DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2011/3

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2nd edition

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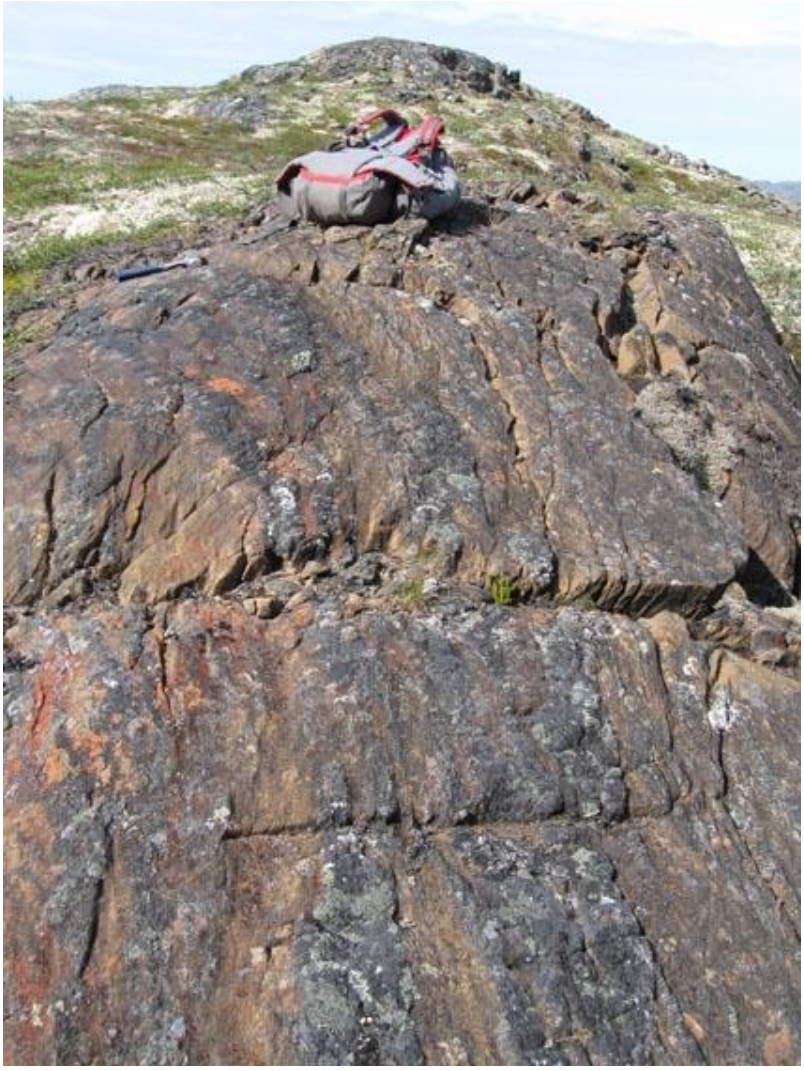


**Figure 1.** ***Olivine-rich peridotite with hornblendite veins***

# Summary

This report is a revised edition of the GEUS report 2010/29 Discovery of new PGE mineralization in the Precambrian Fiskenaesset anorthosite complex, West Greenland, following the geochemical results on ten additional samples, reported in paragraph 4.2.5.

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.

Chromitites in the anorthosite complex also show elevated PGE contents up to 600 ppb Pt and 300 ppb Pd as well as 300 ppb Au. Chromitites are widespread throughout the complex, but only limited investigation for PGE has been carried out in this rock type.

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 potential 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 Qeqertarssuatsiaat (see Fig. 2). It was thus decided to make detailed sampling along a profile over the complex across a PGE-bearing bronzitite on central Qeqertarssuatsiaat 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 Qeqertarssuatsiaat (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 Qeqertarssuatsiaat, 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. Some sections 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 Qeqertarssuatsiaat 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 (tab. 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 Qeqertarssuat-siaat | 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 Qeqertarssuatsiaat | | 0.36 | | 3.6 | | Ultrabasite |
| 130065 | North Qeqertarssuatsiaat | 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 Qeqertarssuatsiaat, 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 Qeqertarssuatsiaat, 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 Qeqertarssuatsiaat 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.

