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Report file no.

21085

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G64 21/5-92

RTZ MINING AND EXPLORATION LIMITED

DB nr. 1085

KARRAT CONCESSION
YEAR END REPORT

by

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April 1992

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1. SUMMARY

The Karrat Exclusive Exploration Concession covers approximately 5,000 km^2 of the early Proterozoic Rinkian mobile belt of Central West Greenland. The southern boundary of the Concession is a NE-SW trending basement ridge that divides the shelf carbonate facies, the Mârmorilik Formation to the southeast from the thick sequence of basinal clastics and volcanics, the Qeqertarssuaq and Nukavsak Formations, to the northwest. Both basinal and shelf facies unconformably overlie early Proterozoic basement gneisses. The carbonates are host to the Black Angel deposit, 15 Mt (17% combined Zn/Pb) and three other high grade showings, >20% combined Zn/Pb over 80 kms of strike. The clastics are known to contain numerous laterally extensive sulphide horizons dominated by pyrrhotite with minor base metal concentrations. In an area 20-30 kms north of the Black Angel deposit, within the basinal clastics, high grade zinc float was reported.

The 1991 exploration programme was designed to locate the source of these high grade float samples and to assess the area directly to the north of the carbonate/clastic divide for other high grade base metal showings.

Twenty five kilometres north of the Black Angel deposit, 20-25m above the basement contact an outcrop of sub-massive "black jack" sphalerite and pyrrhotite was located. The limited outcrop is exposed in a felsenmeer zone within a 20-40m thick sequence of ferruginous meta pelites that can be traced for at least 4 kms along strike. Chip samples from the outcrop returned assays of 45.4% Zn and 24.6% Zn over 40 cms and 60 cms respectively. The lateral and vertical extent of the mineralisation is unknown as the mineralisation was not recognised as being sphalerite in the field.

The mineralisation appears conformable to the regional foliation, is medium grained and essentially pyrrhotite and sphalerite with trace pyrite, marcasite, chalcopyrite and cadmium.

This outcrop lies at the northeast end of a 25 km long zone of anomalous Zn, Cu, Ba stream/heavy mineral geochemistry. The zone lies along the northern flank of the basement ridge that forms the hinge line between the carbonate shelf facies and the basinal clastics to the north.

The 1991 exploration programme was carried out between 1st and 21st August by four geologists who prospected, on foot, an area of 750 km^2. Two hundred and twelve rock samples and thirteen stream sediment samples were collected.

During this exploration programme no detailed lithological or structural mapping was undertaken.

2. INTRODUCTION

Although first mapped by Rink in 1853 the Precambrian rocks of the Umanak area were only documented in any detail by Henderson and Pulvertaft in 1967.

Economic interest in the area began in 1938 when blocks of Pb/Zn mineralisation were discovered in talus at the base of a cliff face opposite the Mârmorilik marble quarry (1936-1940). This discovery eventually led to the opening of the Black Angel mine in 1972.

During the operation phase of the mine (1972-1990) developments of the shale basin exploration model led to an appraisal of the Karrat Group clastic sediments by Cominco Ltd as having potential for large tonnage stratiform base metal deposits of the Sullivan type (170 Mt, 6% Pb, 5.9% Zn, 2 oz Ag). In 1978 reconnaissance exploration was carried out resulting in a major exploration programme in 1979. Fairly extensive mapping and sampling of the cherty and graphitic sulphide horizons, accessible by foot, within the meta pelites and meta greywackes returned sporadically anomalous Cu and Zn values but no sample returned grades >1% Cu or Zn. Follow up work between 1980 and 1985 located high grade zinc float but samples were not traced to source.

The Black Angel mine closed in 1990 and all Exploration Concessions in the area were cancelled. RTZ had been monitoring the exploration potential of Greenland for some time and when major changes to the Mineral Resources Act were legislated in 1991 a "field season of opportunity" presented itself. During the 1991 field season it was possible to obtain large areas of prospective ground under an Exclusive Concession on the basis of approved work programmes not committed expenditure. (The legislation defining expenditure commitments in terms of amounts per km^2 will only come into force from 1 January 1992).

In June 1991 RTZ applied for four Exclusive Exploration Concessions. Combined with the Kap Edvard Holm and Ryberg Concessions (Platinova Resources Ltd joint ventures), a total of ±17,000 km^2 was held under exclusive options. The aim of the 1991 exploration programmes was to prospect as thoroughly as time would allow for sub/outcropping mineralisation with deemed economic potential that could be targeted for detailed follow-up in 1992.

The Karrat Concession was explored using the above criteria and the primary target area was the area directly to the north of the carbonate-clastic hinge line where high grade zinc float was reported.

2.1 Objectives

To locate the source of the high grade zinc float samples collected 20-25 kms north of the Black Angel deposit.

To prospect the 25 km strike of meta pelites/meta greywackes where heavy mineral and stream sediment sample results define a Zn/Cu/Ba anomaly.

To prospect and sample other areas of interest within the Karrat Concession.

2.2 Tenure

The 5,000 km^2 Karrat Exclusive Exploration Concession was granted to RTZ in June 1991. The concession is valid until 31 December 1991 (see Figures 1 and 3). The rights of the Concession holder do not include hydrocarbons or uranium.

The concession is a joint venture between RTZ Mining and Exploration Ltd and Platinova Resources Ltd. Platinova acquires 35% equity in the property after RTZ has expended DKr 2.5 million. RTZ is the project manager.

In June 1991 a new Mineral Resources Act was passed by the Danish Parliament. Based on this act a new set of principles and procedures for the granting of prospecting and exploration licences for hard minerals was drafted.

3. ENVIRONMENTAL

During the two and a half week exploration programme two small tent camps were used by the exploration team of 4 geologists. No wooden tent bases or drums of fuel were used at either camp site. No equipment was left on site, all biodegradable rubbish was either buried or burnt, the remainder of the rubbish was removed from site.

The camp was mobilised by float plane and demobilised by helicopter. No fauna or flora species were unduly disturbed during the exploration programme.

There are no restricted areas within the Concession due to protected species of fauna or flora or historical ruins etc.

4. PREVIOUS EXPLORATION

<u>1962-1963</u> Mapping at a scale of 1:100,000 was carried by Henderson and Pulvertaft of the GGU

<u>1970</u> At the request of N Anderson acting on behalf of New Quebec Mining and Exploration Ltd, JC Sproule and Associates Ltd made a photogeological study of an area north of Umanak between latitudes 71° to 72°10' north and longitudes 63° west, extending east to the ice cap. Reference is made to pyrrhotite rich horizons with trace chalcopyrite in pelitic schists on the Svartenhuk Peninsula. The Mârmorilik carbonates were the main target.

<u>1971</u> Niels Anderson prospecting for Gronlands Efterforsknings Minecompagni AS (GEMCO) located some Mârmorilik type mineralisation in glacial float at the foot of Kangerdlugssuaq Glacier.

A Concession between 71°N and 72°12'N was granted to GEMCO for a period expiring on 31 December 1975. The date of issue is not stated.

<u>1972</u> JC Sproule updated the 1970 photogeological study for Ponderay Exploration Company Limited stressing the Mârmorilik Pb/Zn occurrences. A reconnaissance programme was also carried out by JC Sproule over the whole of the Karrat area.

<u>1975</u> In August Anderson was granted the right by GEMCO to prospect and explore the concession and approached COMINCO about the property. No agreement was finalised, however it was agreed that COMINCO would examine parts of the concession during the field season after work was completed on the Greenex programme. Four days work was carried out. Recommendations at that time were negative, and nothing further was done on the property.

The GEMCO permit expire 31 December 1975.

<u>1977</u> Recent development of the shale basin exploration model and the occurrence of large tonnage stratiform base metal deposits in basins of similar age worldwide led to a reappraisal of the Karrat area. COMINCO carried out a short recce during September 1977. This resulted in a work proposal and the subsequent application for a non exclusive exploration permit.

1978 A reconnaissance trip in the Karrat Group was carried out by RA Gannicott and F Pedersen between 8-12 August. Numerous sulphide samples were taken from talus, glacial float and outcrop, some of which returned anomalous Cu (580-1,360 ppm) and Zn (2,050-4,500 ppm) values.

1979 Charter Consolidated carried out a helicopter supported kimberlite reconnaissance programme in the Karrat area, and to the north and west on the Svartenhuk Peninsula, for the Diapros syndicate. Their programme, during the months of July and August, was directed at bulk heavy mineral sampling of the major stream systems with field processing of all samples.

1979 A 2 month, boat based, exploration programme of the Karrat Group metasediments was undertaken during July and August. An area of 6,750 km^2 was, where accessible, evaluated. Talus prospecting, and cliff face binocular mapping were carried out supplemented by heavy mineral and stream silt sampling. One hundred and seventy seven heavy mineral samples and 234 silt samples were collected. One hundred and thirty three rock samples were collected and analysed for Cu, Pb, Zn, Co, Ni and Mo.

No samples with grades greater than 1% combined Cu, Zn were reported.

1980-1985 A number of stream silt/heavy mineral anomalies were followed up and written off. A number of high grade, 10-19% Zn, float samples were located at the head of the Kangerdluarssuk fjord, 20-25 kms north of Mârmorilik. A slump in Zn prices in the early to mid 1980's downgraded the significance of these samples.

In 1985 Cominco (Greenex AS) sold the Black Angel mine to Boliden. Boliden carried out no exploration programmes in the Mârmorilik/Karrat area.

1990 The Black Angel mine closed and all exploration/exploitation permits were cancelled.

1991 New Mineral Resources Act passed in May. RTZ Concession applied for and granted in June and field work in the Karrat area began on 1 August.

5. GEOLOGY

5.1 General

Approximately 70% of Greenland consists of Precambrian shield rocks. Younger sediments and volcanics occur predominantly on the north, northeast and central east and west coasts.

The shield has been divided into a number of structural zones that reflect the relative age and tectonic complexity of the various parts of the island (see Figure 1).

In the extreme south the Ketilidian mobile belt, 1,900-1,600 My, is dominantly a product of continental accretion. Within the Ketilidian the Gardar province, 1,320-1,112 My, is developed in a zone of rifting and wrench faulting. Abutting the Ketilidian mobile belt to the north is the Archaean craton, 3,700-2,500 My, comprising a sequence of high grade metamorphic gneisses.

To the north of the Archaean craton a major Proterozoic mobile belt can be traced northwards along the west coast. The southern portion of this mobile belt, the Nagssugtoqidian, is characterised by dominantly reworked Archaean, interpreted as a continental collision zone. The northern portion of the belt known as the Rinkian mobile belt is dominated by extensive Lower Proterozoic supracrustal rocks and a structural style distinct from the southern portion.

The central portion of both east and west Greenland between 68°N and 70°N are dominated by Mesozoic sediments overlain by an extensive and thick sequence of Tertiary plateau basalts.

In the northeast quadrant of Greenland the Caledonian fold belt incorporates Upper Proterozoic to Ordovician sediments as well as reactivated Precambrian crystalline basement. Substantial thicknesses of Devonian to Lower Permian continental sediments were deposited in fault controlled basins paralleling the coast line. Upper Permian to Mesozoic sediments were deposited along the coastal fringe as the result of a massive transgression during the late Permian.

The Precambrian basement of north Greenland is overlain by extensive mid Proterozoic to Lower Palaeozoic sediments. The folding and metamorphosis of these sediments during the Ellesinerian orogeny (Devo-Carboniferous) formed the North Greenland fold belt.

5.2 The Rinkian Mobile Belt

The Rinkian Mobile Belt is interpreted to occur over a 500 km long stretch of the west coast of Greenland between Disco Island, 70°N and Kraulshavn 74°N (see Figure 2). This belt has a distinctive structural style which differentiates it from the Nagssugtoqidian Belt to the south and is divided into three units which are, from south to north:-

(i) The Atâ Sund unit, 70°-71°N, dominated by a large gneiss dome with a rim syncline of meta sediments and volcanics containing local calc silicates and marbles.

(ii) The Central Unit or Umanak-Rinks Isbrae area, 71°-72°30'N, extending from Umanak in the south to the Proven charnockite to the north. <u>The Karrat Group meta clastics and meta carbonates lie within this unit</u> and unconformably overlie the basement gneisses. This unit is characterised by gneiss domes and large recumbent nappes.

(iii) The Northern unit which starts north of the Proven charnockite and extend northwards to Kraulshavn, 74°N comprises high grade, granulite facies schists that are interpreted to be highly metamorphosed Karrat Group supracrustals.

5.3 The Umanak-Rinks Isbrae Area (Figures 4 and 5)

The stratigraphy of this area is summarised diagrammatically as a palinspastic reconstruction (see Figure 3). Detailed descriptions of the individual formations are as follows:

a) Umanak Gneiss

This Lower Proterozoic basement gneiss, interpreted to be of meta-sedimentary origin, is exposed in the south and southwest of the area and as the cores of domes to the north (see Figures 4a and 5a). Although the gneiss is unconformably overlain by the Karrat Group, contacts are tectonically parallel. The gneiss is predominantly medium to fine grained with a granodioritic composition. The Nunatak formation; basic to intermediate volcanics and the Sermikavsak formation; amphibolites are distinctive recognisable formations within the gneiss.

No sulphide concentrations of any economic significance have to date been located within the basement gneiss.

b) Karrat Group

The Karrat Group metasediments and metavolcanics comprise a greater than 5 km thick sequence of supra crustal rocks that unconformably overlie the Umanak gneiss over most of the 7,000 km^2 of the Umanak-Rinks Isbrae area.

The Karrat group has been divided into four main formations with the Mârmorilik formation carbonates being interpreted as the time equivalent shelf facies of the basinal Nukavsak formation to the north of the Alfred Wegener basement high (see palinspastic reconstruction - Figure 3). The Kangigdleq formation has been given formation status here as it is a distinctive volcanic horizon that has considerable lateral continuity. The formations are as follows:

(i) The Basal Qeqertarssuaq Formation Varies greatly in thickness and composition, from 2-3m thick in the area east of Mârmorilik to 2,000m+ west of Rinks Isbrae. Composition varies from massive quartzites where thickest to quartzitic semi pelites, amphibolites and occasional marbles with complex inter digitisations. South of the village of Nugatsiaq the Qeqertarssuaq formation is represented by a thin 2-10m pelitic quartzite whereas north of Nugatsiaq the formation is extremely well developed and attains thicknesses of up to 2,000m.

A consistent feature of the Qeqertarssuaq formation is the presence of a 2-20m thick zone with sulphide enrichment. These zones vary from pyrrhotite bearing black pelites with minor pyrite, chert and cherty siltstones to pyritic quartz biotite schists, to cherty pyritic limestones to rare 1-2m pyrrhotite rich graphitic cherts (all samples taken to date from these ferruginous horizons have returned consistently low base metal and precious metal values).

Metamorphism increases from lower amphibolite to greenschist facies away from the basement contact.

The top of the Qeqertarssuaq formation is marked by an amphibolitic horizon of metavolcanic origin named the Kangigdleq formation (Allen and Harris, 1979). As in the case of the Qeqertarssuaq formation the Kangigdleq formation is well represented north of the Nugatsiaq line (see Figure 5b), but virtually absent south of the line.

(ii) The Kangigdleq Formation This formation is marked on published GGU (Geological Survey of Greenland) maps as the upper member of the Qeqertarssuaq formation. In the Kangigdleq fjord (see Figure 5), the type locality, pyroclastics are overlain by fine grained tuffaceous sediments. In the Ingia fjord, deformed elongated clasts representing the Kangigdleq formation can be traced over 8 kms. These basic to intermediate volcanics outcrop over an area of 300 km^2 and have sharp basal and upper contacts with the underlying Qeqertarssuaq and overlying Nukavsak formations. Thickness varies from 25-75m (Ingia fjord) to 250m (Umiamiko Nuna) to 400-600m on the east side of Kangigdleq fjord (Allen and Harris, 1979). The volcanics are dominantly agglomerates, tuff or pillow flow breccias with no thick flows or well pillowed material. Composition varies from komatiites to magnesium tholeiites to occasional andesites.

An estimated 50% of the visible length of the Kangigdleq-Nukavsak formation contact appears to be visibly marked by a semi continuous "gossan" band interpreted as either an ankeritic carbonate, pyrrhotite bearing chert or massive pyrrhotite. Access to this horizon during the major 1979 Cominco exploration programme was severely limited by topography (Allen and Harris, 1979).

South of the village of Nugatsiaq (see Figure 5) the volcanics do not appear to be present unless they occur as a visually unrecognisable basic tuff component in the impure sediments of the Qeqertarssuaq formations.

The Kangigdleq formation is overlain north of the Alfred Wegener hinge zone by the Nukavsak formation.

(iii) <u>The Nukavsak Formation</u> These reddish brown weathering meta-sediments of the Karrat Group dominate the geology of the Umanak-Rinks Isbrae area and are host to the numerous pyrrhotite, chert, graphite sulphide horizons.

The Nukavsak formation attains an estimated thickness in excess of 5,000m and comprises a monotonous sequence of metamorphosed sandstones, siltstones and shales. The rocks are generally dark grey-brown, very fine to fine grained, thinly laminated, quartz-mica-feldspar schists, pelites and semi pelites. Minor components include lenses of quartz, plagioclase and occasionally carbonate.

