotite cut by a few later hornblendite veins.
10	12	Pyroxene peridotite cut by thin veins (< 5 cm) of hornblendite veins.
12	14	Pyroxene hornblende peridotite with later cross cutting hornblendite veins.
14	14.6	Pyroxene peridotite cut by thin veins (< 5 cm) of hornblendite veins.
14.6	14.9	Hornblende pyroxene peridotite cut by thin veins (< 5 cm) of hornblendite veins.
14.9	16	Pyroxene peridotite cut by thin veins (< 5 cm) of hornblendite veins.
16	17.8	Pyroxene hornblende peridotite with later cross cutting hornblendite veins.
17.8	20.5	Pyroxene peridotite with cross cutting hornblendite veins.
20	20.5	Estimated "overlap" between Channel 1 and Channel 2
20	28	Pyroxene hornblende peridotite with cross cutting hornblendite veins.
28	29	Hornblende pyroxene peridotite with 30 to 40 % of pyroxene
29	33.5	Pyroxene hornblende peridotite with cross cutting hornblendite veins.
33.5	37.2	Pyroxene hornblende peridotite with less cross cutting hornblendite veins. More fresh.
37.2	37.6	Hornblende pyroxene peridotite.
37.6	38	Pyroxene hornblende peridotite (more hornblende).
38	39.6	Pyroxene hornblendite with less cross cutting hornblendite veins. More fresh.
39.6	43	(Hornblende) pyroxene peridotite, more olivine, rough surface.
43	44	Pyroxene hornblende peridotite.
44	45	Pyroxene peridotite, less massive. More olivine, rough surface olivine is a bit sheared towards the contact. More orange algae are seen.
45	46	NO SAMPLE. Probably pyroxene peridotite covered by vegetation.

Table 9. *Selected element distribution along profile 3*

Profile 3	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Length
	ppm	ppm	ppm	ppm	%	ppb	ppb	ppb	metres
476950	67	566	60	<0.1	<0.05	<0.05	8	9	1
476951	82	835	80	0,1	<0.05	1.6	12	71	1
476952	70	1214	105	<0.1	<0.05	<0.05	5	15	1
476953	48	1101	101	<0.1	<0.05	<0.05	5	7	1
476954	99	1278	108	<0.1	<0.05	3.3	8	26	1
476955	108	692	70	<0.1	0.05	<0.05	5	12	1
476956	33	896	85	<0.1	<0.05	0.5	<3	5	1
476957	47	1038	99	<0.1	<0.05	<0.05	3	7	1
476958	137	1136	105	0.1	0.06	1,1	16	64	1
476959	36	1064	96	0.1	<0.05	<0.05	4	6	0.8
476960	31	864	87	0.2	<0.05	<0.05	7	21	0.8
476961	45	925	82	0.1	<0.05	<0.05	5	3	1
476962	87	1133	92	0.1	0.05	1.1	8	27	1
476963	29	1252	100	<0.1	<0.05	<0.05	13	60	1.2
476964	81	1230	110	0.1	<0.05	0.6	<3	3	1
476965	47	1328	107	<0.1	<0.05	<0.05	4	2	1.2

Table 10. *Description of rock types along profile 3*

From	To	Description Profile 3
0	2	Pyroxene hornblendite, some pyrrhotite
2	5	NO SAMPLE
5	11	Pyroxene peridotite, some sulphides, mostly chalcopyrite.
11	14	Hornblende peridotite, some sulphides, pyrrhotite and chalcopyrite. Olivine is serpentinized.
14	19	Peridotite with both pyroxene (20 – 30 %) and hornblende (20 – 40 %) in almost equal amounts. Some pyrrhotite and chalcopyrite. Several zones of serpentinized olivine.
19	20	NO SAMPLE

4.2.4 Geochemistry along profiles Itise

Table 11. *Selected element distribution along profile 4*

	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Length
Pr.4	**PPM**	**PPM**	**PPM**	**PPM**	**%**	**PPB**	**PPB**	**PPB**	**m**
499601	7	353	49	<0.1	<0.05	<0.5	9	11	1.00
499602	15	321	48	<0.1	<0.05	<0.5	8	8	1.00
499603	44	267	35	<0.1	<0.05	0.6	7	10	1.00
499604	34	376	50	<0.1	<0.05	<0.5	10	17	1.00
499605	41	366	46	<0.1	<0.05	7.9	na	na	1.00
499606	35	362	48	<0.1	<0.05	0.5	12	27	1.00
499607	21	378	49	<0.1	<0.05	<0.5	9	16	0.90
499608	42	359	47	<0.1	<0.05	0.7	17	28	0.90
499609	33	379	49	<0.1	<0.05	<0.5	11	21	0.90