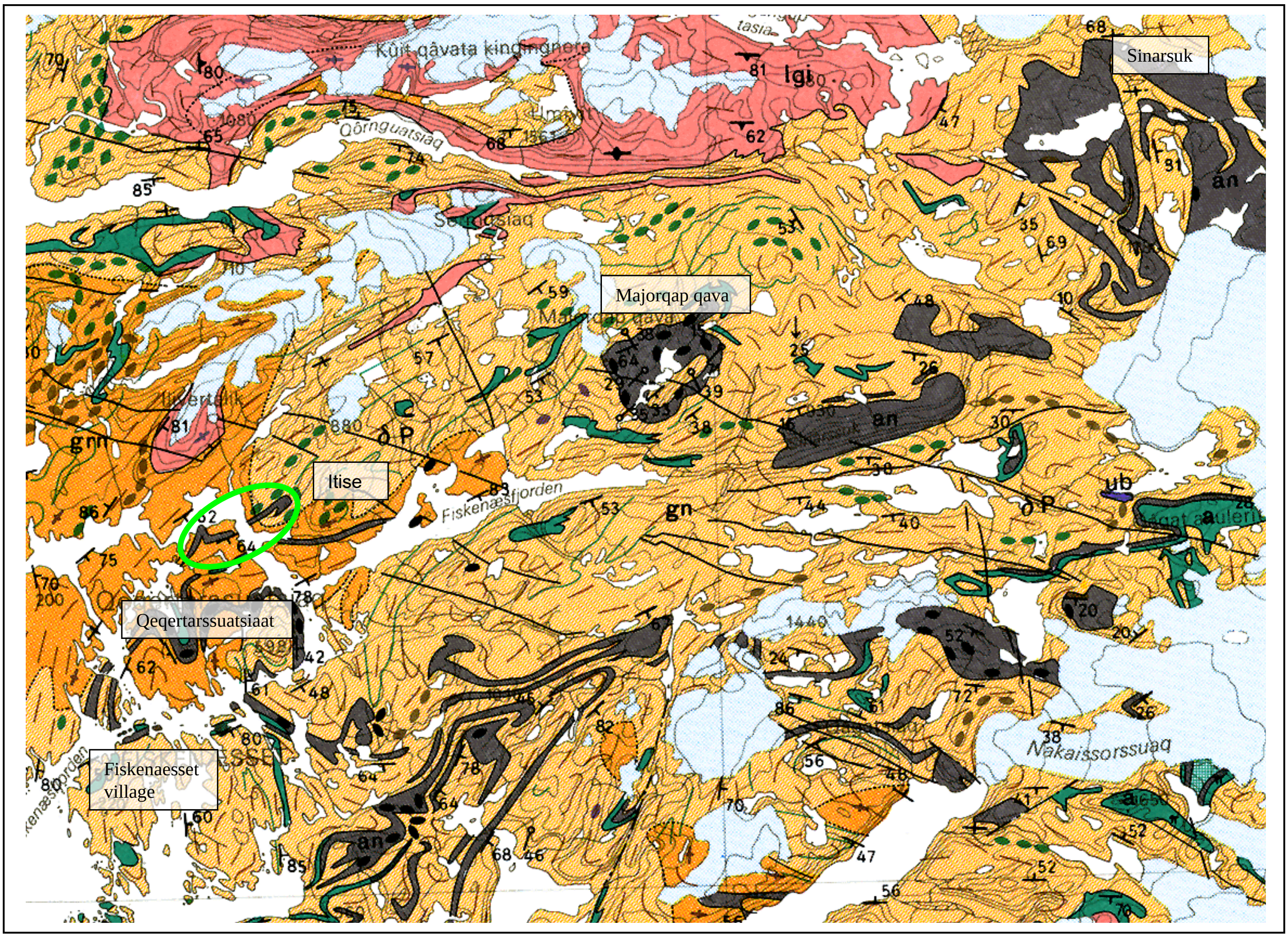
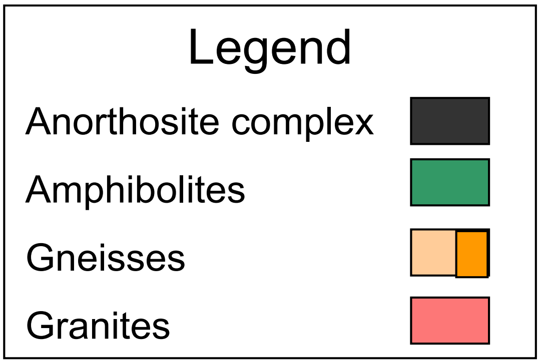



**Figure 2**. *Index map showing distribution of the anorthosite complex and target areas; the green circle indicates the Qeqertarssuatsiaat area and the Itise area. Legend equivalent to the GGU 1:500 000 map.*



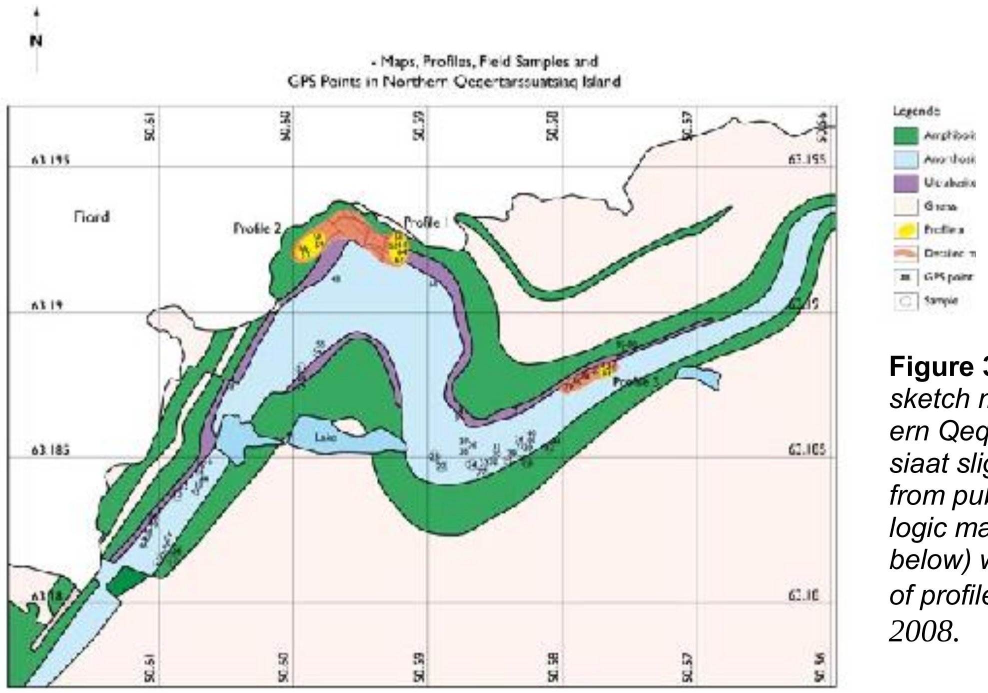



**Figure 3**. *Geological sketch map of northern Qeqertarssuatsiaat slightly updated from published geologic maps (see text below) with location of profiles sampled in 2008*.