Distinctive rusty weathered beds have been mapped at several levels within the Nukavsak formation. They vary in composition from massive pyrrhotite to chert-pyrrhotite-graphite breccias, to disseminated pyrrhotite with minor chalcopyrite, pyrite, sphalerite and marcasite. These various sulphide rich horizons are described in more detail under mineralisation but to date no zones of <1% combined Cu/Zn have been located in outcrop.

The Mârmorilik formation is interpreted to be the shelf facies time equivalent of the lower section of the Nukavsak formation (Allen and Harris, 1979).

(iv) <u>Mârmorilik Formation</u> The Mârmorilik formation comprises a sequence of highly deformed calcitic and dolomitic marbles with intercalations of semi pelites, evaporite bearing marbles and rare quartzites. Stratabound sulphide mineralisation occurs at various levels within the carbonate sequence (Thomassen 1991). The Black Angel deposit (15 Mt, 17% Zn/Pb) is hosted in upper calcitic marbles whilst the smaller Nungarut deposit is hosted in the lower dolomitic marbles.

The carbonates occur to the southeast of the line running NE to SW along the Alfred Wegener's basement high (see Figure 4a) over a strike length of approximately 80 kms (Black Nunatak to Nugssuaq peninsular). At least three other, >50,000 tonnes (estimated), deposits grading >20% Zn/Pb are known to occur within the limited outcrops of Mârmorilik formation along this 80 kms of strike (Uvkusigssat, Agpat, Nûgssuaq) (see Figure 2).

The Mârmorilik carbonates are overlain by a pyrite/pyrrhotite bearing sequence of pelites interpreted to be the time equivalents of the middle to upper Nukavsak formation.

No where in the Umanak-Rinks Isbrae area is the top of the Nukavsak formation present and the pelites/meta greywackes are overlain to the west and southwest by Cretaceous sediments and Tertiary basalts (see Figure 2).

(v) Dykes (See Figures 4, 4a, 5, 5a) A series of parallel NNW/SSE trending dykes cut through the Karrat area. These dykes vary in composition from dolerite to lamproites and vary in age from 1,645-±35 Ma (master dyke NNW/SSE - olivine gabbro - Kalsbeck/Taylor, 1986) to Tertiary. One lamprophyre sheet is dated at 600-±15 Ma (Kalsbeck-Taylor, 1986), another at 30-40 Ma (Allen and Harris, 1979).

(vi) Proven Charnockite The Proven Charnockite is taken as the northern boundary of the Karrat Group. To the north of the charnockite, Karrat group metasediments are interpreted to continue but the high metamorphic grade has destroyed any definitive diagnostic correlative features.

6. REGIONAL STRUCTURE (see Figures 4a and 5a)

The most dominant, visible regional structures within the Karrat Group metasediments are major overturned folds and nappe structures resulting primarily from the diapiric upwelling of the basement gneisses. The axial directions and vergence of the overfolds are consistent with gravity induced folds caused by the Karrat Group sliding off the buoyant gneiss domes (Escher and Pulvertaft, 1976).

Nappe development around the gneiss domes was probably initiated by metamorphic dehydration reactions in lower greenschist conditions which resulted in high pore fluid pressures and allowed gravity sliding (at depths of 4-5 kms) off the slopes of the gneiss domes (King, 1980).

The pyrrhotite-graphite-chert breccia zones within the Nukavsak formation may well have been developed during the sliding of the sediments off the upwelling gneiss domes. This sliding initiated along the more ductile, sulphide-graphite, horizons is consistent with the development of the pisolitic graphite covered chert "balls" common in numerous of the more sulphide rich horizons.

Primary basement highs are interpreted as being approximately EW. The NNW-SSE trending faults presently occurring as Tertiary dolerite dyke swarms are thought to be fundamental structures continually reactivated and feeder zones for the Kangigdleq volcanics.

A combination of the E-W basement ridges, major listric faults and the NNW-SSE faults led to the development of third order basins, in which significant volumes of sulphide were allowed to accumulate. It may be coincidental but all known major concentrations of sulphides within the clastics and carbonates have a close spatial relationship with the two major NNW-SSE dyke filled structures (see Figures 4a and 5a).

A palinspastic reconstruction of the Karrat basin prior to the numerous periods of N-S compressions and extensions (Grocott and Pulvertaft, 1990) would possibly help locate primary third order basins, areas in which to focus exploration.

7. REGIONAL METAMORPHISM

Generally metamorphism is uniform throughout the Karrat Group ranging from upper greenschist to lower amphibolite. Metamorphic grade decreases away from the Umanak gneiss contact.

8. SULPHIDE UNITS

To date there are three main types of sulphide rich horizons recognised and found predominantly within the lower 800m of the Karrat Group metasediments and metavolcanics.

The following descriptions of the sulphide types is taken from Allen and Harris, 1979.

a) Type and Distribution

Three gross divisions were established for the sediment hosted sulphide bearing lithologies present within the Nukavsak formation.

(i) Cherty sulphide iron formations comprised dominantly of chert, with abundant pyrrhotite (±pyrite) and variable graphite content. These are best developed in the lower 500-600m of the Nukavsak formation, sporadically in the Qeqertarssuaq formation, and are evident just above the Kangigdleq formation. Within these multiple "bands", several "bands" show prominent thicknesses (5-10m) and long strike extent (5-10 kms).

(ii) Graphitic sulphide formations composed of graphitic metasediments with abundant pyrrhotite (±pyrite) and a lesser amount of chert. This unit is intermediate between type (i) described above and type (iii) described below. It may occur in conjunction with type (i) and type (iii) or occur by itself. It is in actuality a pyrrhotite rich (>20%) black shale, typically quite thick (2-5m) and may be extensive. It is, however, not a cherty sulphide iron formation as is type (i). Type (ii) shows no preference to a particular stratigraphic level within the Nukavsak formation.

(iii) Pyrrhotite (<3%) Bearing Black Shale. It is this style of sulphide unit that is host to the discovery showing made in 1991 at the head of the Kangerdluarssuk fjord. The pyrrhotite is often locally remobilised to form pyrrhotite rich bands. Type (iii) shows ubiquitous development throughout the Nukavsak formation, but is perhaps more prevalent in the middle-upper turbidite siltstones where they occur as thin rusty (0.3-2m) black shale intervals.

It appears that the cherty sulphide formations where they do not directly overlie the Kangigdleq volcanics are confined to the basin edge between Alfred Wegener Halvø and the southern limit of the volcanics. Cherty sulphide iron formations are not abundant in the Nukavsak stratigraphy above the volcanics, and are scarcely present along Uvkusigssat Fjord or northern Ingia Fjord.

(b) Description and Mineralogy

The mineralogy of the sulphide rich units is primarily quartz, graphite, pyrrhotite, pyrite, biotite, chlorite, amphibole, feldspar and traces of chalcopyrite. The presence of visible chalcopyrite corresponds with ±700-1,000 ppm Cu. Pyrrhotite is by far the most abundant iron sulphide. The ground mass pyrrhotite surrounds rounded breccia fragments of pyrrhotite, and is often altered to marcasite along grain boundaries and fractures. Pyrite occurs as euhedral to subhedral porphyroblasts suggesting a late origin in the paragenetic sequence. Chalcopyrite occurs either as small interstitial anhedral grains between pyrrhotite grains or its alteration products, or is entirely surrounded by pyrite porphyroblasts.

There is no indication of the presence of sphalerite, bornite, covellite, galena, magnetite, hematite, iron carbonate or high iron silicates.

(i) Cherty Sulphide Iron Formations. This unit consists of cherty bands (>75%) interbedded with pyrrhotite-graphite-quartz breccia that define the association. The breccia consists of 30-60% matrix pyrrhotite, is aphanitic to fine grained massive, dull bronze to steel grey in colour depending on recrystallisation, and contains sub angular to rounded graphite coated clasts of oblate pills of cherty siltstone, chert or quartz. The clasts range from a few millimetres to 1-2 cms. Abundant graphite forms schlieren in the matrix. Occasionally massive steel grey pyrrhotite forms 100% of hand specimens. The graphite coated "pills" are frequently composed of recrystallised glassy silica (rounded recrystallised glassy silica inclusion of up to 2 cms diameter and are common in Black Angel ore). Pyrrhotite is almost always greatly in excess of pyrite, but rare examples of coarse grained pyritic cherty breccia do exist. Chalcopyrite is rare, never exceeding 3% with only 1% of samples (or less) containing visible chalcopyrite.

The units seems to have formerly been a laminated pyrrhotite-graphite cherty siltstone or chert. The brecciated nature is probably the physical response, during deformation, between brittle silica, plastic sulphides, and graphite lubricant.

(ii) Graphitic Sulphide Formation. These are essentially non siliceous rocks, consisting of 10-40% remobilised pyrrhotite as anastomosing veins, blobs and stringers, later brecciated but dominantly following the schistosity. The pyrrhotite is hosted by graphite rich schists with abundant chlorite, actinolite and quartz. Schlieren of graphite are ubiquitous. The host rock must initially have been an organic rich, pyrrhotite rich shale. The pyrrhotite is generally dull bronze or grey bronze. Pyrite is less frequent but shows more recrystallisation to clotted porphyroblasts of coarse, angular nature. Traces of chalcopyrite are rare.

(iii) Pyrrhotite Bearing Black Shales. Over several tens of cms to 1-5m, contorted, folded and brecciated black shales and lesser black siltstone units contain 1-5% pyrrhotite (±pyrite). There is local remobilisation of pyrrhotite into shear zones accompanied by deformed graphite rich schists. The pyrrhotite in these instances may be highly recrystallised. Small amounts of pyrrhotite may also occur as filaments, tiny blobs and coalesced clasts in black essentially non graphitic siltstones. These black shale bands may be up to 10-15m thick in the lower and middle Nukavsak formation, and are commonly repeated every 5-30m.

9. 1991 EXPLORATION PROGRAMME

The 1991 exploration programme was planned to prospect an area of approximately 200 km^2 at the head of the Kangerdluarssuk Fjord. This area, centred approximately 20 kms north of Mârmorilik, was chosen because of reported discoveries of high grade zinc float samples in the early 1980s that had never been traced to source. A secondary target zone was the area along the northern flanks of the Alfred Wegener Halvø where earlier stream sampling had indicated a Cu/Zn/Ba anomaly over approximately 25 kms of strike draining Karrat Group stratigraphy.

A team of four geologists was flown into the area on 1 August. Utilising two tent camps this 200 km^2 area was prospected and sampled until 17 August. The team was then mobilised to Mârmorilik where a Bell 206 under charter from GLACE was used by a team of two geologists to prospect the northern flanks of Alfred Wegener Halvø, 18-21 August. Further limited prospecting was carried out on Karrat Island and in the Kangerdlugssuaq-Inukavsait areas.

A total of 212 rock samples were taken dominantly from sulphide rich horizons as grab or chip samples and from sulphide rich float from a combination of talus and moraine. Thirteen stream sediment samples were taken. (A list of sample numbers, locations and a brief geological description is in Appendix 3).

9.1 Results

a) <u>Kangerdluarssuk Fjord Area (Figure 6)</u>

Numerous ferruginous horizons were located in the area at the head of the Kangerdluarssuk Fjord. Here only the lower 6-800m of the Karrat Group meta-clastics are exposed immediately to the east and southeast of the Qaersukavsak gneiss dome.

The contact between the gneiss and the Qeqertarssuaq formation is tectonically conformable and dips 50°-60° to the east. The basal Qeqertarssuaq formation comprises 2-10m of impure quartzites with minor thin intercalations of schists and pelites, occasionally calcareous. Minor concentrations, 1-2%, of pyrrhotite/pyrite occur within the Qeqertarssuaq formation at this location but assay results show no significant base or precious metal concentrations.

The Kangigdleq formation is not represented in the Kangerdluarssuk fjord area and the Qeqertarssuaq formation is conformably overlain by the Nukavsak meta-pelites and meta-greywackes whose attitude decreases to 20°-25° away from the 50-60° basement contact. The area does not appear to be structurally complex, gentle open folds with a NE-SW axial trend dominating.

Apart from minor, <1%, chalcopyrite no significant base metal sulphides were <u>definitely</u> recognised in the various sulphide rich horizons sampled in the Nukavsak formation.

Twenty to twenty-five metres above the basement contact directly to the east of the Qaersukavsak dome a 20-40m thick horizon of ferruginous meta pelites is present over an estimated 4 kms of strike (see Figures 10 and 11). This ferruginous horizon consists of finely laminated, fine grained, meta-pelites with 1-5% sulphides, dominantly pyrrhotite with trace pyrite and marcasite. An outcrop protruding through a felsenmeer zone developed over part of this ferruginous horizon was sampled and described as "possibly sphalerite". Two chip samples were taken on the outcrop. One sample, 60 cms long, parallel to the regional foliation across the entire exposure, the second 40 cms wide across "strike", across the entire outcrop. The samples returned assay values of:

		Zn %	Cu %	Fe %	Pb ppm	Ag g/t	Au ppb
Sample No. 2068	60 cms	24.26	0.04	35	12	5.9	<5
Sample No. 2069	40 cms	45.43	0.03	17.2	7	4.9	<5

As these samples were not recognised in the field, due to the black jack nature of the sphalerite being difficult to recognise in dark grey brown black metasediments, the lateral and vertical extent of this high grade showing is unknown.

The sphalerite rich exposure appears conformable to the regional foliation and is not evidently cross cutting. The mineralisation is medium grained, recrystallised polycrystalline sphalerite rich with subordinate pyrrhotite and pyrite. The sphalerite is iron rich, averaging 8% and contains significant amounts of Cd, 0.57%. The estimated primary mineralogical composition of the samples is as follows:

Mineral or Constituent	Sample No. 2068	Sample No. 2069
Sphalerite	42.4%	79.9%
Pyrrhotite	35.0%	17.6%
Pyrite	12.6%	-
Chalcopyrite	<0.5%	<0.5%
Rock fragments	10.0%	2.5%

A full mineralogical description of the samples is shown in Appendix 1.

The only other anomalous rock sample was a float sample of Mârmorilik formation carbonate taken on moraine close to the inland ice that assayed 1.91% Zn.

Thresholds used for the definition of anomalous rock samples are as follows:

Rock Samples	No of Samples	Threshold
Cu	191	426 ppm
Pb	191	60 ppm
Zn	191	502 ppm

A complete set of analytical results are shown in Appendix 2. A list of sample numbers with sample description can be found in Appendix 3. Appendix 4 gives the Pearson Product Moment correlation and the Spearman Rank Correlation scores, and Appendix 5 and 6 show elemental histograms and statistics for the 1991 Karrat rock samples.

In this ±200 km^2 area (see Figure 6) all anomalous rock samples are denoted in red. Apart from the discovery area the only other areas that show consistent anomalous base metal values is close to inland ice directly east of the discovery outcrop and float samples taken on moraine close to the outcrop in the eastern portion of the area.

There is a greater than 0.5 correlation factor between Cu and Zn but Pb values are consistently low, generally <50 ppm even in the high grade zinc samples. The single strongly anomalous Pb value is from a float sample approximately 4 kms along strike to the south from the discovery outcrop that returned values of 14 ppm Cu, 1,920 ppm Pb and 297 ppm Zn. Copper values attain a maximum value of 2,740 ppm with 5 samples >1,000 ppm.

b) Alfred Wegeners Halvø (Figure 7)

Prospecting of the Alfred Wegener Halvø area was severely limited due to a relatively heavy fall of fresh snow.

25 rock samples were taken 7 of which returned anomalous results in either Cu, Pb or Zn with maximum values of 1,885 ppm Cu, 80 ppm Pb and 5,260 ppm Zn from pyrrhotite rich float boulders.

c) Kangerdlugssuaq-Inukavsait Area (Figure 8)

Eleven rock samples were collected in this area of highly visible pyrrhotitic gossans. Five grab samples taken from outcrop returned best values of 560 ppm Cu, 24 ppm Pb and 1,600 ppm Zn.

d) Karrat Island (Figure 9)

Eleven grab samples were collected from a restricted area on the southern end of Karrat Island. None of the samples returned anomalous values for Cu, Pb, Zn (see main text).

A representative suite of rock samples from the Karrat Group was taken from the Karrat Island area to be used in spectrographic test work being carried out by G Hunt, RTZ Mining and Exploration, Exploration Research Division based in Newbury.

10. CONCLUSIONS

Ore grade base metal sulphides have been located in outcrop for the first time within the Lower Proterozoic Karrat Group black shale basin meta sediments. The ferruginous horizon within which the ore grade sulphides are located can be traced along strike for at least 4 kms. The lateral and vertical extent of the mineralisation is unknown. Ore grade float samples located by earlier prospecting are highly unlikely to have been derived from the discovery outcrop. This implies the possibility of lateral continuity to the mineralisation. A Zn/Cu/Ba geochemical anomaly extends from the discovery outcrop approximately 25 kms along strike to the southwest.

Considering the age, geological and structural setting of the Karrat Group, in the light of the recent discoveries, the potential for Sullivan type base metal deposits must be considered high. The Karrat Group can also be compared with the Proterozoic meta-clastics of the Appalachians of the USA. Here, as in the Karrat area, the extensive sulphide formations are almost everywhere barren but locally are host to substantial Cu Zn ore deposits eg Ducktown, Tennessee; Oreknob, North Carolina.

The potential for volcanogenic massive sulphide deposits exists within the "gossanous" horizon developed at the top of the Kangigdleq formation volcanics. Due to difficulties of access by foot the potential of this extensive sulphide horizon has not been assessed.