Table 12. *Description of rock types along profile 4*

From	To	Description Profile 4
-0.5	0	NO SAMPLE
0	2	Pyroxene hornblendite with 50 – 80 % hornblende and 20 – 35 % pyroxene.
2	3	Hornblendite, 80 – 90 % hornblende.
3	5.6	Pyroxene hornblendite with 50 – 80 % hornblende and 20 – 35 % pyroxene.
5.6	5.8	Hornblendite, 80 – 90 % hornblende
5.8	8.7	Pyroxene hornblendite with 50 – 80 % hornblende and 20 – 35 % pyroxene.
8.7	9.5	NO SAMPLE

Table 13. *Selected element distribution along profile 5*

	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Length
	ppm	ppm	ppm	ppm	%	ppb	ppb	ppb	m
499650	35	922	89	<0.1	<0.05	<0.5	<3	<2	1.00
499651	61	1122	110	<0.1	<0.05	3.3	4	9	1.00
499652	61	783	83	<0.1	<0.05	1.4	6	6	1.00
499653	69	882	91	<0.1	<0.05	0.6	7	5	1.00
499654	26	964	102	<0.1	<0.05	1.8	7	5	1.00
499655	64	902	95	<0.1	<0.05	1.0	6	8	1.00
499656	63	569	74	<0.1	<0.05	1.3	8	4	1.10
499657	56	849	98	<0.1	<0.05	2.6	7	23	0.80
499658	47	1020	102	<0.1	<0.05	1.4	<3	<2	2.10
499659	38	1046	106	<0.1	<0.05	0.7	<3	5	2.00
499660	54	982	101	<0.1	<0.05	0.9	<3	2	2.00
499661	39	884	96	<0.1	<0.05	0.9	9	3	2.00
499662	60	715	85	<0.1	<0.05	1.0	9	6	2.00
499663	39	969	104	<0.1	<0.05	3.1	7	4	2.00
499664	247	926	91	0.1	0.09	2.0	9	18	2.00
499665	30	833	92	<0.1	<0.05	1.0	<3	2	2.00
499666	40	909	97	<0,1	<0.05	2.6	<3	<2	2.00
499667	43	1032	109	<0.1	<0.05	0.7	<3	<2	2.00
499672	25	894	100	<0.1	<0.05	2.8	<3	<2	2.00

Table 14. Description of rock types along profile 5

From	To	Description
0	3	Pyroxene hornblende peridotite
3	7	Hornblende pyroxene peridotite, rich in olivine, rough surface, some sulphides
7	12	Hornblende pyroxene peridotite, striped surface from pyroxene layers, some sulphides.
12	14	NO SAMPLE
14	18	Pyroxene peridotite, striped surface from pyroxene layers, no sulphides.
18	22	Pyroxene, hornblende, peridotite, rough surface, no sulphides.
22	24.9	Pyroxene, hornblendite, more altered.
24.9	28	Pyroxene, peridotite with alternating zones of dunite and pyroxene hornblendite.
28	31	Pyroxene, hornblende, peridotite with 5 cm of dunite and 0.5 m of hornblendite and hornblende peridotite.
31	32	Pyroxene Peridotite, 70 - 80 % of olivine.

Table 15. *Selected element distribution along profile 6*

Table 15	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Length
Pr.6	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppb**	**ppb**	**ppb**	**m**
475370	42	885	92	<0.1	<0.05	1.4	7	3	0.50
475371	21	830	95	<0.1	<0.05	1.2	7	3	0.60
475372	39	878	97	<0.1	<0.05	1.3	7	4	0.30
475373	40	885	96	<0.1	<0.05	2.1	<3	2	0.50
475374	92	775	79	0.1	<0.05	3.0	5	10	2.10
475375	105	794	80	<0.1	<0.05	2.4	10	42	2.00
475376	111	890	84	<0.1	<0.05	2.4	7	24	1.50
475377	192	937	87	0.2	<0.05	2.8	4	28	1.50

Table 16. *Description of rock types along profile 6*

From	To	Description
0	0.5	Hornblende pyroxenite.
0.5	1.1	Hornblende pyroxene peridotite.
1.1	1.4	Hornblende pyroxenite.
1.4	4	Pyroxene peridotite.
4	9	Hornblende pyroxenite or pyroxene hornblendite.