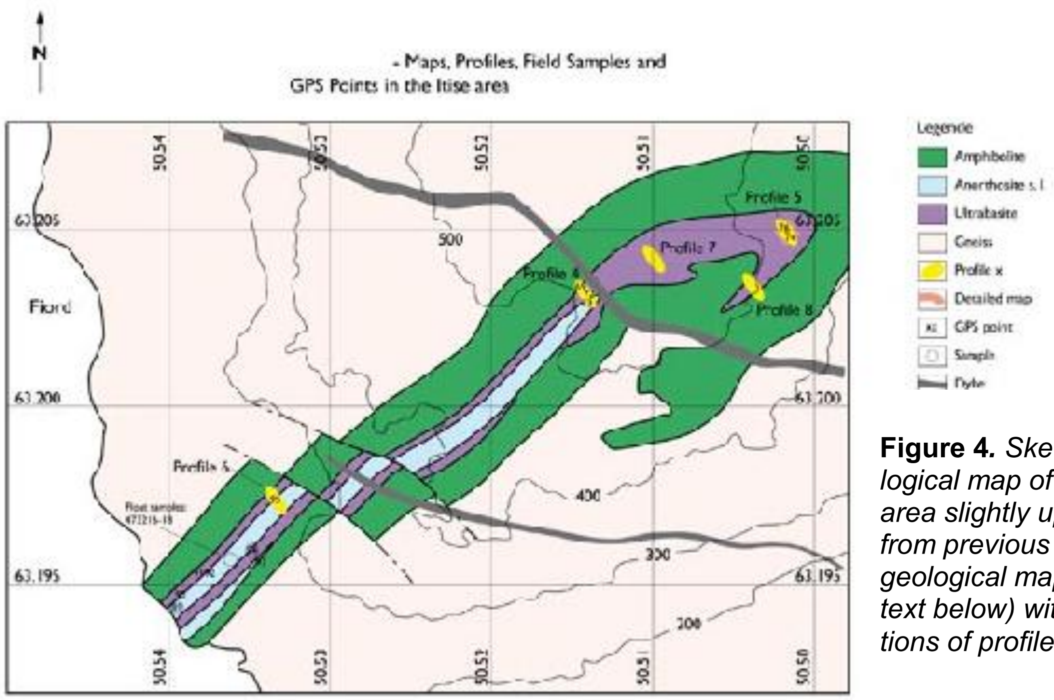



**Figure 4.** *Sketch geological map of the Itise area slightly updated from previous published geological maps (see text below) with locations of profiles*

1

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 Qeqertarssuatsiaat (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 3) 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 Qeqertarssuatsiaat 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 Qeqertarssuatsiaat, 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 Qeqertarssuatsiaat.

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. 3).

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 contami-*

*nation 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.*

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 and 2009 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:

- Profile 1 on the central part of Qeqertarssuatsiaat. 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 1991.
- Profile 2 in the north-eastern part of the intrusion in Sinarsuk. 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 – Qeqertarssuatsiaat: 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.

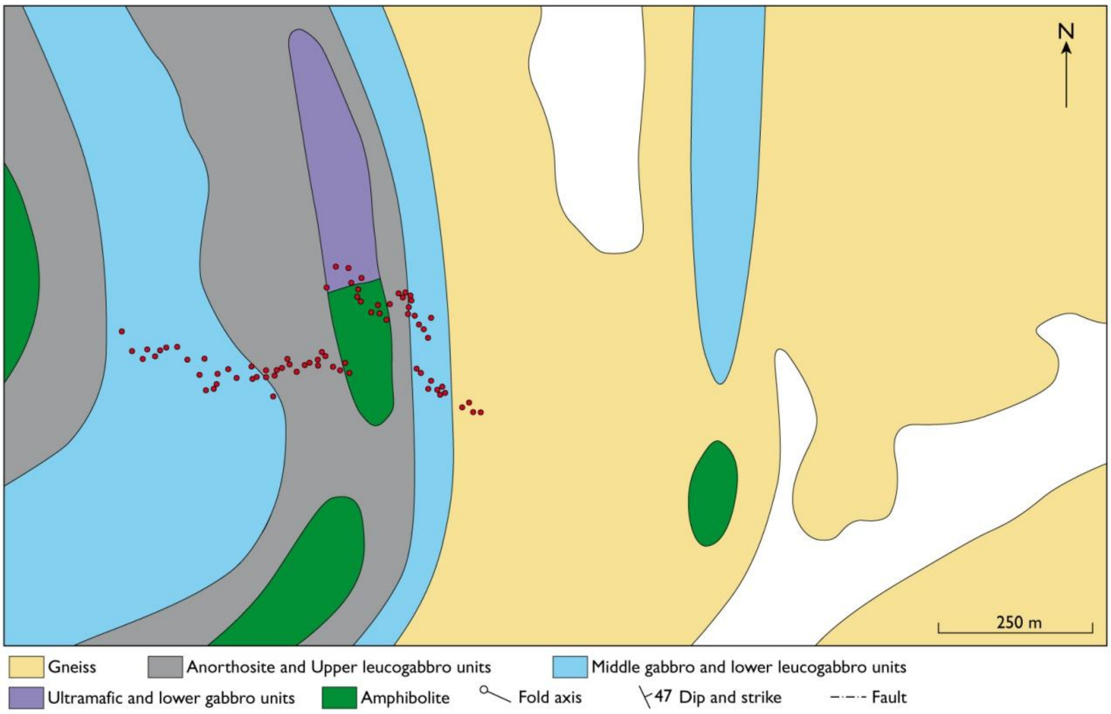



**Figure 6.** *Pt in Profile 1 – Qeqertarsuatsiaaq. The figure shows the geology based on the 1:100 000 geological map, Fiskenaesset; legend according to the same map. Red dots represent samples collected along the profile. The profile is off-set in order to sample perpendicular to strike.*

Profile 2 – 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.