The diamond potential associated with the lamprophyres within the Karrat Group should be kept in mind.

The significance of the 1991 discovery is two fold. Firstly, that the sphalerite, at least in one location is of the "black jack" variety which is very difficult to recognise in outcrop. Secondly, all previous Karrat exploration programmes have been geared to prospecting and sampling major gossans. The discovery outcrop occurs within a sequence of ferruginous, 1-5% pyrrhotite, meta pelites and not a major pyrrhotite gossan horizon, the primary target for all previous exploration. Thus significant base metal mineralisation may well have been overlooked.

Eighty percent of the Cominco heavy mineral concentrate samples were taken from major glacial drainage outwash fans with extreme dilution and as such are not considered to be representative.

Due to lack of significant helicopter support on previous exploration programmes it is estimated that at best only 50% of the exposed Karrat Group rocks in the Umanak-Rinks Isbrae area have been prospected.

11. RECOMMENDATIONS

A regional airphoto/TM structural study of the Karrat Group licence area be carried out to try to target primary third order basins, to identify structural controls of known sulphide mineralisations and identify, where possible, gossanous/ferruginous horizons especially in areas not visually accessible by boat.

To determine as early as possible in 1992 the economic potential of the discovery outcrop. This should be done by detailed prospecting, mapping and sampling on sections at 250m intervals along the ±4 kms of strike to the north and south of the discovery outcrop. If results of this, the first phase of the proposed 1992 programme, are positive, it would be possible to mount a 2-3,000m, 6-10 hole drill programme in 1992.

Using the knowledge gained in the first phase of the 1992 programme the northern flanks of Alfred Wegener Halvø (the source area for the 25 km long geochemical anomaly) should be prospected and sampled in detail.

Utilising a boat base, a team of experienced "arctic" and "climber" geologists, with helicopter support, should prospect and sample the remainder of the 1,489 km^2 Karrat licence thoroughly.

To continue studies into the possibility of utilising a remote sensing Co_2 laser system to map 1-2,000m sheer cliff faces for Zn rich sulphides using diagnostic reflectance characteristics of sphalerite.

12. FINANCIAL REPORT - 1991 FIELD SEASON

Audited expenditures for the period 18 June 1991 to 31 December 1991. All amounts are in Danish Kroner unless otherwise specified.

(Average exchange rate for the period of the expenditure based on average monthly rates is : DKr 11.275 : Stg £1).

	DKr	**Stg £**
Staff Costs	180,581	16,016
Mobilisation/Transportation	252,287	22,376
Rights and Consents	4,049	359
Geological	26,958	2,391
Geochemical	32,034	2,841
Geophysical	389	35
Office costs and overheads	2,548	226
Financial and Corporate	1,672	148
Miscellaneous	10,018	888
Management Fees	51,054	4,528
TOTAL	**±DKr 561,588**	**±£49,808**

NOTE: All figures are approximate due to rounding up/down.

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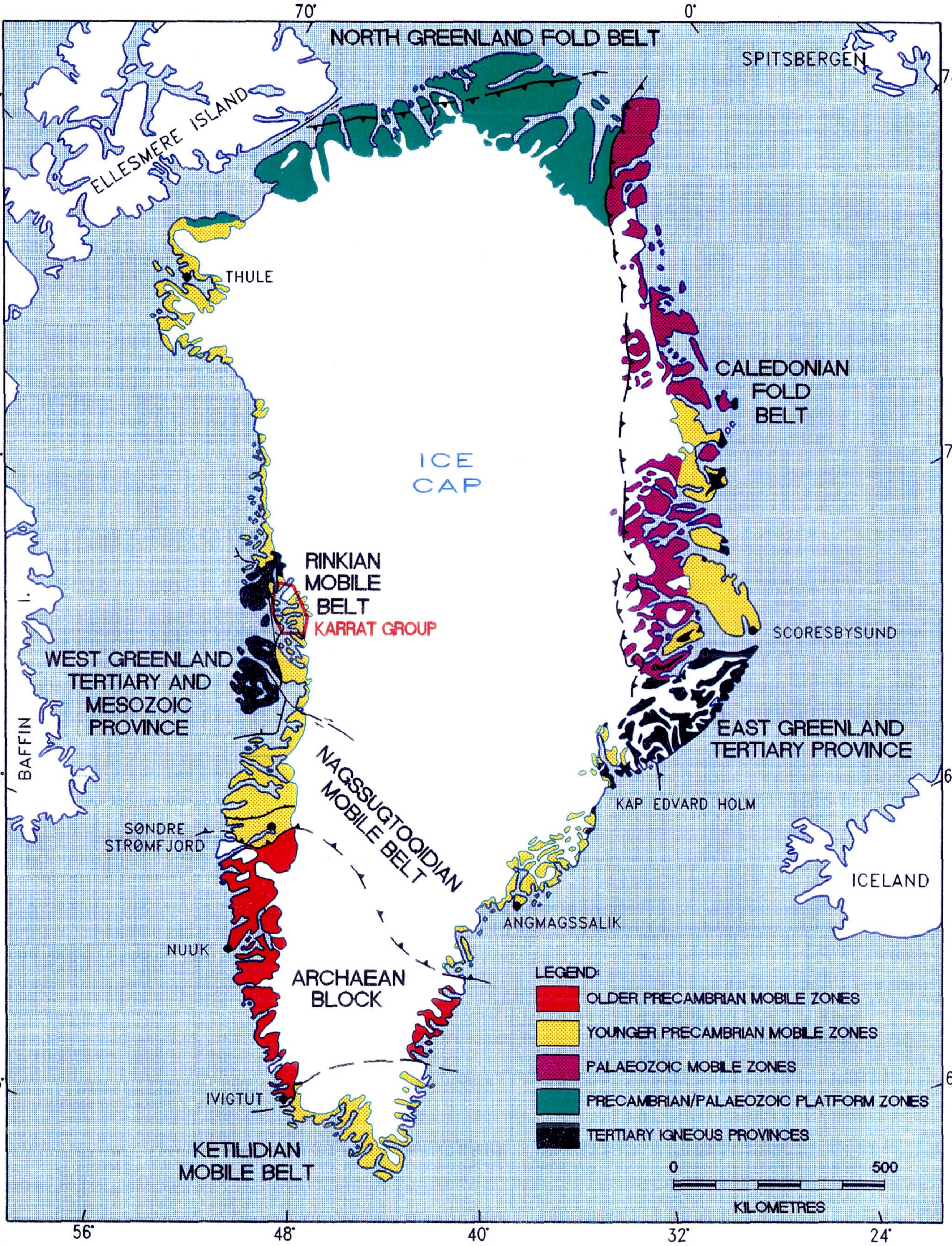
FIGURES

GREENLAND

MAJOR STRUCTURAL DIVISIONS AND LOCATION OF THE KARRAT LICENCE AREA



\GREEN\TENURE RTZM&E 1991

EXCLUSIVE PROSPECTING LICENCE

FIGURE 1

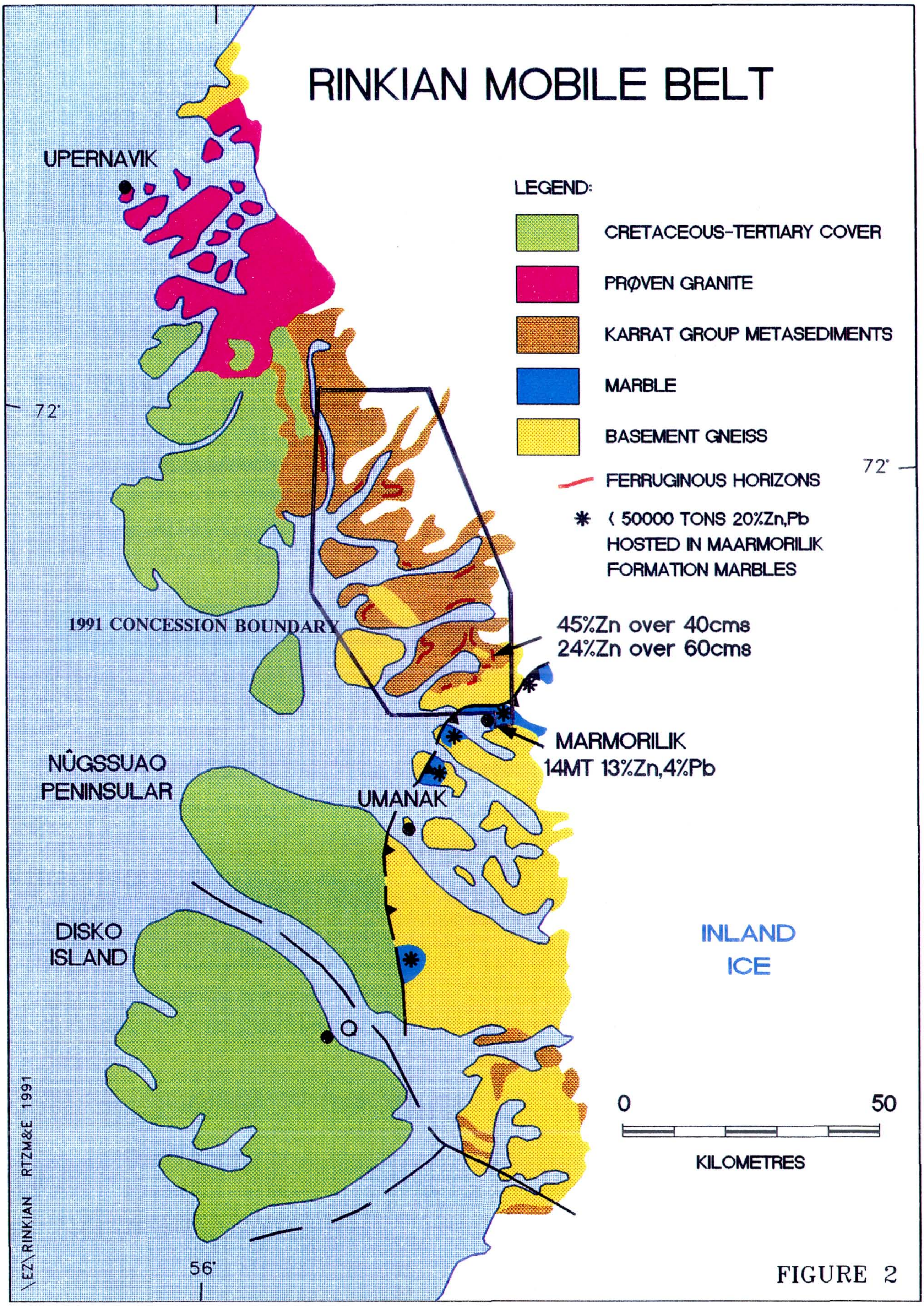
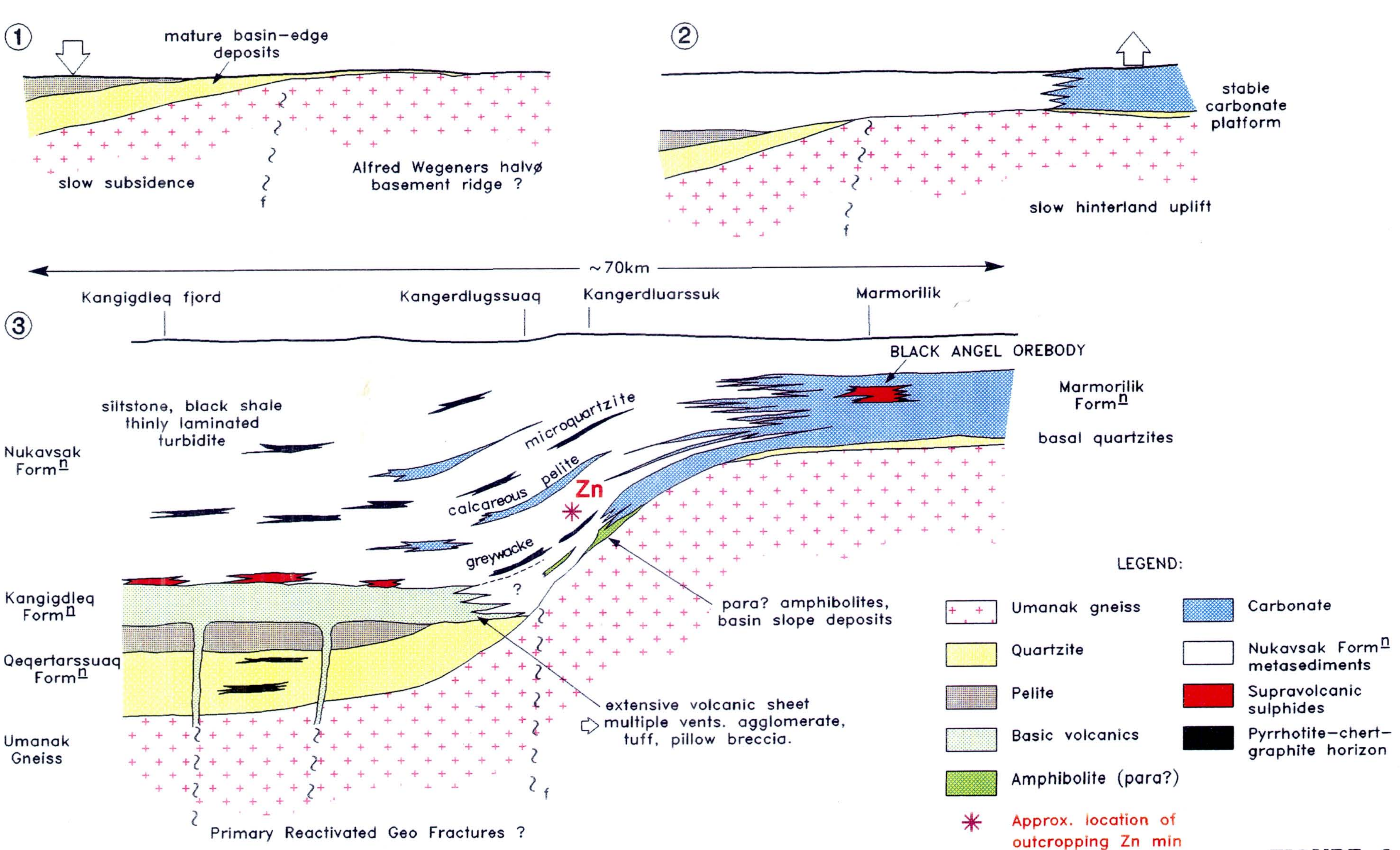

RINKIAN MOBILE BELT
UPERNAVIK
LEGEND:
CRETACEOUS-TERTIARY COVER
PRØVEN GRANITE
KARRAT GROUP METASEDIMENTS
MARBLE
BASEMENT GNEISS
FERRUGINOUS HORIZONS
* (50000 TONS 20%Zn,Pb
HOSTED IN MAARMORILIK
FORMATION MARBLES
72°
72°
1991 CONCESSION BOUNDARY
45%Zn over 40cms
24%Zn over 60cms
MARMORILIK
14MT 13%Zn,4%Pb
NÛGSSUAQ
PENINSULAR
UMANAK
DISKO
ISLAND
INLAND
ICE
0
50
KILOMETRES
56°
\EZ\RINKIAN RTZM&E 1991