Table 17. *Selected element distribution along Profile 7.*

See next page.

Table 17	Cu	Ni	Co	Bi	S	Au	Pt	Pd	Distance	Rh
Pr. 7	ppm	ppm	ppm	ppm	%	ppb	ppb	ppb	metres	ppb
495239	5	241	18	<0.1	<0.05	<0.5	4	<2	1.5	n.a.
495240	1	229	16	<0.1	<0.05	<0.5	6		2.0	n.a.
495241	1	181	12	<0.1	<0.05	4.2	8	3	3.0	n.a.
495242	28	864	99	<0.1	<0.05	2.5	9	4	4.0	n.a.
495243	9	1693	153	<0.1	<0.05	1.6	4	6	5.0	n.a.
495244	26	895	86	<0.1	<0.05	1.7	6	7	6.0	n.a.
495245	9	1413	118	<0.1	<0.05	1.9	3	3	7.5	n.a.
495246	20	515	59	<0.1	<0.05	1.2	7	4	8.0	n.a.
495247	16	608	64	<0.1	<0.05	0.8	<3	3	9.0	n.a.
495248	46	959	98	<0.1	<0.05	1.3	<3	6	10.0	n.a.
495249	45	839	86	<0.1	<0.05	1	3	5	10.5	n.a.
495250	12	1370	123	<0.1	<0.05	1.6	7	9	11.0	n.a.
495251	4	535	64	0.1	0.05	1.1	5	8	12.0	n.a.
495252	99	746	89	0.2	0.09	2.3	5	26	12.5	n.a.
495253	106	682	82	0.3	<0.05	6.4	4	2	13.5	n.a.
495254	55	563	72	0.2	<0.05	2.2	6	6	14.5	n.a.
495255	12	257	17	<0.1	<0.05	1.3	3	4	15.0	n.a.
495256	7	1356	135	<0.1	<0.05	1.5	5	<2	16.0	n.a.
495257	110	774	81	<0.1	<0.05	1.5	4	<2	17.0	n.a.
495258	96	490	47	<0.1	<0.05	1.8	9	3	18.0	n.a.
495259	8	480	42	<0.1	<0.05	1.4	5	<2	19.0	n.a.
495260	100	887	92	0.2	0.08	0.9	7	<2	20.0	n.a.
495261	32	612	73	<0.1	<0.05	1.3	13	6	22.0	n.a.
495262	2	264	22	<0.1	<0.05	1.1	5	<2	22.5	n.a.
495263	31	749	86	<0.1	<0.05	1.8	8	7	23.0	n.a.
495264	44	698	80	<0.1	<0.05	1.3	7	5	24.5	n.a.
495265	4	454	39	<0.1	<0.05	0.7	7	<2	25.5	n.a.
495266	114	830	86	0.1	0.08	1.5	7	6	26.5	n.a.
495267	67	680	79	<0.1	<0.05	1.3	9	5	28.0	n.a.
495268	30	622	74	<0.1	<0.05	1.8	6	9	29.0	n.a.
495269	19	838	96	<0.1	<0.05	1.1	7	<2	29.5	n.a.
495270	19	505	58	<0.1	<0.05	0.6	8	3	30.5	n.a.
495271	8	416	60	<0.1	<0.05	0.9	17	17	33.0	n.a.
495272	25	375	54	<0.1	<0.05	1.8	7	4	34.0	n.a.
495273	28	110	12	<0.1	<0.05	2.5	27	64	34.5	n.a.
495274	6	352	53	<0.1	<0.05	1	11	7	35.5	n.a.
495275	3	667	100	<0.1	<0.05	1.9	26	12	37.0	n.a..
495276	20	620	88	<0.1	<0.05	1.2	19	6	38.0	n.a.
495277	2	691	104	<0.1	<0.05	0.9	23	12	38.5	n.a.
495278	38	610	89	<0.1	<0.05	<0.5	7	14	39.0	n.a.
495279	1	690	108	<0.1	<0.05	<0.5	7	16	39.5	n.a.
495280	3	703	113	<0.1	<0.05	<0.5	22	8	40.5	n.a.
495281	97	544	79	0.1	<0.05	1.3	10	55	41.0	n.a.
495282	30	264	48	<0.1	<0.05	1.4	234	836	42.0	27
495283	229	142	13	0,2	<0.05	7.9	34	54	43.5	n.a.
495284	1	233	43	<0.1	<0.05	<0.5	5	5	44.0	n.a.
495285	12	187	30	<0.1	<0.05	<0.5	11	24	44.5	n.a.
495286	452	438	64	0.1	0.18	8.1	119	264	46.5	7
495287	239	350	46	<0.1	0.09	4.6	82	250	47.0	9
495288	63	251	32	<0.1	<0.05	1	23	30	47.5	n.a.
495289	278	242	40	0.3	<0.05	18.1	18	84	48.0	n.a.
495290	173	404	60	0.2	<0.05	8.4	48	161	49.0	n.a.
495291	115	1206	111	<0.1	<0.05	0.6	<3	2	53.0	n.a.
495292	36	458	17	<0.1	<0.05	0.7	45	184	55.0	n.a.
495293	716	151	11	0.3	0.12	10.4	63	339	56.0	8
495294	1059	373	40	<0.1	0.37	11.5	67	386	59.5	7
495295	446	320	22	0.2	0.14	6.6	26	139	60.5	n.a.
495296	7	1196	108	<0.1	<0.05	<0.5	<3	6	61.5	n.a.