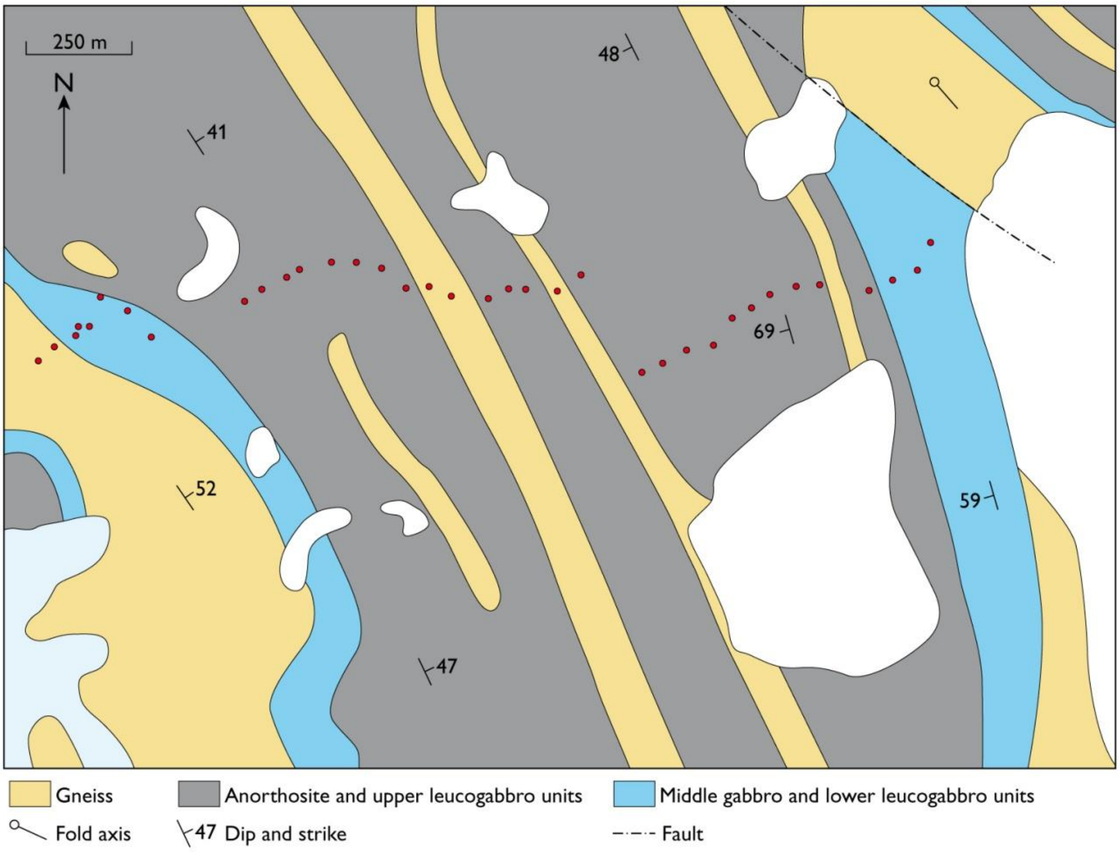



**Figure 7.** *Profile 2 – Sinarsuk: The geology based on the 1:100 000 geological map, Sinarssut; legend according to the same map. Red dots represent selected samples collected along the profile; samples are also collected in between the dots. The profile is off-set, several times in order to sample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

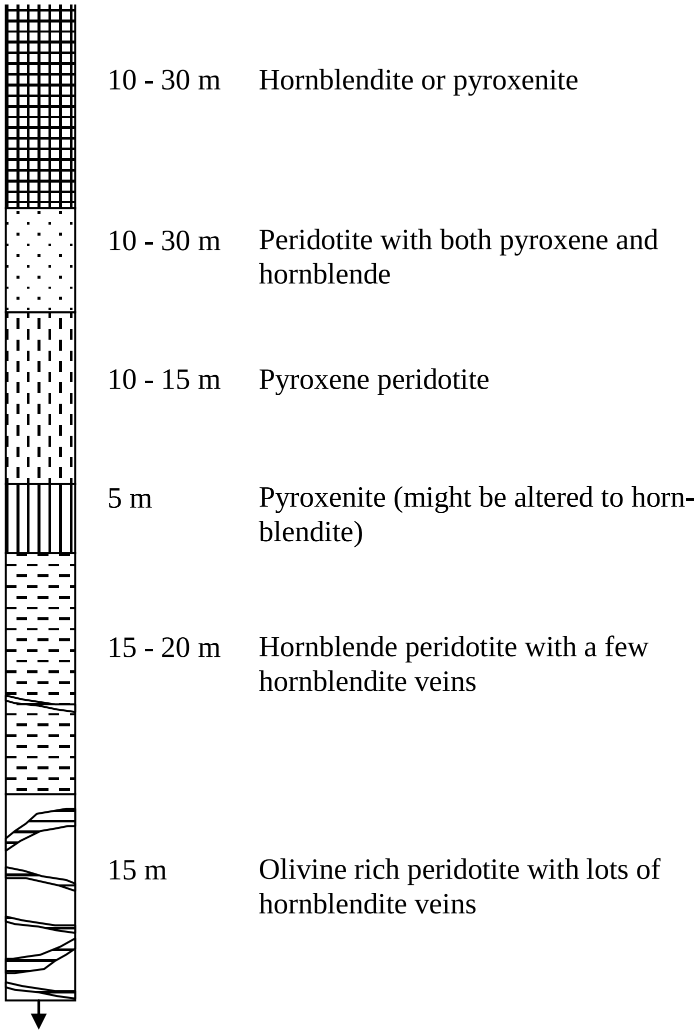
The geochemical work along the profile in the Sinarsuk area did reveal low, but interesting Pt and Pd anomalies, and further detailed geochemical work in that area may pinpoint areas with PGE mineralization.