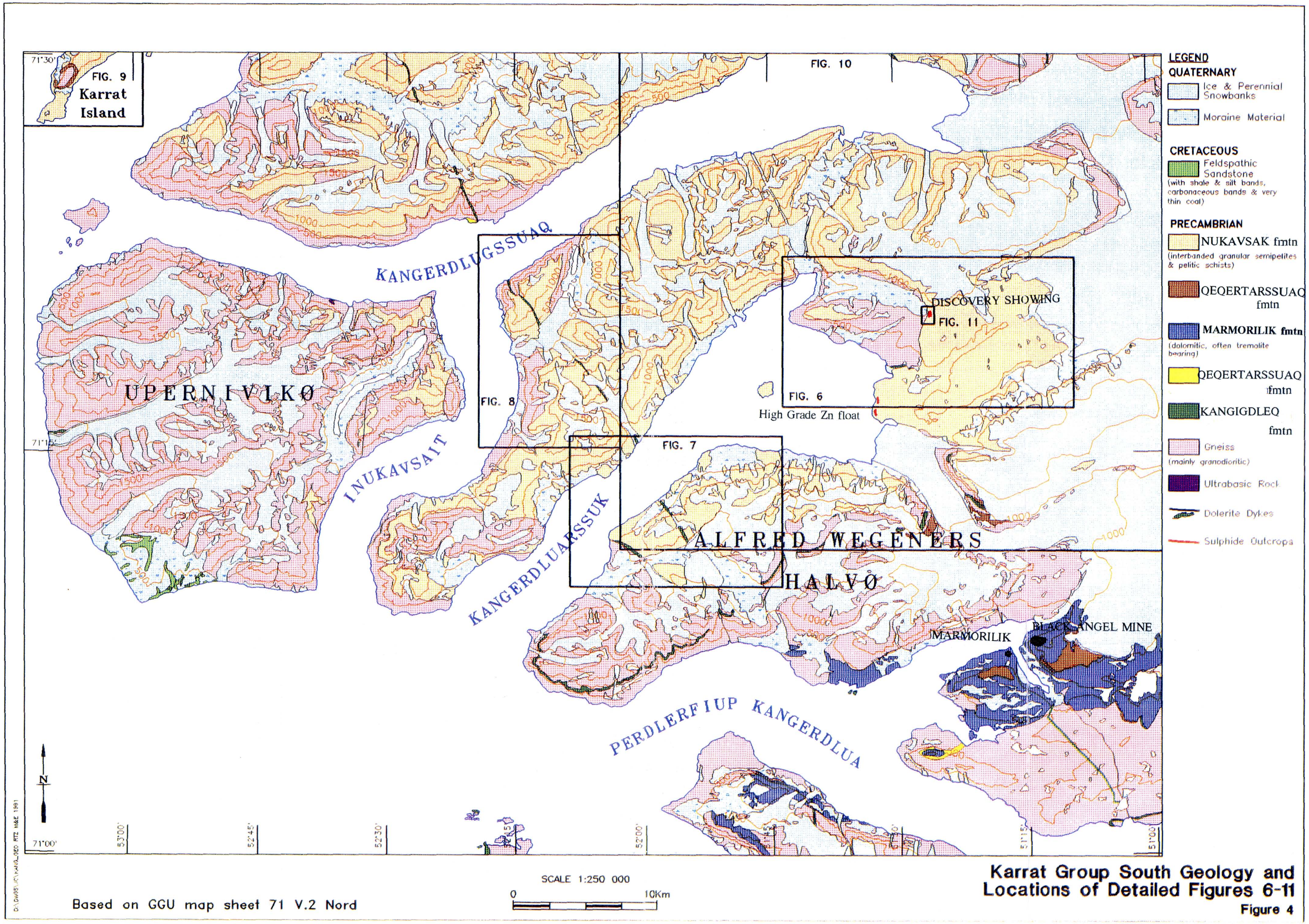
FIGURE 2

PALINSPASTIC RECONSTRUCTION OF THE KARRAT GROUP BASIN



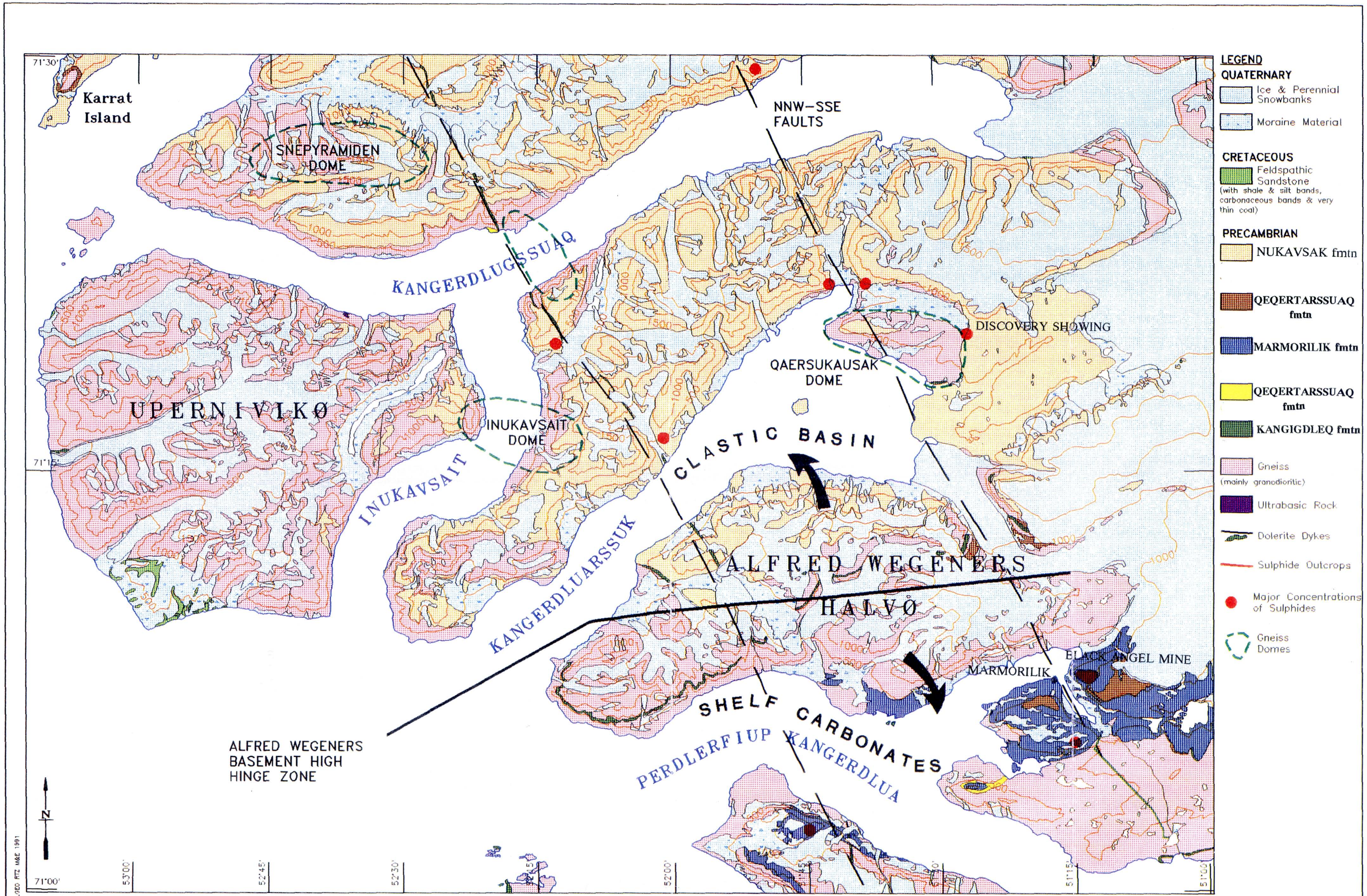
\EZ\KAR_SEC RTZM&E 1991 (AFTER ALLEN & HARRIS 1979)

FIGURE 3



Karrat Group South Geology and Locations of Detailed Figures 6-11

Figure 4



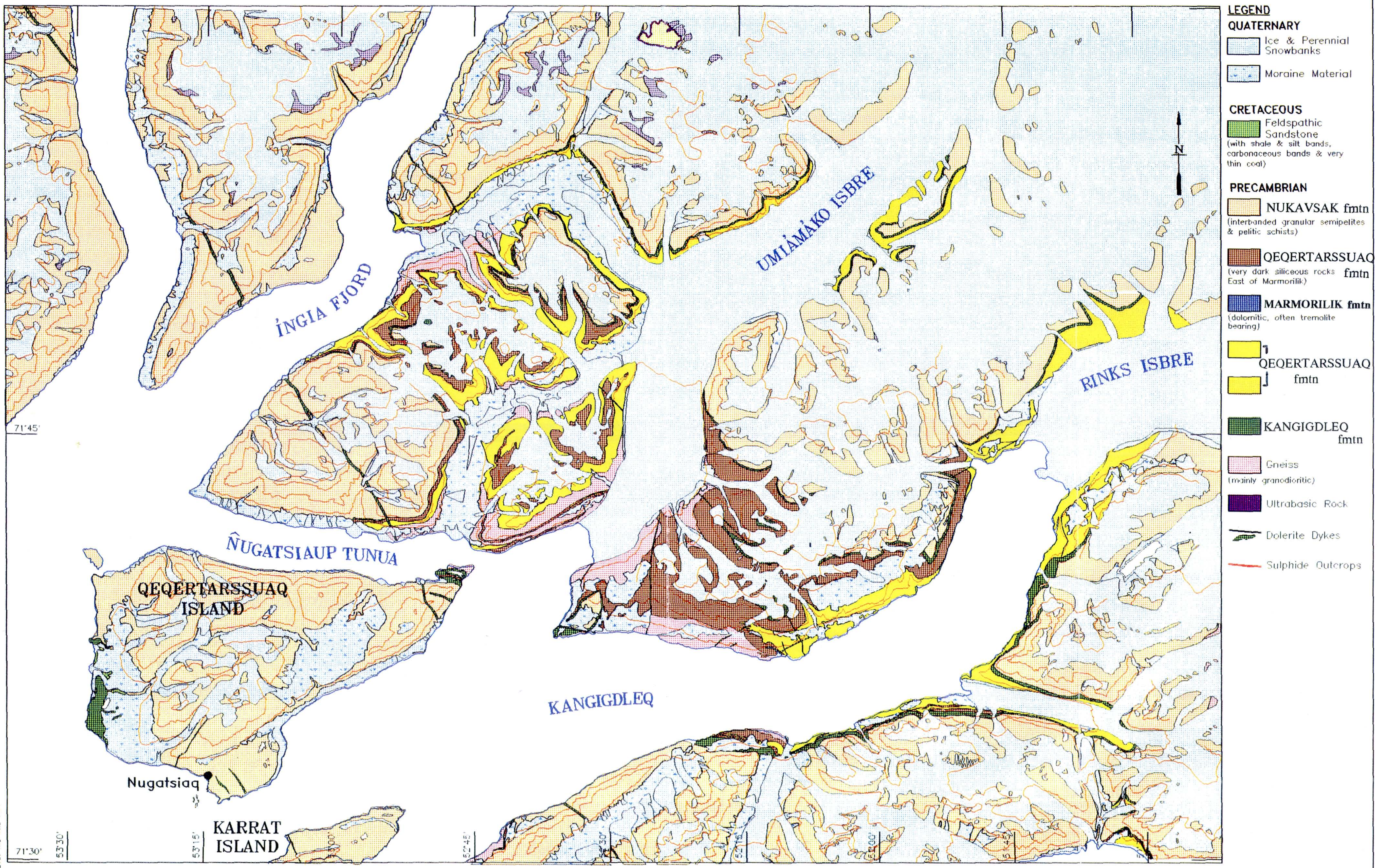
SCALE 1:250 000

0 10Km

Based on GGU map sheet 71 V.2 Nord

Karrat Group South Geology and Major Structural Features

Figure 4a



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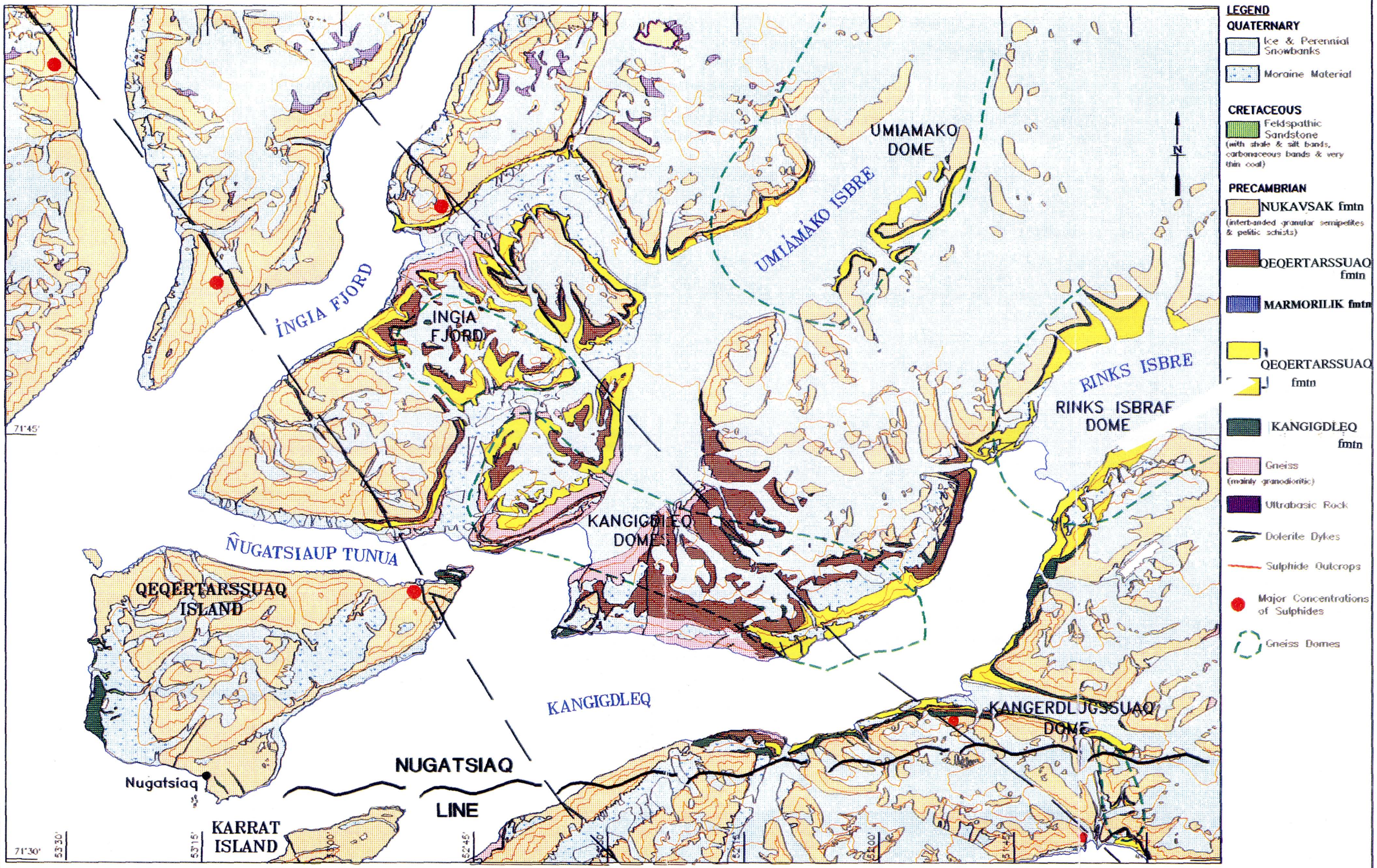
0 10Km