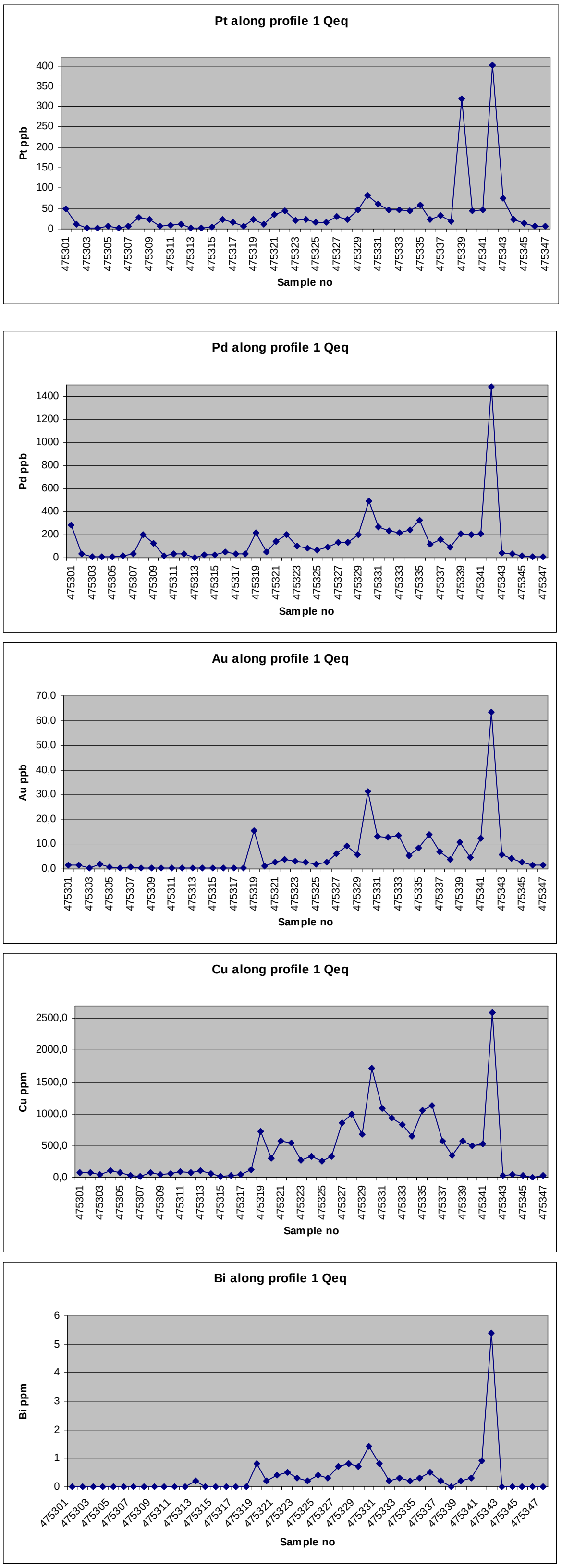
Table 18	Cu	Ni	Co	Bi	S	Au	Pt	Pd
Pr. 8	ppm	ppm	ppm	ppm	%	ppb	ppb	ppb
497301	14	2044	144	n.d.	n.d.	0.7	n.d.	n.d.
497302	59	902	63	0.2	n.d.	1.4	4	4
497303	73	1558	116	n.d.	n.d.	0.6	6	6
497304	56	1976	129	n.d.	n.d.	n.d.	n.d.	n.d.
497305	12	104	9	n.d.	n.d.	0.9	n.d.	
497306	127	484	23	n.d.	n.d.	n.d.	4	4
497307	30	883	64	n.d.	n.d.	n.d.	6	6
497308	90	520	52	0.6	n.d.	3.3	12	12
497309	14	675	78	n.d.	n.d.	n.d.	4	4
497310	17	728	78	n.d.	n.d.	n.d.	7	7
497311	15	796	76	n.d.	n.d.	n.d.	4	4