## 4.2 Follow up work on known PGE mineralization

### 4.2.1 Detailed mapping on northern Qeqertarssuatsiaat

The area on northern Qeqertarssuatsiaat 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 Qeqertarssuatsiaat (Profile 1-3) and four profiles on Itise (Profiles 4-7).

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 Qeqertarssuatsiaat and Itise

Seven profiles were sampled across the ultrabasic rocks on Qeqertarssuatsiaat and Itise (Figs. 4 & 5). The degree of exposure did not allow a complete sampling across the entire width of the ultrabasic rocks. The areas sampled along profiles on Qeqertarssuatsiaat 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 = Qeqertarssuatsiaat. 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 Qeqertarssuatsiaat

Profile 1, Qeqertarssuatsiaat
The profile is ~60 m long. The analytical results are shown in Appendix B. Selected results from a c. 25 m long part of profile is shown in Table 4. 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); 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 Qeqartarssuatsiaat. 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 profile 1. The green colour denotes the part of the belt with PGE contents. The yellow colour denotes Ghisler Reef.*

| | 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 | | 1.0 |
| 475328 | 996 | 464 | 28 | 0.8 | 0.36 | 9 | 24 | 136 | | 1.0 |
| 475329 | 686 | 471 | 52 | 0.7 | 0.18 | 9 | 46 | 196 | | 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 | | 1.0 |
| 475332 | 940 | 368 | 41 | 0.2 | 0.19 | 21 | 48 | 236 | | 1.0 |
| 475333 | 837 | 656 | 71 | 0.3 | 0.21 | 22 | 48 | 219 | | 1.0 |
| 475334 | 655 | 407 | 50 | 0.2 | 0.19 | 9 | 45 | 238 | | 1.2 |
| 475335 | 1063 | 685 | 90 | 0.3 | 0.30 | 13 | 58 | 325 | | 1.2 |
| 475336 | 1136 | 491 | 78 | 0.5 | 0.11 | 9 | 24 | 115 | | 1.0 |
| 475337 | 572 | 747 | 90 | 0.2 | 0.15 | 11 | 34 | 157 | | 1.6 |
| 475338 | 342 | 612 | 66 | <0.1 | 0.12 | 4 | 19 | 90 | | 1.5 |
| 475339 | 566 | 826 | 96 | 0.2 | 0.21 | 23 | 318 | 211 | | 1.5 |
| 475340 | 503 | 735 | 74 | 0.3 | 0.19 | 9 | 45 | 199 | | 1.5 |
| 475341 | 526 | 467 | 54 | 0.9 | 0.18 | 17 | 48 | 205 | | 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 | | 1.1 |
| 475344 | 49 | 368 | 48 | <0.1 | <0.05 | <2 | 24 | 31 | | 1.5 |
| 475345 | 30 | 438 | 53 | <0.1 | <0.05 | 4 | 14 | 14 | | 0.8 |

Profiles 2 and 3, Qeqertarssuatsiaat

The chip- and channel sampled profiles (Table 7 and 8) 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 |
|---|---|---|---|---|---|---|---|---|---|
| | 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*

| | 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 |
|---|---|---|---|---|---|---|---|---|---|
| | 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*

| | Cu | Ni | Co | Bi | S | Au | Pt | Pd | Length |
|---|---|---|---|---|---|---|---|---|---|
| | 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.

| | Cu | Ni | Co | Bi | S | Au | Pt | Pd | Distance | Rh |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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. |

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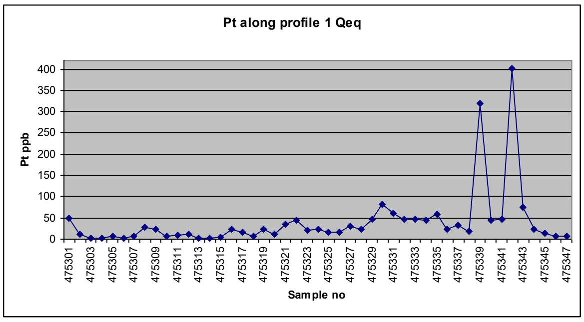
### 4.2.5 Au, PGE and other trace element variation across the mineralised ultrabasic rock unit

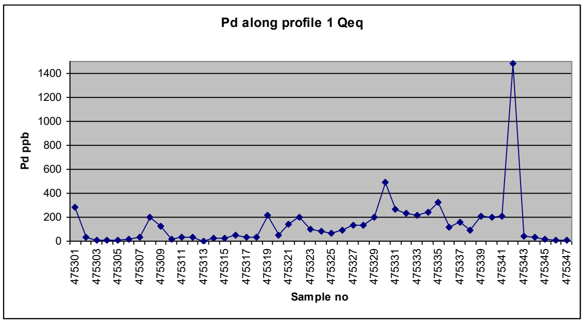
Plots of the results of Pt, Pd, Au, Cu and Bi across the best mineralised part of Profile 1, Qeqertarssuatsiaat, including the Ghisler Reef, are shown in Figure 8; similar plots for the profiles at Itise, are shown in Figure 9.