Based on GGU map sheet 71 V 2 Nord

Karrat Group North Geology

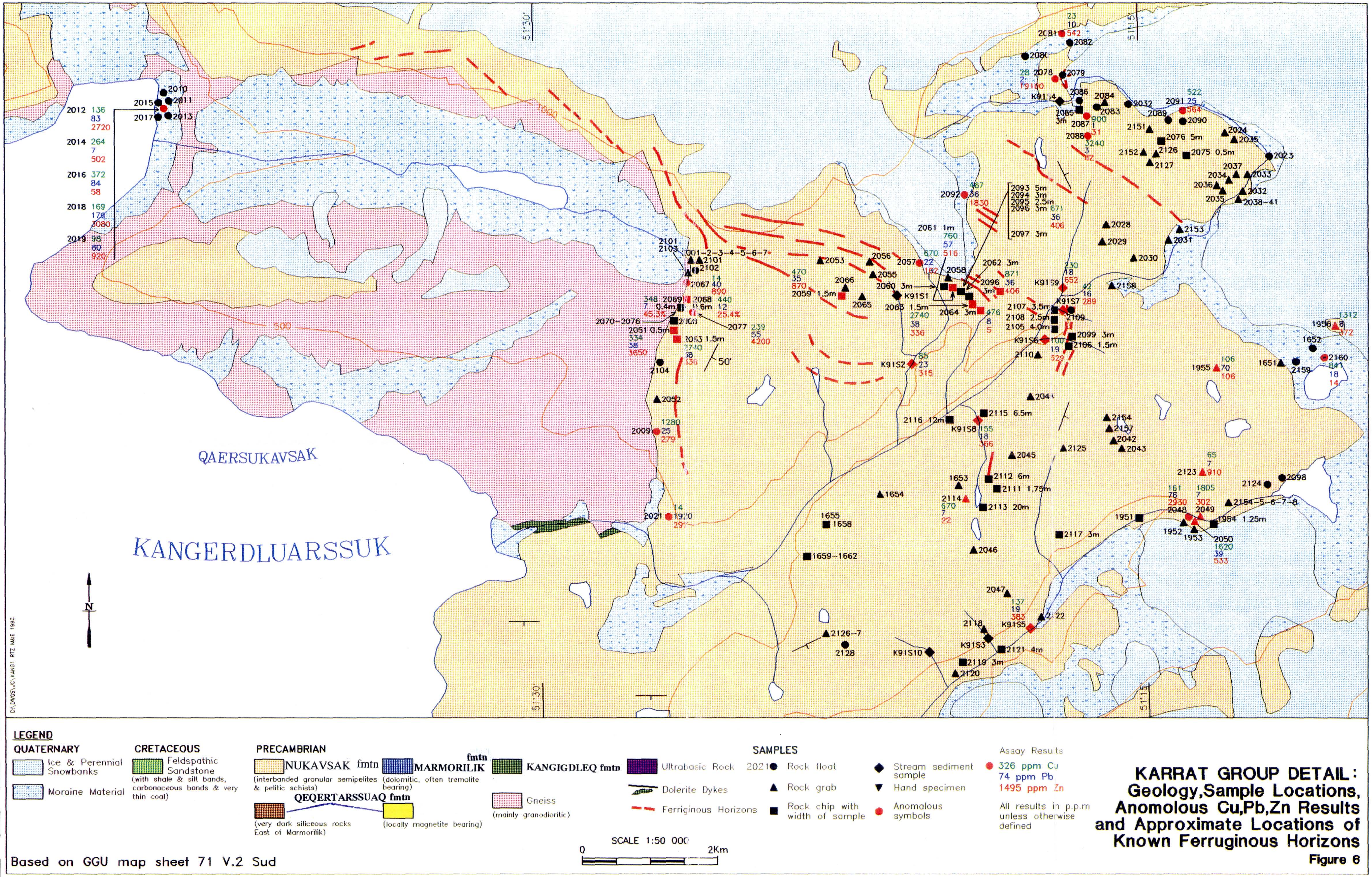
Figure 5



Based on GGU map sheet 71 V 2 Nord

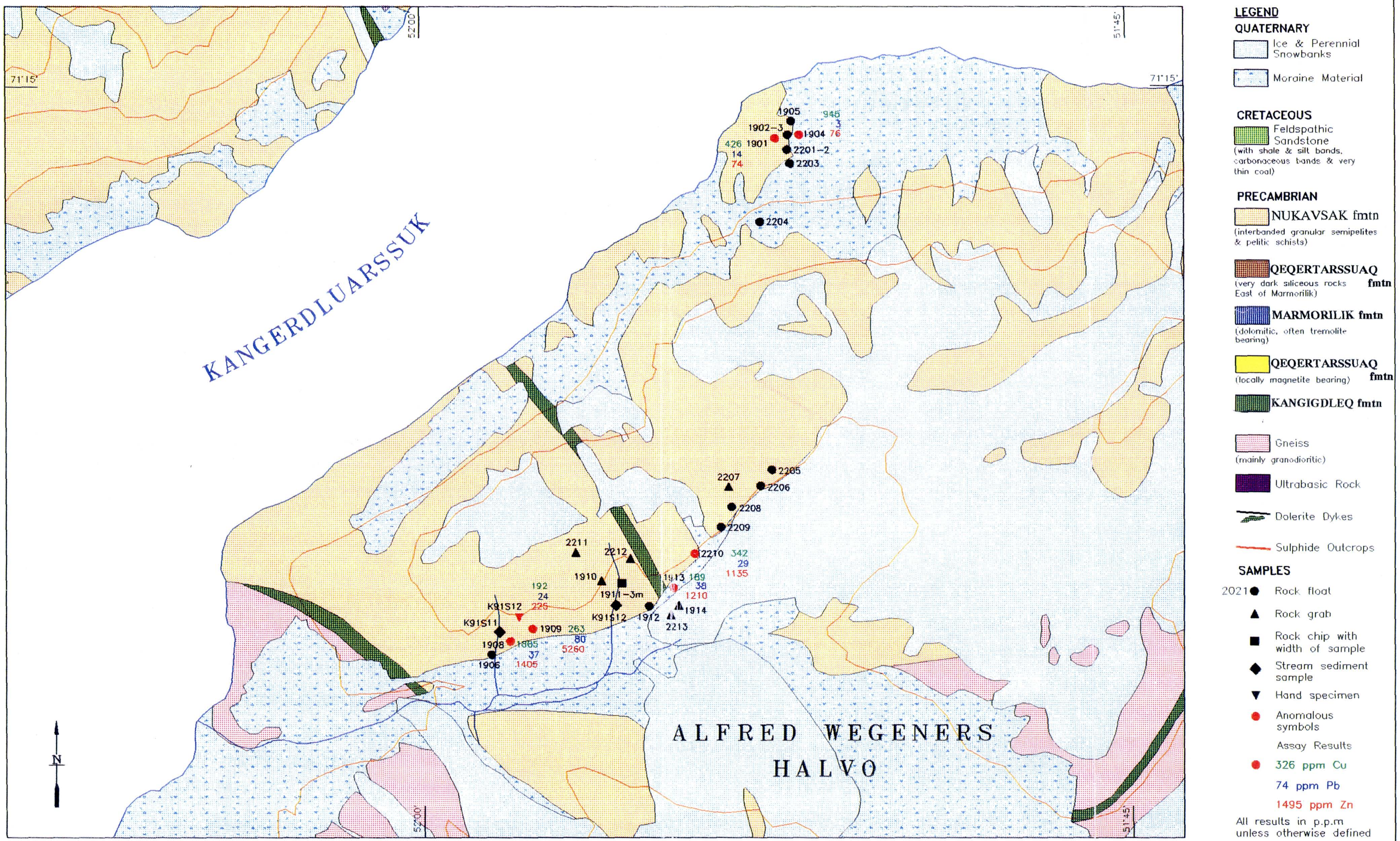
Karrat Group North Geology and Major Structural Features

Figure 5a



KARRAT GROUP DETAIL: Geology, Sample Locations, Anomolous Cu,Pb,Zn Results and Approximate Locations of Known Ferruginous Horizons

Figure 6

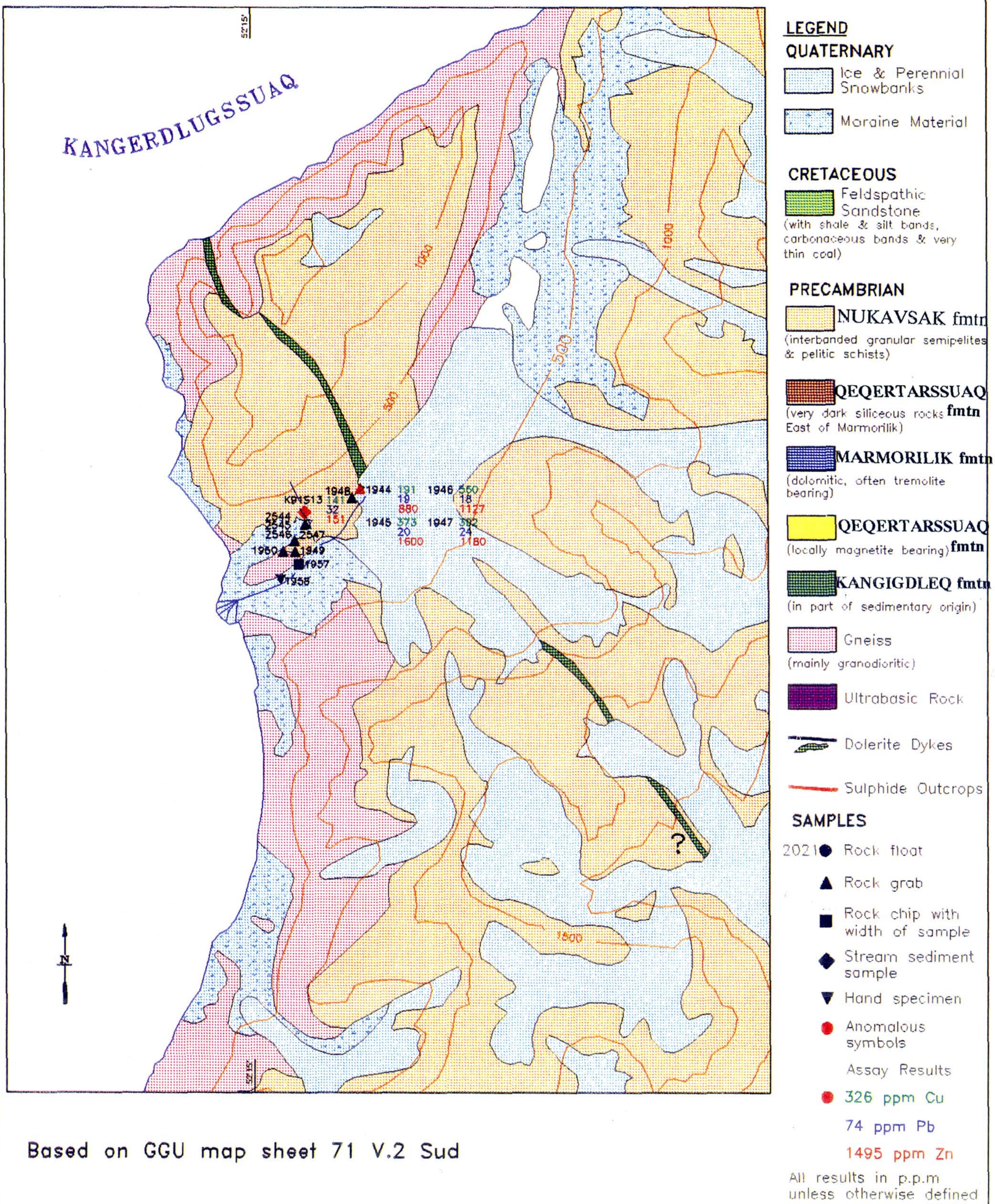


SCALE 1:50 000

0 2Km

Based on GGU map sheet 71 V.2 Sud

KARRAT GROUP DETAIL:
Geology, Sample Locations and Anomolous Cu,Pb,Zn Results on the North Flank of Alfred Wegeners Halvo
Figure 7



Based on GGU map sheet 71 V.2 Sud

0 2Km

D:\DWGS\JC\KANG2 RTZ M&E 1992

KARRAT GROUP DETAIL: Geology, Sample Locations and Anomolous Cu,Pb,Zn Results in the Kangerdlugssuaq / Inukausait Area

Figure 8

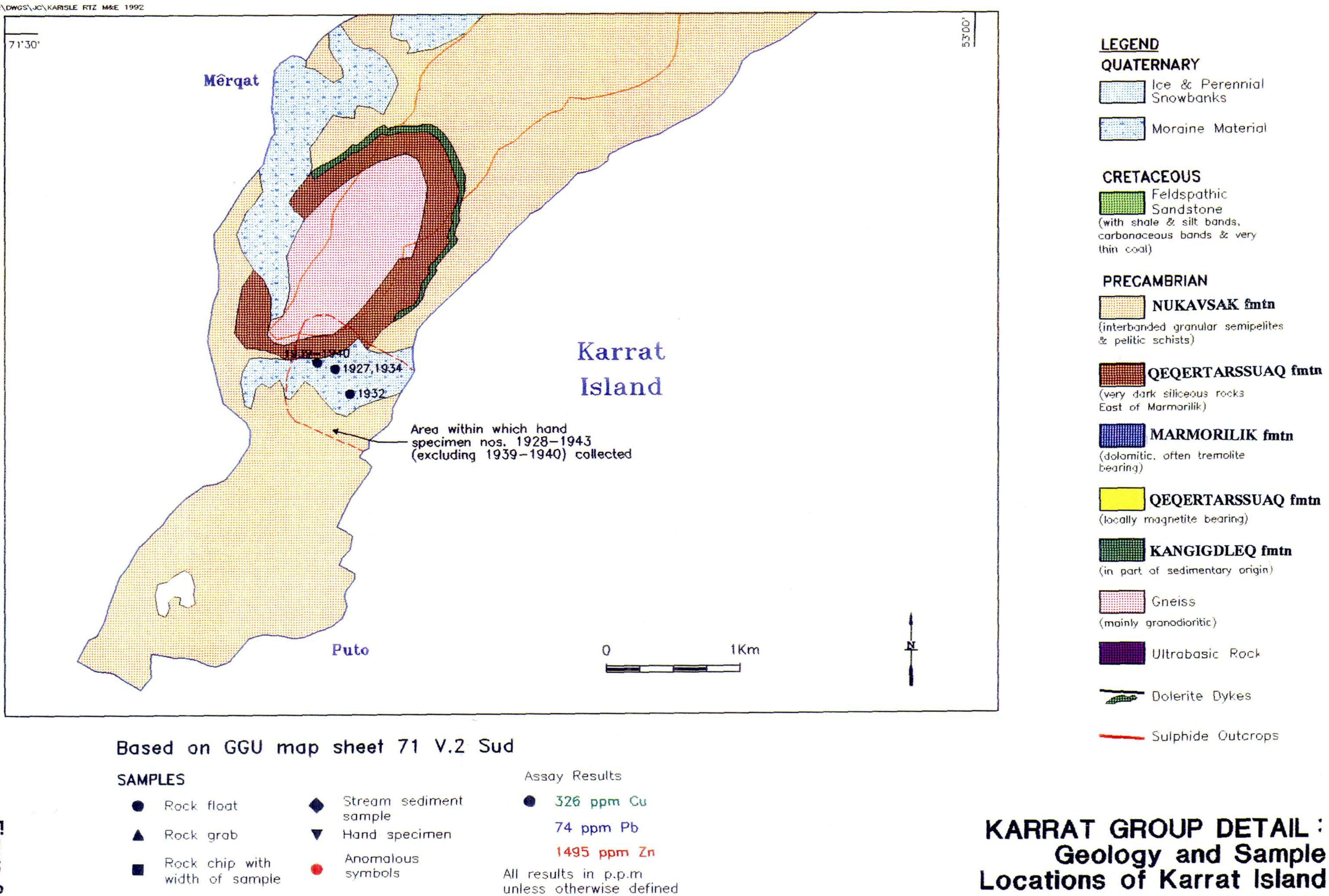
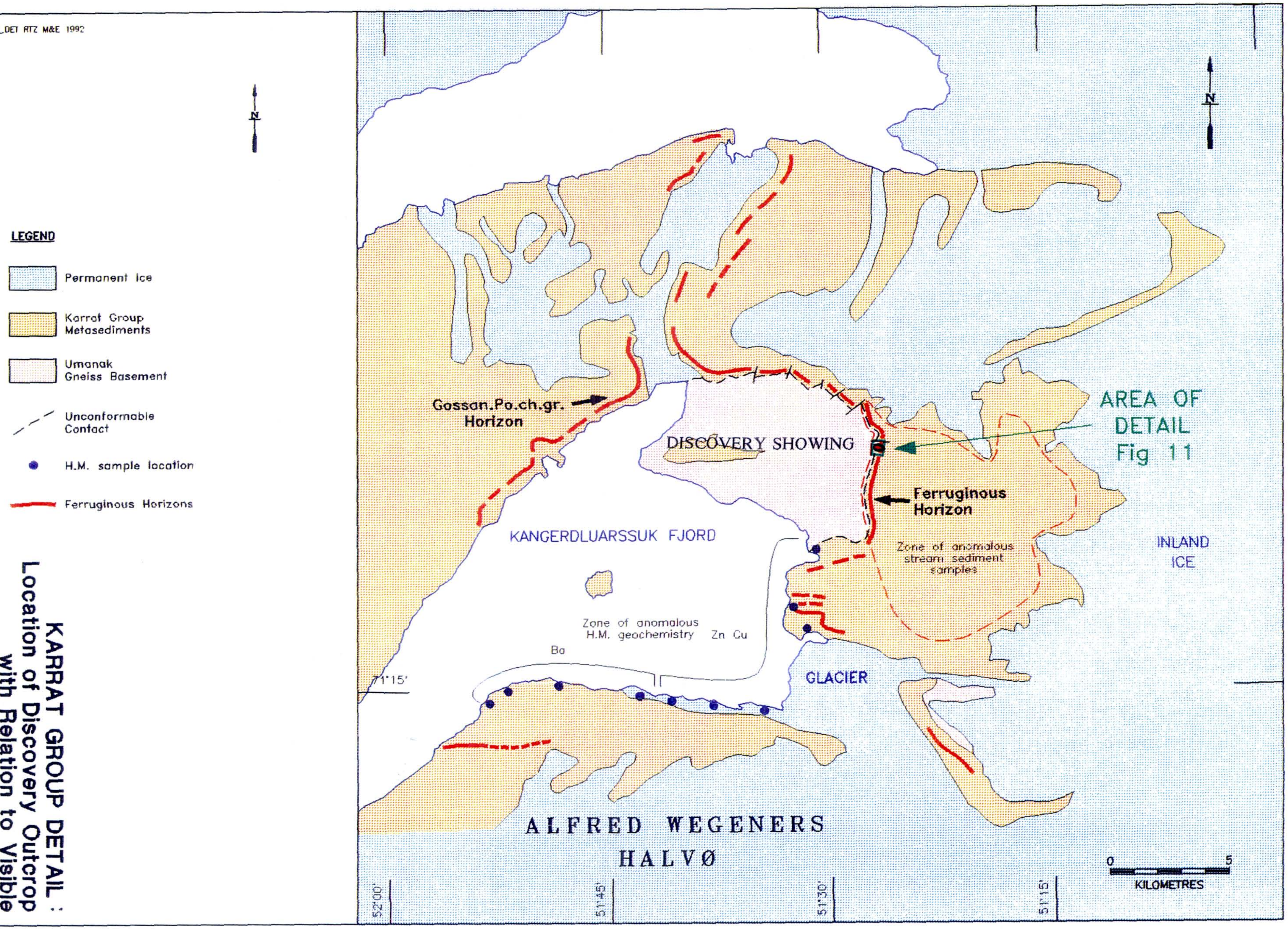
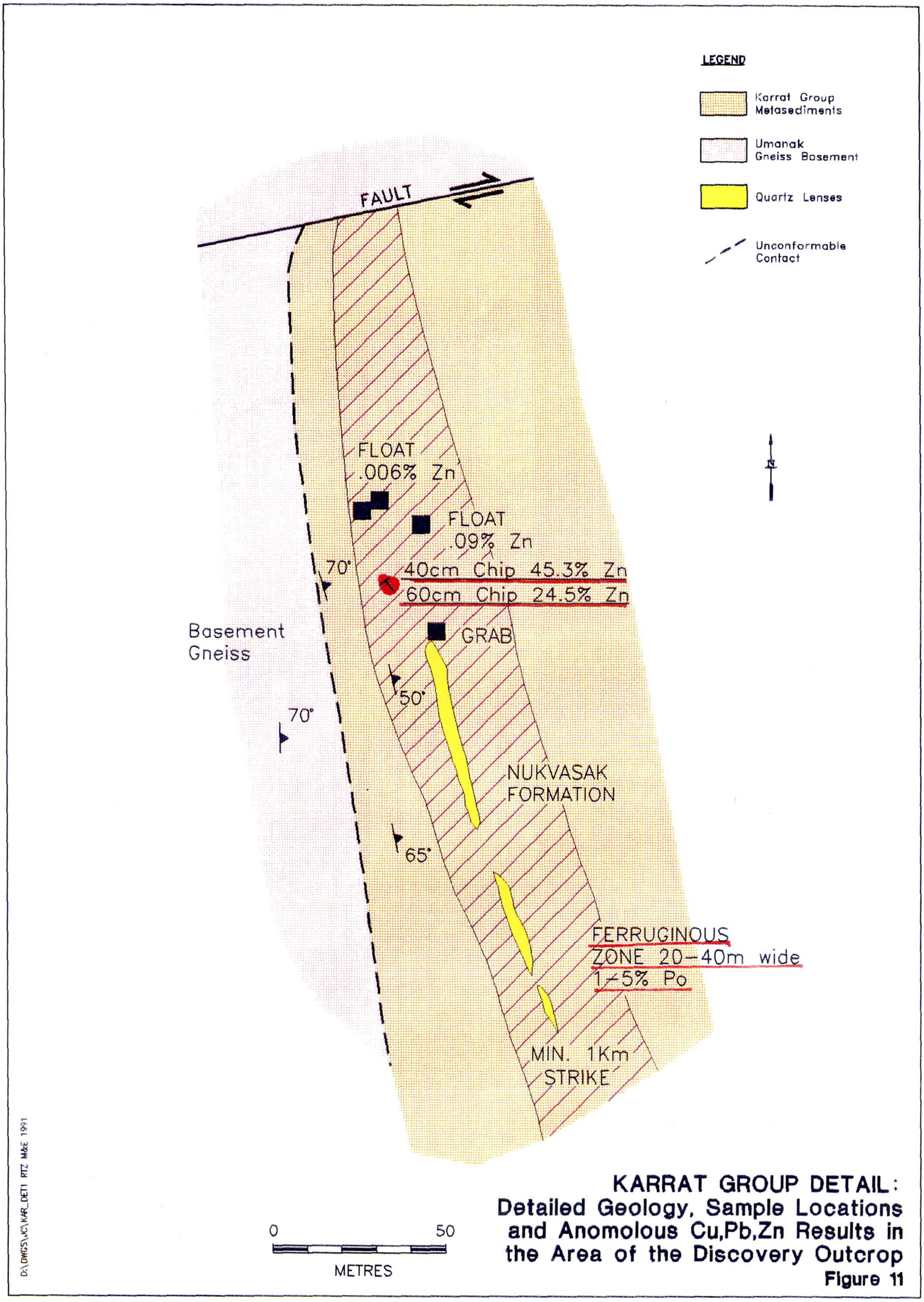