Table 18. *Selected element distribution along Profile 8. n.d. = not detected.*

4.2.5 Au, PGE and other trace element variation across the mineralised ultrabasic rock unit

Plots of the results of Pt, Pd, Au, Cu and Bi across the best mineralised part of Profile 1, Qeqertarssuatsiaq, including the Ghisler Reef, are shown in Figure 9. Similar plots for profile 7 at Itise, are shown in Figure 10.

The covariance between the plotted elements is near perfect along Profile 1. Bi shows clearly to be correlated with the PGE as well as copper. Along profile 7, Bi does not show the same correlation. Part of the explanation is probably that the Bi contents generally are quite low along this profile and is actually rather close to the detection limit. Along both profiles gold and PGE show near perfect correlation.



Pt along profile 1

Pd along profile 1

Au along profile 1

Cu along profile 1

Bi along profile 1

Figure 9. *Pt, Pd, Au, Cu and Bi distribution along Profile 1. Data are shown in Appendix B*

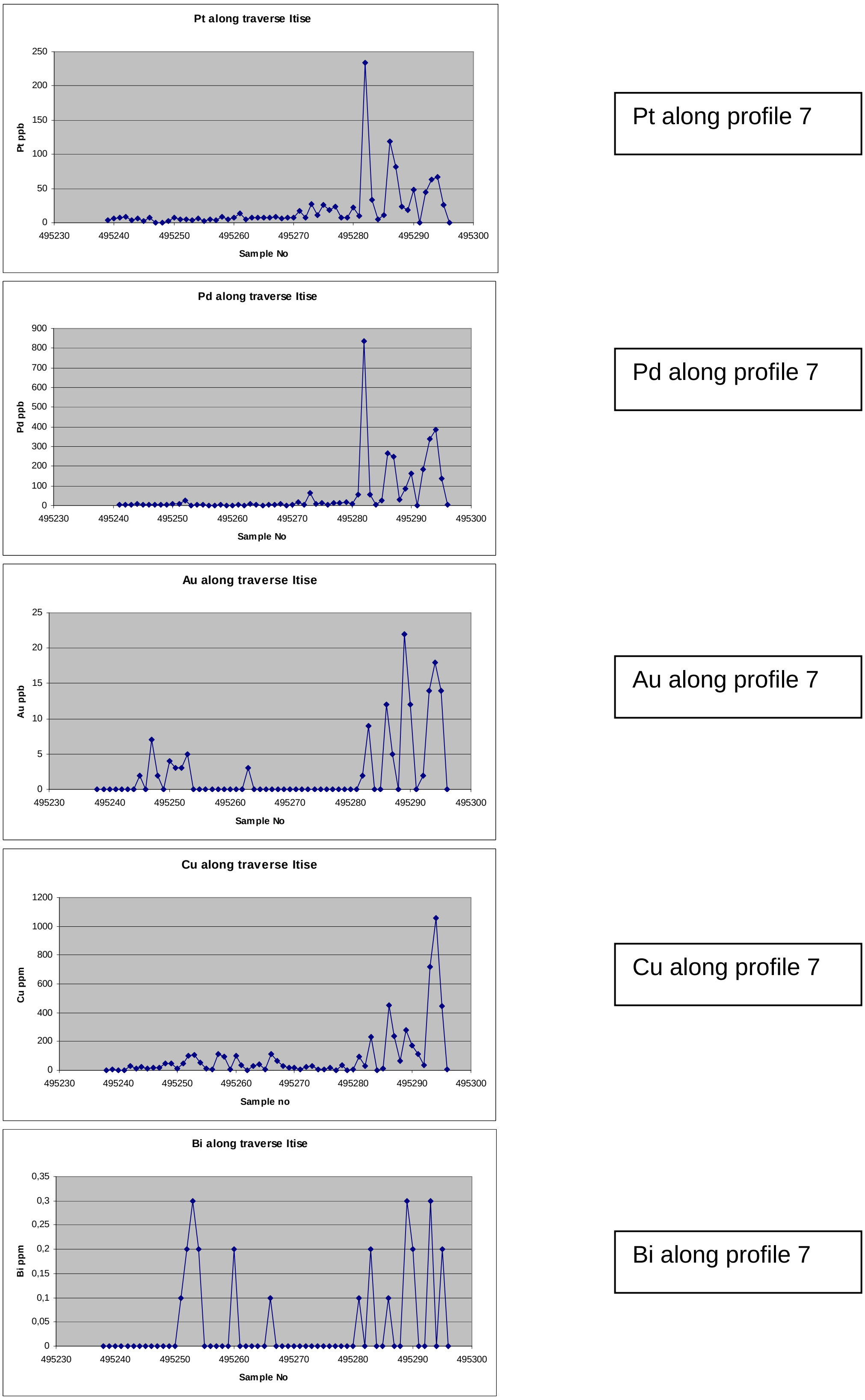


Figure 10. Pt, Pd, Au, Cu and Bi along profile 7 on Itise. Data are shown in Appendix B

4.2.6 Mineralogical investigations

A chip sample (393873) from Qeqertarssuatsiaq, collected in 1991, covering c. 2 m and weighing about 1.5 kg, has been investigated by CNTLabs, St. Petersburg, for its contents of PGE-minerals. The full report can be seen in Appendix C.

The main minerals of this sample included olivine, edenite and magnetite together with small amounts of pentlandite and chalcopyrite. Eleven precious metal minerals were found:

- Froodite PdBi2,
- Sobolevskite (Pd, Pt) Bi,
- Insizwaite PtBi2,
- Maslovite PtTeBi,
- Michenerite (Pd, Pt) TeBi,
- Keithconnite Pd1-x (Te, Bi),
- Unnamed Cu3Pt3Bi4S10,
- Electrum AuAg,
- Native Ag,
- Parkerite Ni3Bi2S2
- Native Bi.

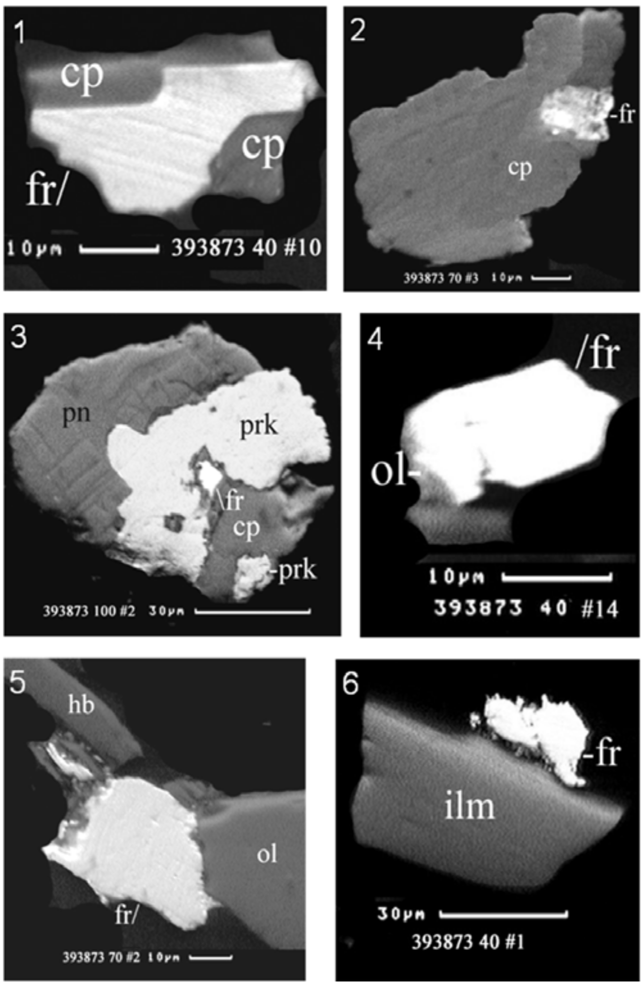


Figure 11. *SEM-back scatter images. fr - froodite, cp – chalcopyrite, pn – pentlandite, prk – parkerite, ol – olivine, hb – hornblende, ilm – ilmenite (CNTLabs, St. Petersburg).*