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.

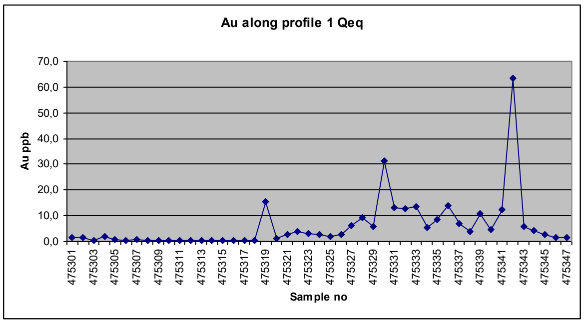
The anomalous high values of PGE and Au reported in this report are all from an ultramafic layer in the Fiskenaesset complex with no associated chromitite layers. The question whether concentrations of PGE could occur in the widespread chromitites in the anorthosites and the less widespread occurrences in ultramafics of the complex has not been tested since the investigations of Platinomino A/S about 40 years ago. The bulk samples analysed by Lakefield Research of Canada showed between 10 and 40 ppb Pt, Pd, Rh and Au, respectively (Ghisler 1976, table A15).



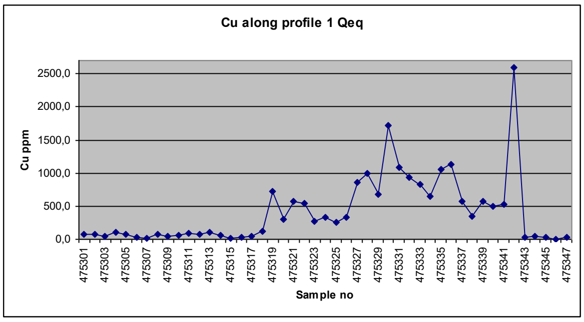

Pt along profile 1



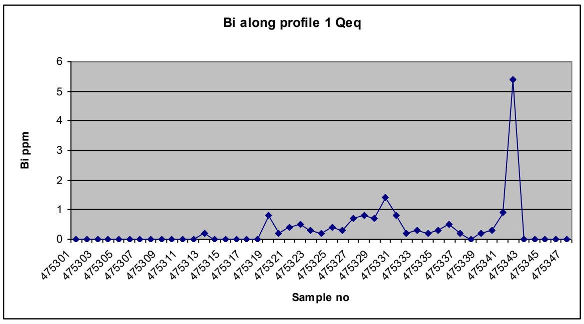

Pd along profile 1




Au along profile 1

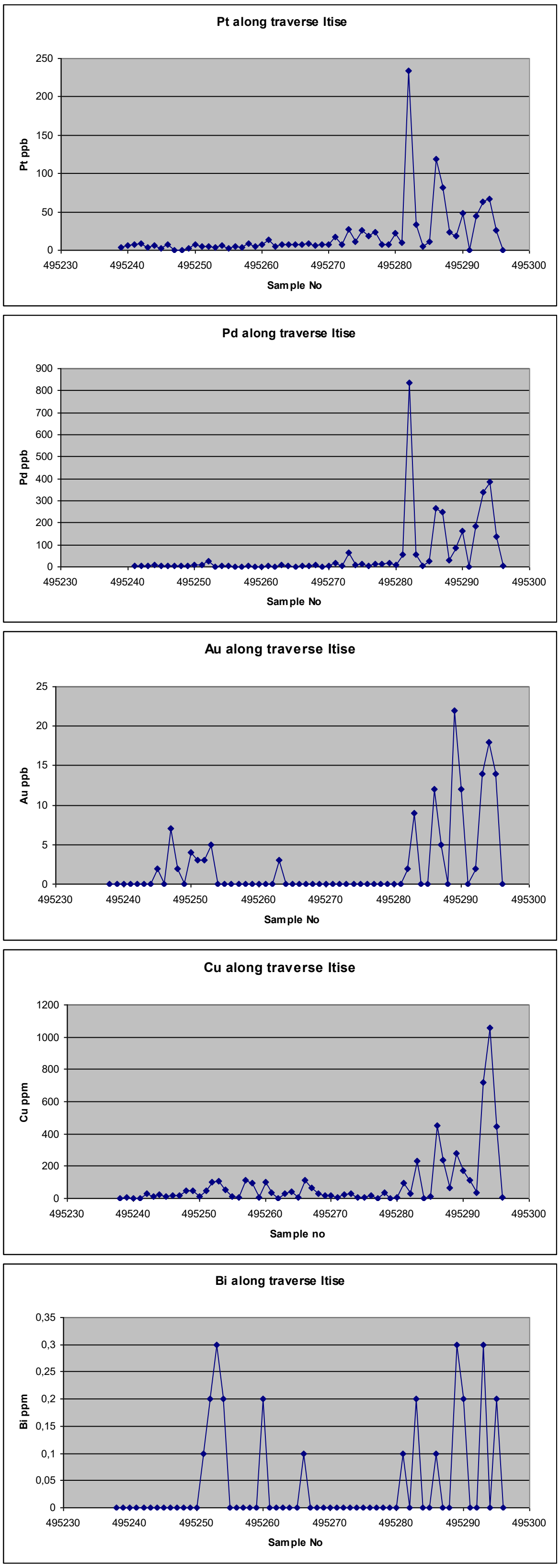



Cu along profile 1




Bi along profile 1

**Figure 8.** *Pt, Pd, Au, Cu and Bi distribution along Profile 1. Data are shown in table 6*




Pt along profile 7

Pd along profile 7

Au along profile 7

Cu along profile 7

Bi along profile 7

**Figure 9.** Pt, Pd, Au, Cu and Bi along profile 7 on Itise. Details shown in table 17

## 4.2.6.PGE and gold analyses from chromitites

The anomalous high values of PGE and Au in the above report are all from an ultramafic layer in the Fiskenaesset complex with no associated chromitite layers. The question whether concentrations of PGE could occur in the widespread chromitites in the anorthosites and the less widespread occurrences in ultramafics of the complex has not been tested since the investigations of Platinomino A/S about 40 years ago. The bulk samples analysed by Lakefield Research of Canada showed between 10 and 40 ppb Pt, Pd, Rh and Au, respectively (Ghisler, 1976, table A15).

Due to the fact that since then chromitites from UG2 of the Bushveld Complex have become a significant producer of PGE (Cawthorne, 2005), six chromitite grab samples from anorthosite and two samples from ultramafics in the Fiskenaesset complex were analysed with up-to-date analytical methods (Fire Assay-MS) (Tab. 18):

**Table 18***: Chemical analyses of six chromitite grab samples from anorthosite and four samples from ultramafics in the Fiskenaesset complex.*

| | ***Sample No*** | ***Rock type*** | ***Pd ppb*** | ***Pt ppb*** | ***Au ppb*** |
|---|---|---|---|---|---|
| 1 | 53224 | Chromitite | 37 | 17 | 26 |
| 2 | 53227 | Chromitite | <1 | 4 | 16 |
| 3 | 53282 | Chromitite | <1 | 1 | <2 |
| 4 | 1257 | Chromitite | <1 | 10 | 6 |
| 5 | 1260 | Chromitite | <1 | 3 | 10 |
| 6 | MG 6 | Chromitite | <1 | 2 | 10 |
| 7 | 149 | Ultrabasite | 106 | 370 | 11 |
| 8 | 513964 | Ultrabasite | 7 | 16 | 14 |
| 9 | 497332 | Ultrabasite | 113 | 351 | <0.5 |
| 10 | 497335 | Ultrabasite | 63 | 218 | 1.8 |