Figure 9

KARRAT GROUP DETAIL: Geology and Sample Locations of Karrat Island



KARRAT GROUP DETAIL :
Location of Discovery Outcrop
with Relation to Visible
Ferruginous Horizons and
Anomolous Geochemical Zones
Figure 10

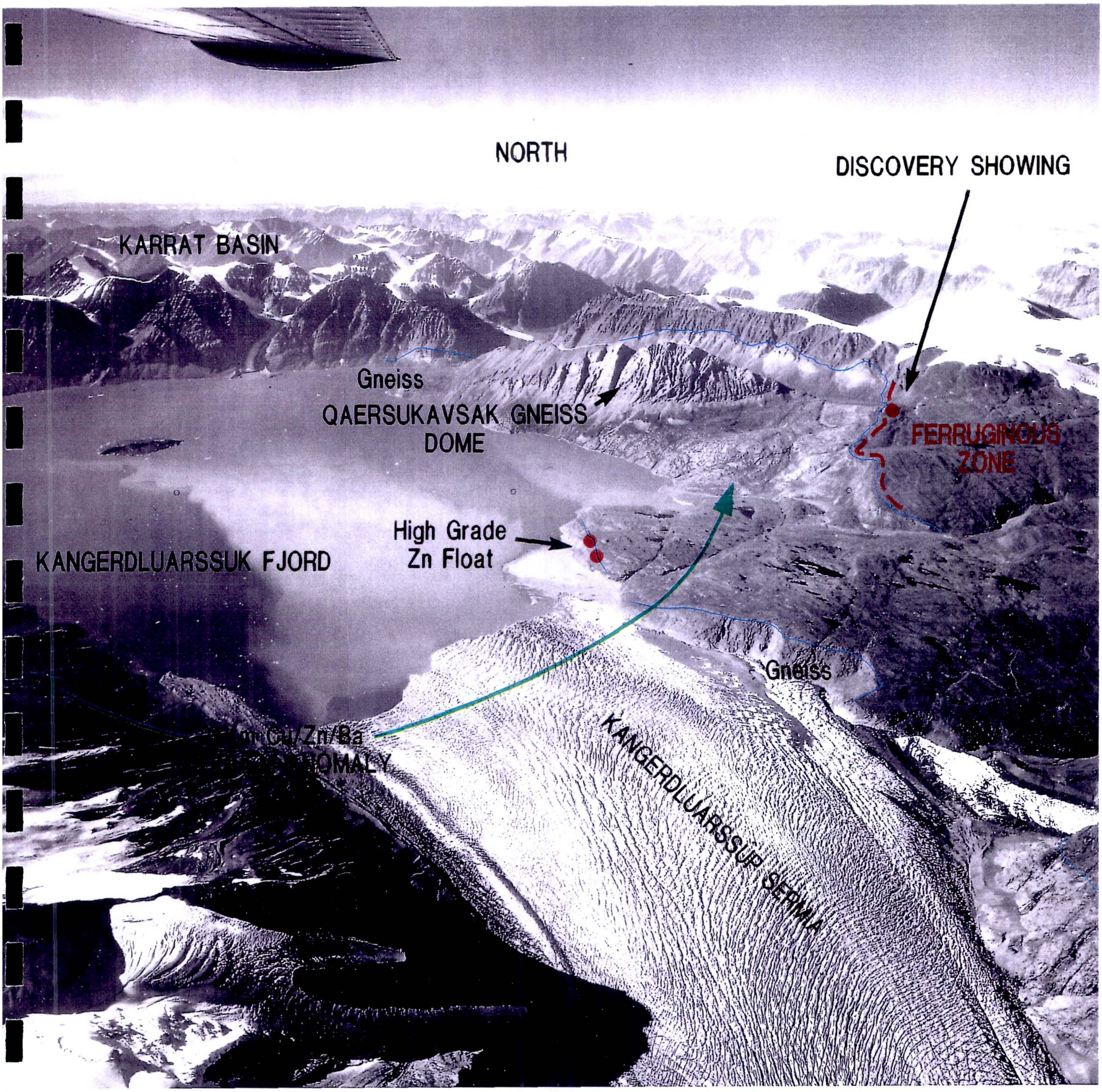


KARRAT GROUP DETAIL: Detailed Geology, Sample Locations and Anomolous Cu,Pb,Zn Results in the Area of the Discovery Outcrop

Figure 11

PHOTOGRAPHS

KANGERDLUARSSUK FJORD
OBLIQUE AERIAL VIEW - FACING NORTH



0 5Kms

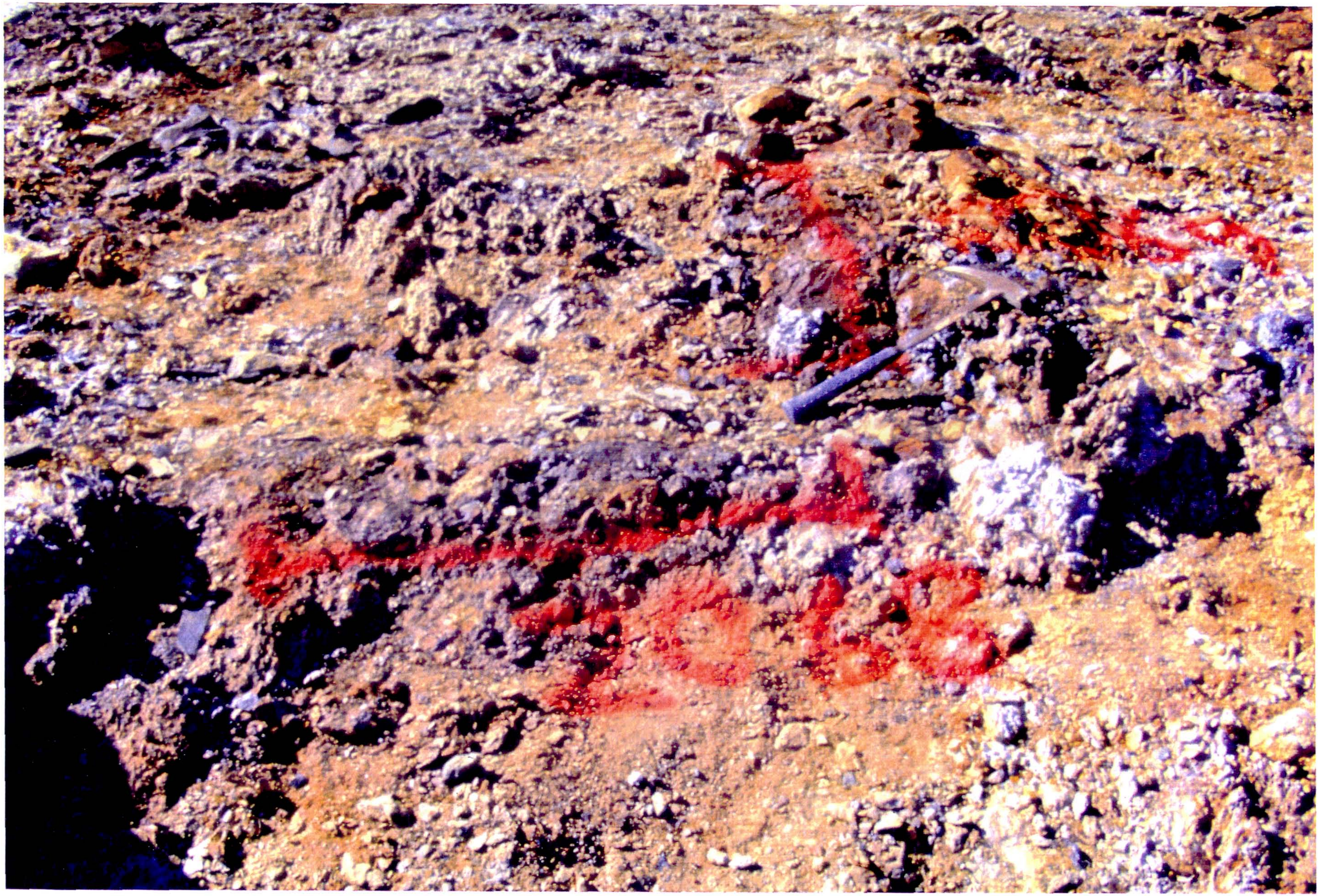
APPROX SCALE

PHOTO 1

PHOTO 2

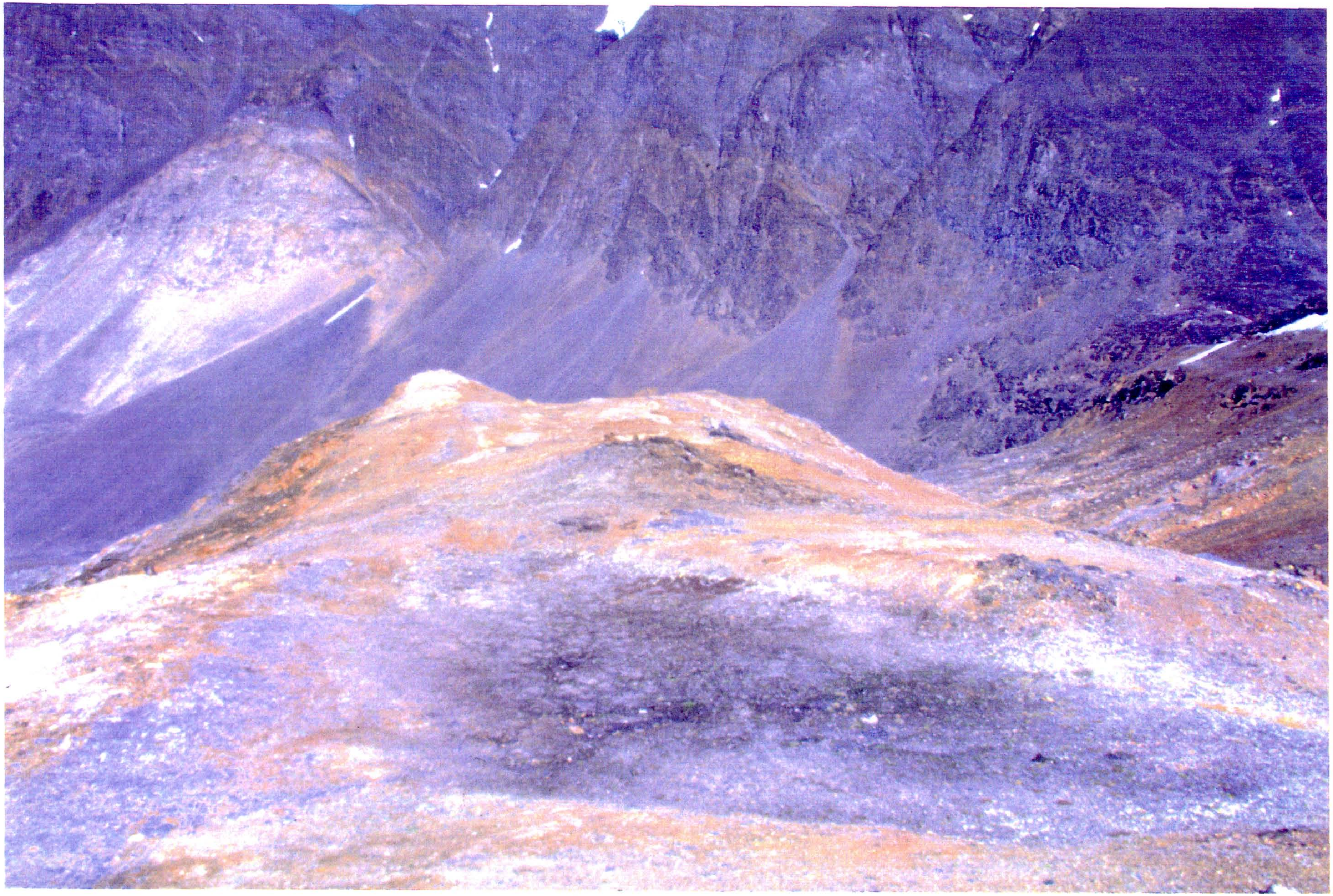
Typical rust weathering of the pyrrhotite rich zones within the Nukavsak formation.

PHOTO 3



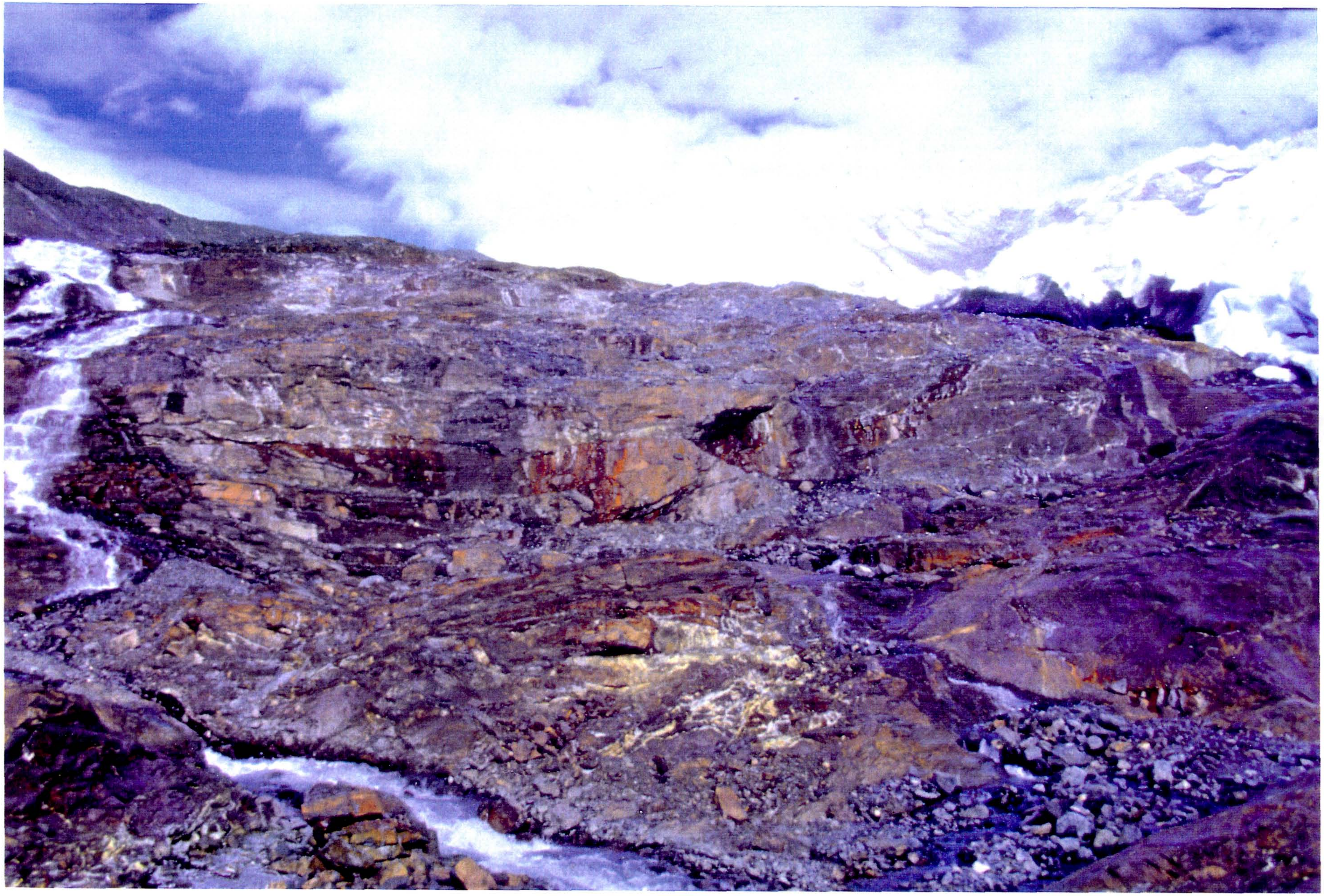
The discovery outcrop showing the limited outcrop within a felsenmeer zone and the sample locations of sample nos. 2068 and 2069.