Preliminary microscopic investigation of selected samples from the Sinarsuk area revealed one sample (no 513883) with a PGE mineral. It was analysed on SEM at GEUS and later on a microprobe at the Institute of Geography and Geology at the University of Copenhagen. The mineral proved to be melonite (see analysis in Table 19).

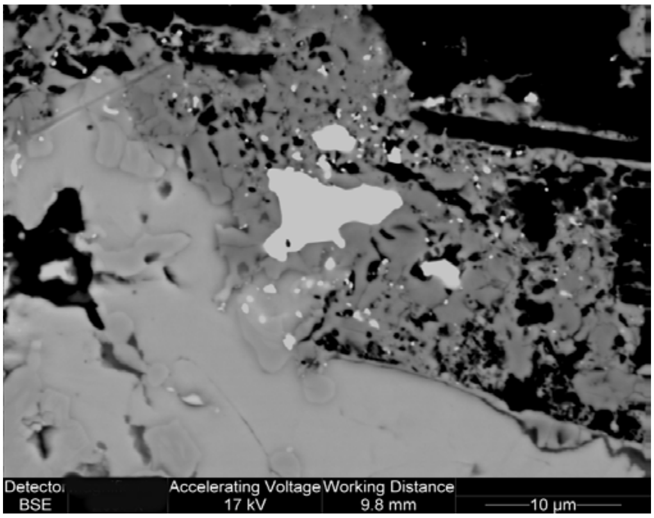


Figure 12. *Melonite (white) in altered magnetite next to chalcopyrite (light grey) SEM back scatter image. Sample 513883*

Table 19. *Microprobe analysis carried outon the melonit, sample 513883 (Fig. 12) at Institute of Geography and Geology, University of Copenhagen.*

Element	%	%	%	%	%	%	%	%
Te	76.85	75.20	65.60	75.97	74.39	58.77	74.10	62.00
Fe	2.66	4.62	11.70	2.61	3.25	12.67	3.69	10.67
Pd	0.172	0.140	4.400	0.195	0.178	0.435	0.226	0.492
Ni	19.82	19.50	12.33	19.59	18.92	15.58	18.75	12.58
Cu	0.327	0.230	0.182	0.274	0.175	0.415	0.530	0.325
Pt	1.16	1.40	1.61	1.16	1.51	1.73	1.67	5.2
total	100.98	101.09	95.82	99.79	98.42	89.60	98.96	91.26

5. Comparison with other types of PGE mineralization

The present study on the PGE mineralization in the Fiskenaesset complex has revealed geological resemblance with some well-known economic PGE deposits: The Fiskenaesset PGE mineralization is hosted in ultrabasic rocks ranging from dunites, over peridotites to pyroxenites and hornblendites. A further characteristic is the abundance of hornblende pegmatites as observed in the vicinity of Ghisler Reef, indicating that late mobilisation may have played a role in deposition of the PGE. Similar observations have been made at the PGE deposits like Sudbury, the Great Dyke, Noril'sk-Talnakh, and the komatiite-hosted PGE mineralization such as Raglan and Pechenga (Farrow & Lightfoot, 2002). Several of these deposits have also Bi anomalies associated with the PGE. However, the majority of the world class PGE deposits have high contents of sulphides hosted in Cu and Ni sulphides. Ghisler Reef has high Bi contents but low sulphur contents.

The PGE grades so far discovered in the Fiskenaesset complex is comparable with the world class PGE deposits seen elsewhere as seen in Table 20 below. The last column is the grade over mining width of 2 metres. The table shows some localities returning near-commercial PGE grades.