***1. GGU 53224****. East coast of Qeqertarsuatsiaat. 2.5 - 5 m thick hornblende chromitite with plagioclase augen in anorthosite. Sampled by M.Ghisler 1966.*
***2. GGU 53227****. East coast of Qeqertarsuatsiaat. Massive 7 cm thick hornblende chromitite layer from a 50 cm thick plagioclase layered chromitite horizon in anorthosite. Sampled by M.Ghisler 1966.*
***3. GGU 53282.*** *Top of Qagsse Mountain. Massive 2.70 m thick hornblende chromitite from 20 m thick plagioclase layered chromitite fold core in anorthosite. Sampled by M.Ghisler 1966.*
***4. Platinomino 1257****. "Beer Mountain" south of Sinarsuk. 3.5 cm thick plagioclase layered hornblende chromitite from chromitite horizon. Sampled by P.Appel 1970.*
***5. Platinomino 1260****. "Beer Mountain" south of Sinarsuk. 10 cm thick hornblende chromitite layer with plagioclase augen and schlieren from chromitite horizon. Sampled by P.Appel 1970.*
***6. Platinomino MG 6.*** *Majorqap qava. Massive 30 cm thick hornblende chromitite with schlieren of plagioclase altered to epidote in anorthosite. Sampled by M.Ghisler 1970.*
***7. Platinomino 149****. Sinarsuk. Hornblende peridotite with three 1 cm thick layers of chromitite in lenses of boudinaged ultramafic horizon. Sampled by K.Secher 1970. See photo fig. 22 in Ghisler (1976).*
***8. GEUS 513964****. Sinarsuk. Chromitite layer 10 cm thick from hornblende peridotite. From 5m x 20 m ultramafic lens belonging to the same boudinaged ultramafic horizon as above. Magmatic layered ultramafics with numerous chromitite layers from a few centimetres to some tens of cm thick. Sampled by P. Kalvig 2008.*
***9. GEUS 497331****. Sinarsuk. Hornblende peridotite with one 5 mm thick layer of chromitite. From a 25 m thick chromitite-layered ultramafic lens belonging to the same ultramafic horizon as no. 7 and no.8. Sampled by P. Kalvig 2009.*
***10. GEUS 497335****. Sinarsuk. Hornblende peridotite with two 5 mm thick layers of chromitite. From same ultramafic lens as no. 9 but from a locality c. 200 m farther to the south. Sampled by P. Kalvig 2009.*

The results show a content of PGE from chromitites in the anorthosites in the range of 10-40 ppb in accordance with the results obtained by Platinomino (Ghisler 1976). Only one sample (53224) shows elevated values. Pd dominates over Pd, except in sample 53224, which also shows an elevated Au value.

One of the chromitite samples hosted in ultramafics (149) shows distinctly elevated PGM values, again with Pt dominating over Pd.

Twelve analyses of precious metals in anorthosite hosted chromitites given in Ghisler (1976) as well as the above six new analyses presented above only show very slightly elevated PGE values. Even though the number of analyses is limited they indicate that it is unlikely to find exploitable PGE values in the widespread chromitites horizons in the anorthosites of the Fiskenaesset complex.

Chromitites in ultramafics however show very distinct PGE and Au anomalies. The Platinomino sample 130009 from 1969 presented in Appel et al. (2010, Table 1) - a chromitite layered bronzitite, (se photo fig.21 in Ghisler,1976) returned interesting values of 600 ppb Pt and 300 ppb Pd as well as 300 ppb Au. These values compares well with the elevated PGE and Au values of sample 149 given above.