PHOTO 4



Looking northwards over the discovery showing area with the "target" gneiss/Nukavsak formation contact in the background.

PHOTO 5



Typical Pyrrhotite, graphite, chert horizon exposed close to the ice cap at the head of the Kangerdluarssuk Fjord.

Typical Pyrrhotite, chert, graphite breccia unit in the Nukavsak formation.

PHOTO 6

Good example of a typical Nappe structure in the Karrat area.

Looking west out over the Kangerdluarssuk Fjord with Alfred Wegeners Halvø on the left.

PHOTO 9

A ±1,200m sequence of Nukavsak formation pelites showing the lack of visible marker horizons and the general monotonous aspect of the metasediments.

APPENDIX 1

Ore Petrography of two Zinc-rich exploration samples from Greenland Nos 2068 and 2069

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IMR/29 November 1991/LAB.7207.4

ORE PETROGRAPHY OF TWO ZINC-RICH EXPLORATION SAMPLES FROM GREENLAND

1 INTRODUCTION

A series of reconnaissance samples from an area in Greenland were submitted to Anamet Services by Riofinex North limited for routine ICP geochemical analysis. Two of these samples (#2068 and #2069) were found to contain anomalously high zinc contents and it was requested that they be analysed again using a more appropriate technique for higher elemental abundances. These subsequent analyses confirmed the ICP results and indicated significant Zn contents of 24.26 per cent (#2068) and 45.43 per cent (#2069). Mr S Swatton of Riofinex North subsequently requested that a mineralogical examination of these two samples be performed to provide information on the nature and mode of occurrence of the zinc mineralisation.

2 METHODS OF INVESTIGATION

The samples had been jaw- and roll crushed to <2.0mm in size prior to blending and the splitting off of a representative sub-sample for analysis. The mineralogical examinations were therefore performed on representative sub-samples that were split from the remaining <2.0mm coarse assay rejects. Approximately 50g of each sample was washed, deslimed and wet-screened into a number of appropriate size fractions (>1000, <1000>500, <500>200, <200>100 and <100μm) to facilitate the examination. Examination of the resultant size fractions under a binocular microscope indicated that both samples consisted predominantly of higher density ore minerals. It was therefore not necessary to prepare heavy liquid concentrates to separate the ore minerals from any associated gangue minerals.

Simple grain mounts were prepared of each of the size fractions and these were polished prior to microscopic investigation using reflected light techniques. The individual ore minerals were identified on the basis of their optical properties in reflected light. The appearance of the sphalerite indicated that it is Fe-rich and might possibly contain some Cd. A number of quantitative electron microprobe analyses were therefore performed on several sphalerite grains from both samples to determine their composition and establish whether any within or between sample compositional variations exist.

3 SAMPLE #2068

3.1 Introduction

Examination of the crushed fragments of this sample under a binocular microscope indicates that it consists predominantly of a very dark brown, almost black coloured sphalerite together with subordinate amounts of pyrite, micaceous rock fragments and various goethite-rich ferruginised and oxidised materials. Examination of the individual size fractions using an ore microscope essentially confirmed the identities of these phases, but also indicated the presence of both discrete pyrite grains as well as significant amounts of fine grained marcasite and marcasite-pyrite aggregates that represent the alteration products of former pyrrhotite grains. Subordinate amounts of relict, unaltered pyrrhotite also survive locally and very minor amounts of chalcopyrite are present, generally as inclusions within sphalerite.

3.2 Textural Relationships

The largest individual ore fragments are <2.0mm in size with the result that limited information is available on the larger scale textural relationships within the sample. The textures that are preserved do, however, provide a significant amount of fine-scale information that provides an indication of the probable nature of the ore. The ore is medium grained with the great majority of individual grains ranging in size between a lower limit of approximately 350µm and an upper limit that is in excess of 2.0mm. The ore is polycrystalline in nature and consists essentially of closely packed polygonal grains of sphalerite and pyrrhotite (or marcasite-pyrite replicas of former pyrrhotite grains) within which are intergrown areas or patches of coarsely crystalline pyrite.

The well defined polygonal nature of the constituent sphalerite and pyrrhotite grains, as well as their grain boundary relationships, combined with a moderate grain size suggests that the ore has been subjected to a significant degree of recrystallisation. Grain boundaries tend to be straight to slightly curved and meet in well defined triple junction points. The sphalerite in pyrrhotite-rich areas is characteristically finer grained and is present as elongated grains that are located along pyrrhotite grain boundaries or as more equant grains that are located at triple junction points. Sphalerite-rich fragments may show the presence of minor rounded pyrrhotite inclusions, but it is not possible to determine whether these are present as true inclusions or are also located on grain boundaries without recourse to structure etching. The available evidence is, however, sufficient to indicate that a remarkably high degree of equilibrium was attained during the recrystallisation of these ores and that a significant degree of coarsening has taken place.

The relationships between the coarsely crystalline pyrite and sphalerite-pyrrhotite are not readily observed because liberation has commonly occurred along their mutual grain boundaries. Several small, euhedral pyrite crystals (both cubes and pyritohedra) that are generally less than 750µm in size are sparingly present within sphalerite-rich aggregates. These pyrite crystals commonly contain numerous irregularly shaped sphalerite inclusions. The pyrite also appears to be developed within the pyrrhotite-rich areas and the overall impression is that the coarsely crystalline pyrite might, at least in part, represent a late-stage replacement of some of the pyrrhotite. This replacement would, however, have taken place in association with the recrystallisation of the ore and should not be confused with the pervasive replacement of pyrrhotite by fine grained marcasite-pyrite which is clearly a later-stage phenomenon that is presumably related to near-surface weathering processes.

Small numbers of rock fragments are present within the samples and these appear to be largely micaceous in nature and consist of medium grained mica that is intergrown with variable amounts of other silicate minerals. Several of the larger fragments show the development of a marked preferred orientation that is characteristic of schistose rocks. These most probably represent fragments of country rock or unmineralised partings within the ore. The schistose nature of these fragments also supports the interpretation that the enclosed ore has been subjected to recrystallisation, possibly following a deformational episode.

The ore fragments themselves occasionally show signs of fracturing and brecciation, but the scale of the samples makes it difficult to determine whether this is genuine post-recrystallisation deformation or simply results from near surface weathering processes. Goethite is moderately abundant locally and individual fragments may be traversed by goethite-filled veinlets. The bulk of the goethite is derived from the oxidation of pyrrhotite, marcasite and pyrite with a subordinate amount being derived from the oxidation of the sphalerite. The alteration of pyrrhotite to fine grained marcasite-pyrite aggregates is consistent with effects that are known to occur during near surface weathering processes.

3.3 Descriptions of Individual Ore Minerals

3.3.1 Sphalerite

The sample is dominated by the presence of significant amounts of medium grained sphalerite that is generally present in the form of discrete polygonal grains and, to a very much lesser extent, as minor inclusions within pyrite. The sphalerite is very dark in colour and when examined under the ore microscope, it shows the presence of abundant dark reddish brown internal reflections. Sphalerite of this nature is generally characterised by a high Fe content and a number of quantitative electron microprobe analyses were performed to determine both the Fe and Cd contents. The reported analyses are of different grains within the sample, but duplicate analyses on different areas of the same grain indicate that no significant compositional zoning is present. The results of these analyses are summarised in Table 1 and confirm that the sphalerite is Fe rich (7.59 - 8.13% average 8.00%) and may be referred to as marmatite.

Table 1 - Sample # 2068: Electron Microprobe Analyses of Sphalerite Grains

ANALYSIS	Zn (%)	Fe (%)	Cd (%)	S (%)	TOTAL
1	57.19	7.85	0.52	34.00	99.56
2	57.31	7.93	0.62	34.15	100.01
3	57.15	8.13	0.56	33.86	99.70
4	57.31	7.89	0.59	33.88	99.67
5	56.95	8.19	0.60	33.93	99.67
6	56.91	8.27	0.58	33.91	99.67
7	57.24	8.04	0.56	33.95	99.79
8	57.86	7.59	0.54	33.75	99.74
9	56.89	8.09	0.60	33.82	99.40
MEAN	57.20	8.00	0.57	33.92	99.69

Essentially pure theoretical end member sphalerite (ZnS) exhibits a relatively high Zn content of 67.0 per cent, but Fe may substitute for Zn in the crystal structure with the result that the sphalerite in this sample contains a lower average Zn content of 57.2 per cent (56.89 - 57.86%). The approximate sphalerite content of this sample (based on an average Zn content of 57.2%) can therefore be calculated to be 42.4 per cent by weight. Microscopic observations suggest that this appears to be a realistic figure for the overall sphalerite content of the sample.

The Cd content of the sphalerite (0.52 - 0.62%, average 0.57%) is also significant with the Cd also being present as a substitute for Zn in the crystal structure. This substitution therefore also results in a slight decrease in the overall Zn content of the sphalerite. The sphalerite grains were not analysed for Mn, but qualitative energy dispersive analyses of a number of grains indicates that small amounts of Mn are also present, most probably in the range between 0.1 and 0.3 per cent. This Mn will also substitute for Zn in the crystal structure thereby causing a further slight lowering of the total Zn content.

The sphalerite grains are largely optically homogeneous and free from inclusions apart from small numbers of tiny (generally < 15µm in size) inclusions of pyrrhotite and, to a lesser extent, chalcopyrite. These inclusions are sparingly disseminated throughout the sphalerite and are rarely present in significant numbers in any single grain. Both the pyrrhotite and chalcopyrite grains may occasionally be larger (maximum 50µm in size) and are commonly elongated. The morphology and orientation of these larger grains suggests that they represent minor phases that have segregated to low energy sites on grain boundaries within polygonal sphalerite aggregates and do not represent true inclusions. This can be investigated further by structure etching if necessary.

The bulk of the sphalerite grains appear fresh and unaltered, but in a number of cases the outer margins of individual grains may show incipient to partial oxidation and replacement by goethite. In a number of cases, the oxidation/replacement has proceeded to a far greater extent and small relict, and often triangularly shaped fragments of sphalerite survive within a mass of secondary goethite. These textures arise because oxidation and replacement of the sphalerite takes place along the well defined dodecahedral cleavage planes thus leading to the development of characteristic sphalerite boxwork structures.

3.3.2 Pyrrhotite and Marcasite-Pyrite Replacements

Pyrrhotite originally represented the next most important mineral in the ore assemblage. It is present essentially in the form of discrete polygonal crystals and, to a relatively minor extent, as inclusions within sphalerite. The pyrrhotite is optically homogeneous and is generally free from inclusions. It is non-ferromagnetic and appears to be the hexagonal variety. The bulk of the pyrrhotite grains show at least some degree of alteration and replacement by fine grained marcasite-pyrite aggregates and a continuum exits between completely replaced grains and those grains showing only moderate degrees of replacement.

Alteration of this nature commonly occurs at lower temperatures and it is commonly (but not always) related to the early stages of near surface weathering process. The alteration commences along grain boundaries and fractures from where it proceeds into the pyrrhotite grains along the well defined basal cleavage planes. The pyrrhotite may be converted directly marcasite, but in most cases, fine grained aggregates of both marcasite and pyrite are formed. The conversion of pyrrhotite (essentially $Fe_{1-x}S$) to marcasite and pyrite (FeS_2) under these conditions proceeds via the removal of Fe from the system which results in a marked reduction in volume. This in turn increases the porosity of the samples resulting in the development of characteristic shrinkage cracks that develop parallel to the relict traces of the former pyrrhotite basal cleavage planes. The resulting textures are therefore clearly indicative of the presence of former pyrrhotite grains, even in cases where the replacement is complete.

3.3.3 Pyrite

Pyrite is present in smaller amounts than pyrrhotite and appears to be largely intergrown with sphalerite. The pyrite is generally coarsely crystalline with the result that the great majority of grains are cleanly liberated. Textural relationships are therefore not well preserved. Observations of composite grains show that the pyrite generally exhibits euhedral to subhedral morphologies in which both cubes and pyritohedra are represented. The pyrite appears to be most frequently intergrown with sphalerite where it tends to show the development of crystal outlines against sphalerite grain boundaries. The marginal areas of such pyrite grains commonly contain small numbers of irregularly shaped sphalerite inclusions that range between 10 and 50μm in size. These relationships suggest that the pyrite crystals have grown *in situ*, possibly during recrystallisation.

Pyrite is far less commonly intergrown with pyrrhotite and textural relationships suggest that the pyrite represents a complete or partial replacement of the pyrrhotite. This replacement is, however, markedly different from the widespread alteration of pyrrhotite to fine grained marcasite-pyrite aggregates described earlier (Section3.3.2). The alteration of pyrrhotite to massive pyrite without any shrinkage requires either the introduction of additional sulphur or the removal of excess Fe concomitant with recrystallisation that will obliterate any evidence of volume changes. The nature and mode of occurrence of the massive, coarsely crystalline pyrite in the ore strongly suggests that it developed prior to or during the recrystallisation event.

The pyrite is generally optically homogeneous, but does contain small numbers of sphalerite inclusions that are generally developed towards the margins of their host grains. These inclusions are generally irregularly shaped or rounded and rarely exceed 50μm in size. Chalcopyrite inclusions are also sparingly present, but rarely exceed 25μm in size and are relatively rare. Composite two-phase chalcopyrite-sphalerite are also present. Similarly sized inclusions of pyrrhotite may also be present within the pyrite, but these are very rare. The pyrite is generally fresh and does not show evidence of oxidation and replacement by goethite.

3.3.4 Chalcopyrite

This is a relatively minor accessory constituent of the ore and is generally present in the form of tiny (<5μm in size) inclusions within sphalerite grains. These inclusions are widely, but erratically disseminated throughout the sphalerite and are never present in sufficient numbers to constitute the type of textures that are referred to as "chalcopyrite disease". A small number of slightly larger chalcopyrite grains (typically 5 to 40μm in size) are very sparingly present along grain boundaries between sphalerite grains or are located at triple junction points. Small rounded chalcopyrite inclusions (generally < 25μm in size) are very sparingly present within certain of the pyrite grains.

3.3.5 Goethite

The sample has been subjected to a significant degree of near surface weathering and this is reflected in the development of significant amounts of goethite at the expense of the pyrrhotite and, to a lesser extent, sphalerite. The most common occurrence of goethite is in the form of very fine grained aggregates that pseudomorphously replace the fine grained marcasite-pyrite replacement textures of former pyrrhotite grains. This replacement faithfully replicates the original textural features of these grains with the result that they can be readily recognised, even in situations where the replacement is complete. All stages of this process are present and a continuum exists between those marcasite-pyrite aggregates that exhibit only incipient alteration and completely replaced grains.

The Fe-rich sphalerite also shows local replacement by goethite, but in most cases the degree of replacement is far more restricted than that in the case of marcasite-pyrite after pyrrhotite. The replacement is generally restricted to the immediate vicinity of grain boundaries or fractures, but in a number of cases, the replacement has proceeded along the dodecahedral cleavage planes of the sphalerite. This results in the development of characteristic goethite boxwork textures that replicate the former cleavage elements of the original sphalerite, thereby facilitating its recognition in completely altered materials.

Significant amounts of goethite have been produced during the weathering process and much of this has been precipitated along narrow fractures and along grain boundaries between various phases. This goethite is commonly banded and may show the development of botryoidal and concretionary structures. This exotic goethite has also been precipitated in the associated rock fragments, particularly along grain boundaries and along the cleavage planes of mica grains. This results in a good replication of original textures within the silicate rock fragments.

3.3.6 Transparent Minerals and Rock Fragments

The ore sample contains approximately 12 per cent by volume of rock fragments. Their constituent minerals were not examined in detail, but observations in reflected light indicate that they are generally highly micaceous and may be termed schistose. A minor amount of carbonate, presumably calcite, is also present.