Table 20. *Grades at different PGE deposits compared with Ghisler Reef*

Locality	**Pt + Pd (ppm)**	**Width (m)**	**Grade across the reef (Pt+Pd ppm)**
Merensky	6.9	0.4	1.38/2m
Stillwater	0.75	Ore body	
Kola	1.81	Ore body	
Qeqertarssuatsiaat (Ghisler Reef)	2 0.7	1 5	1/2m 0.7/5m
Itise	1.1	1	0.55/2m

6. Conclusions

The anorthosite complex has a strike length of c. 200 km. The complex is not continuous, but is tectonically broken up into fragments from 50 km to a few metres in length. The complex has undergone amphibolite and granulite facies metamorphism.

The discovery of the Ghisler Reef has proven that parts of the Fiskenaesset anorthosite complex may contain economic PGE deposits and thus should be regarded as a future exploration target.

The promising PGE reef (Ghisler Reef) grades 695 ppb Pt+Pd+Au over 5 m and 2 ppm combined Pt+Pd+Au +Rh over 1 m has been located in a sequence of pyroxenite, peridotite and dunite cut by hornblendite veins on Qeqertarssuatsiaq (Profile 1). A PGE Reef on Itise towards east is interpreted to be an extension of Ghisler Reef. The total strike length of the PGE-bearing ultrabasic rock unit is c. 5 km and the exposed thickness of the ultrabasic rock sequence is more than 50 m. The PGE contents discovered so far indicate near-ore grade over mineable widths.

Platinum and palladium show strong correlation with gold, copper and bismuth.
Detailed mineralogical investigations show that PGE occur in discrete minerals, often as bismuthides. The association of PGE with copper and bismuth is not common, but has been reported from deposits like the Great Dyke and Sudbury.

7. Recommendations

The Fiskenaesset area was mapped in scale 1:20,000 in the 1970'ies. A large number of high quality detailed field maps stemming from the mapping campaigns are stored at GEUS. These maps provide an excellent base for outlining, which parts of the anorthosite complex should be investigated. An office-based investigation of all available field maps and aerial photographs in order to outline possible prospective areas with sizeable ultra-basic rock units within the anorthosite complex is strongly recommended.

The first step should be detailed mineralogical and petrological investigations of Ghisler Reef focussing on similarities and dissimilarities between known large scale economic PGE-bearing intrusions elsewhere. This should go hand in hand with detailed mapping of the complex on northern Qeqertarssuatsiaq Island and Itise, focussing on potential discordant pegmatitic, ultrabasic rock phases. Additionally, a sampling programme, including trenching at selected places, should be part of the campaign in order to gain better knowledge of the surface dimensions of the PGE bearing ultrabasic rock suite, and to understand better the relationships to the other phases of the anorthosite complex.

Such a programme is not within the present plans and finances. Based on the encouraging results of this pilot study, it is therefore suggested to consider a two-year project of further detailed and targeted studies of the PGE potential at post doc level by an experienced researcher. A project proposal to that end has been worked out and can be presented for consideration by BMP.

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Appendix A. Geological Maps

Geological sketch map of the investigated area on Qeqertarssuatsiaq
Geol.Map.N.Qeq.jpg
Geological sketch map of the investigated area on Itise
Geo.Map.Itise.jpg
Sketch maps from Qeqertarssuatsiaq
Profile 1 and 2.jpg on Qeqertarssuatsiaq
Profile 1.jpg on Qeqertarssuatsiaq
Profile 3.jpg on Qeqertarssuatsiaq
Sketch map from Itise
Profile 5.jpg on Itise
See enclosed CD

Appendix B. Analytical results

Major and trace element analysis of samples collected during the field seasons 1991 and 2008 (Actlabs-2008.pdf and Analyses-1991.pdf)
List of samples collected in 2008 (Sample list2008.pdf)
List of samples and results of major and trace element analysis on samples collected by Ali Polat 2009 (Ali Polat Tables 2009.xls)
List of samples and results of major and trace element analysis on samples collected by Per Kalvig 2009 (Kalvig2009analysis.xls)
List of samples and results of major and trace element analysis on samples collected by Ole Dahl 2009 (Ole Dahl analysis.xls)

Analytical results for rhodium on selected samples (Rhodium analysis.xls)

See enclosed CD

Appendix C. PGE minerals in an ultrabasic rock rock from Northern Qeqertarssuatsiaq

Containing the following report:
PGE minerals_393873.pdf
See enclosed CD