Chromitites in ultramafics in the Fiskenaesset complex have been reported from only a few localities. Ultramafics form by volume a minor part of the complex and mainly occur as discontinuous, boudinaged stratigraphic horizons in the lower part of the complex. However, they due to tectonic thickening in several places form significant thick layers, which can be followed for several kilometres, such as described in Appel et al. (2010).

So far there has not been done systematic investigation of the PGE potential of the ultramafics in the inland part of the Fiskenaesset area. The results and considerations given above suggest that it would be worthwhile to look for PGE in chromitite layered ultramafics. The ultramafics have been mapped out by GGU in great detail in the scale of 1:20.000, accordingly there is sufficient basic geological information for further exploration.

## 4.2.7 Mineralogical investigations

A chip sample (393873) from Qeqertarssuatsiaat, 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 $PdBi_2$,
- 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 $Ni_3Bi_2S_2$
- Native Bi.

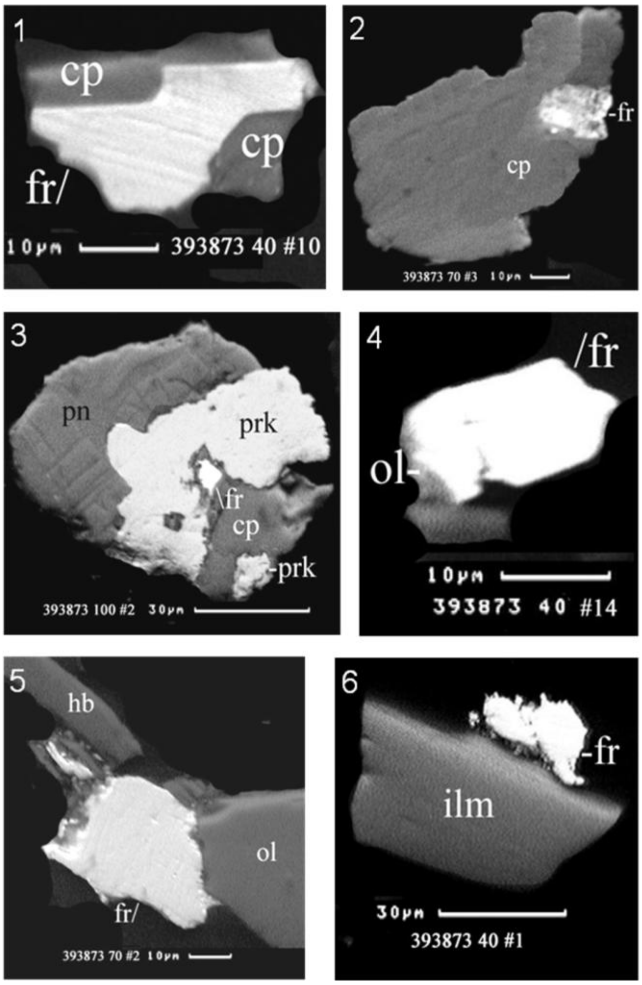



**Figure 10**. *SEM-back scatter images. fr - froodite, cp – chalcopyrite, pn – pentlandite, prk – parkerite, ol – olivine, hb – hornblende, ilm – ilmenite (CNTLabs, St. Petersburg).*

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 18).

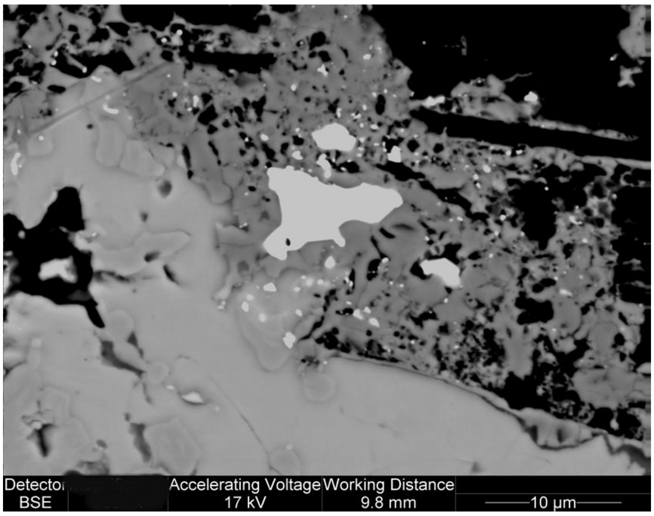



**Figure 11.** *Melonite (white) in altered magnetite next to chalcopyrite (light grey) SEM back scatter image. Sample 513883*

**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 two 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<br>0.7 | 1<br>5 | 1/2m<br>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 Qeqertarssuatsiaat (Profile 1). A PGE Reef on Itise towards east is interpreted as the extension of the 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 ultrabasic 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 Qeqertarssuatsiaat 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.

# 8. Acknowledgement

The authors are grateful for the contributions by Martin Ghisler enlightening us on PGE associated with chromitites.

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# Appendix A. Geological Maps

Geological sketch map of the investigated area on Qeqertarssuatsiaat
Geol.Map.N.Qeq.jpg
Geological sketch map of the investigated area on Itise
Geo.Map.Itise.jpg
Sketch maps from Qeqertarssuatsiaat
Profile 1 and 2.jpg on Qeqertarssuatsiaat
Profile 1.jpg on Qeqertarssuatsiaat
Profile 3.jpg on Qeqertarssuatsiaat
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 from Northern Qeqertarssuatsiaat

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