3.4 Discussion

The sample represents a medium grained, recrystallised polycrystalline sphalerite-rich ore that contains subordinate amounts of pyrrhotite and pyrite. A relatively small proportion of schistose rock fragments are present, but their relationships towards the ores minerals were not be observed. The various textural relationships within the fine grained (<2.0mm) ore fragments suggest that the ore has been thoroughly recrystallised to yield medium sized polygonal grains of sphalerite and pyrrhotite as well as euhedral to subhedral crystals and aggregates of pyrite. The sphalerite is Fe-rich (average 8.00%) and contains significant amounts of Cd (0.57%) which results in a lower total Zn content (57.2%). The relatively simple nature of the ore together with a medium grain size and simple grain boundary relationships, however, indicates that beneficiation should be relatively easy. It should prove possible to produce a zinc concentrate containing in excess of 50 per cent Zn (possibly 52.5 - 55.0%) for which a bonus should also be payable for the Cd content.

4 SAMPLE #2069

4.1 Introduction

Examination of the crushed fragments of this sample under a binocular microscope indicates that it consists essentially of a very dark brown, almost black sphalerite together with subordinate amounts of goethite and ferruginised materials. Examination of the various size fractions in reflected light confirmed that the sample consists predominantly of cleanly liberated sphalerite grains together with smaller amounts of goethite that is present both as incomplete replacements of sphalerite grains and as psuedomorphous replicas of former pyrrhotite grains (marcasite-pyrite alteration products). Very minor amounts of extensively ferruginised schistose rock fragments are also present.

4.2 Textural Relationships

The bulk of the individual sphalerite grains in this sample exceed 2.0mm in size with the result that the great majority of grains are completely liberated. Very limited textural evidence is therefore available on which to interpret the textures of the original ore. The available evidence suggests that the original ore consists predominantly of sphalerite together with subordinate pyrrhotite that were present in a medium to coarse grained recrystallised polycrystalline aggregate.

4.3 Descriptions of Individual Ore Minerals

4.3.1 Sphalerite

This sample consists predominantly of cleanly liberated sphalerite grains that are characterised by the presence of dark reddish brown internal reflections. The sphalerite is very similar to that in the previous sample (#2068) and eight electron microprobe analyses were performed on different fragments to determine the composition of this phase. These results are summarised in Table 2 and confirm that the sphalerite is very similar in composition to the sphalerite in the previous sample. It is characterised by a high Fe content (7.41 - 8.63%, average 8.07%) and a moderate Cd (0.57 - 0.64, average 0.60%) content which result in a lowering of the total Zn content (56.16 - 57.87, average 57.0%). This composition is not significantly different from that of the sphalerite in the previous sample.

Table 2 - Sample # 2069: Electron Microprobe Analyses of Sphalerite Grains

ANALYSIS	Zn (%)	Fe (%)	Cd (%)	S (%)	TOTAL
1	56.95	8.09	0.64	33.97	99.65
2	57.87	7.41	0.65	34.11	100.04
3	57.32	7.81	0.60	33.93	99.66
4	56.16	8.73	0.57	33.92	99.38
5	56.36	8.63	0.58	33.78	99.35
6	56.36	8.55	0.57	33.72	99.20
7	57.45	7.74	0.57	33.97	99.73
8	57.21	7.63	0.58	34.10	99.52
MEAN	56.96	8.07	0.60	33.94	99.57

Recalculation of the Zn content (45.43%) of this sample in terms of sphalerite (on the basis of 57.0% Zn) yields a theoretical sphalerite content of approximately 79.9 per cent. This reflects the very high sphalerite content of this oxidised sample. This very high calculated sphalerite content is consistent with the high sphalerite content as determined by microscopic examination. Examination of individual sphalerite grains indicates that they are compositionally homogeneous and do not show evidence of compositional zoning. Minor amounts of Mn (0.1 - 0.3%) are also present in the sphalerite.

The sphalerite is very similar in appearance to the sphalerite in the previous sample in that it is generally optically homogeneous and free from inclusions other than minor amounts of pyrrhotite and chalcopyrite. The chalcopyrite is generally present in the form of tiny inclusions (generally <5µm in size) that are sparingly disseminated throughout their sphalerite hosts. The distribution of the chalcopyrite is, however, relatively erratic and these inclusions may be more abundant in certain grains than in others. The pyrrhotite inclusions tend to be larger than those of chalcopyrite (commonly 10 - 50µm in size), but are also rounded. The higher degree of oxidation (weathering related) of this sample is reflected in the widespread alteration of the pyrrhotite inclusions to fine grained marcasite-pyrite aggregates and, under more extreme conditions, to goethite.

The bulk of the sphalerite grains and fragments appear to be fresh and unaltered, but a subordinate number do show varying degrees of oxidation and replacement by goethite. The bulk of this replacement occurs around grain margins and along fractures, but in a small number of cases it has progressed to a greater extent. This results in the development of indigenous goethite along the dodecahedral cleavage planes of the sphalerite to produce characteristic replica boxwork textures.

4.3.2 Pyrrhotite

The sample shows the presence of a small proportion of porous goethite-rich grains and aggregates that show the presence of characteristic pyrrhotite replica textures. These textures consist largely of the fine grained basal cleavage elements of the former pyrrhotite grains that were preserved during an earlier stage of alteration to fine grained marcasite-pyrite aggregates. The overall degree of alteration is very high and only rare traces of fine grained marcasite-pyrite aggregates survive. No relict pyrrhotite (other than rare inclusions within sphalerite) survives. The morphologies of the pyrrhotite replicas suggests that this phase was present largely in the form of discrete polygonal grains that generally exceeded 1.0mm in size.

4.3.3 Goethite

This represents the most important phase in the ore after sphalerite. It is present essentially as an Fe-rich oxidation product of pyrrhotite (marcasite-pyrite aggregates) and, to a very much lesser extent, as an alteration product of Fe-rich sphalerite. The goethite is therefore present both as a replacement of pre-existing sulphide minerals and as secondary precipitate along various permeable features including fractures and grain boundaries. The *in situ* replacement goethite generally results in a very good replication of characteristic boxwork elements of both pyrrhotite and sphalerite, whereas the secondary goethite precipitates are characterised by various porous, botryoidal and concretionary textures.

4.4 Discussion

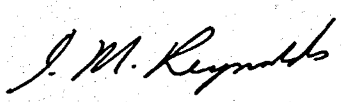
The available evidence indicates that this sample originally consisted of a recrystallised medium to coarse grained sphalerite-rich ore containing subordinate amounts of pyrrhotite. The sphalerite is Fe-rich (average 8.07%), but contains significant amounts of Cd (average 0.60%). This results in a lowering of the total Zn content to approximately 57.0 per cent. The medium to coarse grained nature of the ore together with simple mineralogy and grain boundary relationships indicates that beneficiation will be relatively easy. It should be possible to produce very clean sphalerite concentrates that contain in excess of 50 per cent Zn (probably 52.5 - 55.0% Zn) from these materials. The Cd content is also sufficiently high to attract bonus payments from a smelter.

5 GENERAL DISCUSSION

The two samples both appear to represent well recrystallised sphalerite ore specimens that have been subjected to varying degrees of secondary alteration resulting from near surface weathering processes. This has resulted in the extensive decomposition of original pyrrhotite and the development of significant amounts of secondary goethite. Replication of primary textures is, however, very good and it is possible to estimate the original mineralogical composition of each of these ores as shown in Table 3 (in weight %). Sample #2068 contains approximately 42.4 per cent by weight of sphalerite and sample #2069 approximately 79.9 per cent. Both of these samples may therefore be regarded as being high grade zinc ores.

Table 3 - Estimated Primary Mineralogical Composition of Samples

MINERAL OR CONSTITUENT	SAMPLE #2068 (%)	SAMPLE #2069 (%)
Sphalerite	42.4	79.9
Pyrrhotite	35.0	17.6
Pyrite	12.6	-
Chalcopyrite	<0.5	<0.5
Rock Fragments	10.0	2.5



I M Reynolds
MINERALOGIST

APPENDIX 2

A complete set of Analytical Results from the 1991 Karrat rock samples

KARRAT ROCK SAMPLES

SAMPLE NO	AUPPB	AGPPM	CUPPM	FE%	NIPPM	PBPPM	ZNPPM
1651	9	2	80	4.42	53	18	138
1652			83			36	36
1653			94			32	260
1654	16	1.6	67	3.14	57	21	136
1655			92			25	102
1656	13	2	67	2.64	8	28	44
1657			138			43	86
1658	11	2.2	144	6.1	17	42	135
1659			69			40	97
1660	17	2.8	226	11	37	46	226
1661			165			38	225
1662	3	2.2	168	7.94	10	27	104
1951	3	2.2	205	7.09	72	24	217
1953	9	3.9	117	3.35	251	42	193
1954			108			14	263
1955			106			70	106
1956	6	10	1312	55.19	178	8	372
2001	3	0.6	19	0.5	7	7	27
2002			23			38	76
2003	3	1	34	2.61	15	10	34
2004			13			12	28
2005			25			43	37
2006	3	1.3	17	2.6	42	9	64
2007			271			10	96
2008	8	4.7	384	51.6	1830	21	364
2009		5	1280	20.6	717	25	279
2010			249			18	65
2011	7	3.3	123	19.1	149	10	180
2012			136			83	2720
2013			26			15	100
2014	3	2.1	264	19.6	145	7	502
2016			372			84	58
2017			39			10	56
2018			169			179	3080
2019	3	3.5	98	31.1	510	80	920
2020	8	2.6	38	6.78	118	4	78
2021	7	2.6	14	0.933	22	1970	297
2022			15			24	86
2023			7			10	31
2024			87			29	70
2025	3	0.7	123	1.452	38	15	43
2026		3	144	3.51	70	16	113
2027	3	1.4	124	4.02	74	21	115
2028	6	1.5	174	2.95	44	20	76
2029		3	67	2.9	39	5	64
2030	3	0.9	148	3.67	71	51	101
2031			74			38	62
2032	3	0.9	132	7.2	103	29	342
2033	3	1.4	225	5.09	271	29	314
2034			355			34	463

2035			324			48	319
2036	6	1.4	303	6.82	147	26	292
2037			39			21	110
2038			109			27	112
2039	3	1.4	60	4.37	44	10	112
2040			30			18	92
2041	3	1.5	82	7.01	59	16	85
2042			26			29	59
2043			42			23	144
2044	3	1.2	64	4.89	49	9	96
2045			107			18	115
2046			35			14	53
2047	3	1.5	51	3.06	51	14	90
2048	47	3.9	161	38.4	670	76	2930
2049	3	1.7	1805	11.2	178	7	302
2050			1620			39	533
2051			334			38	3650
2052			40			21	80
2053	3	1.7	174	14.9	21	20	71
2054		3	74	2.73	13	20	37
2055	8	0.6	58	1.66	13	18	63
2057	11	1.7	670	16.4	350	22	162
2058	5	1.6	275	2.61	29	21	170
2059	7	1.5	470	4.54	224	35	870
2061			760			57	516
2062			326			28	324
2063	12	7.6	2740	8.78	200	38	336
2064			476			8	50
2065			203			26	206
2066	3	1.2	93	2.4	21	9	37
2067	3	1.6	14	0.486	40	40	890
2068	3	5.9	440	35	790	12	327000
2069	3	4.9	348	17.2	29	7	434000
2070		3	16	1.91	5	12	14
2071		3	19	1.52	5	6	12
2072		3	13	0.96	49	3	16
2073		3	12	1.96	17	3	28
2074		3	8	3.6	11	8	6
2075		3	9	3.63	13	11	7
2076		3	7	2.52	8	9	5
2077			239			55	4200
2078	3	2.1	28	6.21	8	2	19100
2080			88			30	300
2081	3	1.5	23	6.7	83	10	542
2082	5	0.8	85	8.54	83	10	280
2083			211			35	473
2084			202			31	210
2085	3	0.9	155	7.32	17	2	107
2086	3	2.5	203	42.2	469	1	84
2087			900			1	31
2088			3240			3	82

2089		3	118	2.23	49	24	113
2090			194			26	117
2091			522			25	564
2092			467			36	1830
2093	3	2.2	241	11.5	247	44	371
2095	3	2	54	3.9	61	14	136
2096		6	671	4.59	377	36	406
2097	3	1.5	277	7.43	158	27	354
2098	3	2.2	21	15.3	10	28	47
2099		3	100	3.32	18	20	51
2100	3	1.9	117	9.35	29	19	118
2101	43	6	297	69.22	160	14	16
2102	6	12	328	19.01	200	41	616
2103			277			3	2100
2104			176			38	434
2105			70			39	73
2106			113			37	54
2107			225			21	223
2108			166			28	124
2109	9	1.3	312	6.06	132	23	420
2110			217			11	44
2111	3	1.1	166	5.55	31	23	118
2112			137			42	117
2113			113			18	76
2114	7	1.1	670	26.3	451	7	22
2115			113			5	13
2116			168			36	84
2117	3	1.5	129	5.44	89	14	173
2118	3	1.2	71	6.08	46	14	69
2119	10	1.4	96	4.38	21	29	37
2120		3	58	3.62	29	18	74
2121			58			14	36
2122			125			32	120
2123	7	0.6	65	3.28	29	7	910
2124	3	1.6	103	8.8	72	5	81
2125	3	1.6	91	9.09	87	25	125
2126	3	1.3	93	6.24	49	9	58
2127	11	1.7	92	6.31	20	37	65
2128	3	3	14	19.68	300	5	9
2151	3	2.4	390	8.33	51	27	232
2152			182			30	123
2154			18			5	20
2155			35			7	49
2156	3	0.6	26	2.47	18	52	30
2157			48			1	151
2158	3	1.1	76	3.27	63	7	131
2159			6			6	6
2160	3	5	841	40.01	240	18	14
1901	14	3.3	426	22.7	700	14	74
1902			36			9	94
1903			359			7	136

1904		3	945	8.55	172	3	76
1905	9	2.7	180	8.69	129	15	243
1906			246			30	329
1908	176	5.4	1895	19.4	216	37	1405
1909	3	5.4	263	19.9	1380	80	5260
1910			169			19	131
1911		3	64	4.11	74	21	136
1912			261			34	473
1913			189			38	1210
1914	3	1.9	186	3.75	145	26	415
2201			79			10	225
2202			85			10	121
2203	5	2.1	58	6.04	98	13	192
2204	3	2.2	284	7.12	124	13	74
2205			93			27	81
2206	3	1.8	389	9.78	256	14	118
2207			87			14	202
2208			137			10	159
2209			174			10	157
2210	3	1.7	342	10.78	336	29	1135
2211	9	1.3	37	2.93	18	10	81
2212	3	1.7	72	4.65	53	22	121
2213			223			41	399
1927	6	3.1	91	7.37		21	175
1932	3	3.2	277	19.85		21	148
1934			177			-1	156
1939	3	2.1	187	12.1		7	65
1940			221			17	174
1944	3	2.6	191	7.69		19	880
1945	13	3.5	373	12.6		20	1600
1946		6	560	17.64	760	18	1127
1947	3	3.2	392	13.35		24	1180
1949	6	2.4	125	3.76		27	66
1950			130			14	46
1957	7	2.3	40	7.475		11	94
2544	13	2.5	212	10.9		10	65
2545			10			3	64
2546	6	0.8	23	2.165		7	20
2547			41			8	121

APPENDIX 3

List of 1991 Karrat Rock Samples giving sample number, sample type, airphoto reference and brief geological description

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
1651	RGR	207/61	Sh	1		675	Dark grey, siliceous and micaceous schist with minor elongated po/py mineralisation
1652	F	207/61	Ti			645	Semi-quartzite, strongly folded with intercal of dark grey schist. Dissem. of py/cpy
1653	RGR	111/96	Ns			680	Dark grey, graphite shale, gossanous weathering
1654	RGR	111/96	Mr	1		690	Dark grey, fine grained siliceous shale/schist with po/py min.
1655	RC	111/96	Kr			660	Chips over 2.5m (vert), dark grey, graphitic and fissile shale, po/py min.
1656	RC	111/96	Kr	1	F5		Chips over 2.5m (vert), dark grey, graphitic and fissile shale, po/py min.
1657	RC	111/96	Kr		P31+		Chips over 2.5m (vert), dark grey, graphitic and fissile shale, po/py min.
1658	RC	111/96	Kr	1	P32	670	Chips over 2.5m (vert), dark grey, graphitic and fissile shale, po/py min.
1659	RC	111/96	Jt			600	Chips over 2.5m (vert), dark grey, graphitic schist, up to cm large po/py aggregates
1660	RC	111/96	Jt	1	F5		Chips over 2.5m (vert), dark grey, graphitic schist, up to cm large po/py aggregates
1661	RC	111/96	Jt		P34		Chips over 2.5m (vert), dark grey, graphitic schist, up to cm large po/py aggregates
1662	RC	111/96	Jt	1		610	Chips over 2.5m (vert), dark grey, graphitic schist, up to cm large po/py aggregates
1951	$RC_{1.75cm}$	112/106A	Bs	1	JF8/13	405	Repeat chip sample the foliation. Nûk sediments, well silicified in parts. Minor Po
1952	RGR	112/106A	Ct		F8/16		2m wide stratabound unit, silicified contain Po very rich to massive in places
1953	RGR	112/106A	Dt	1	F8/18		High concs of po and cpy in silicified Nûk unit traced for 275m length 4m wide
1954	$RC_{1.25cm}$	112/106A	Du		F8/18		Representative chip through above unit sub parallel to flat lying fault
1955	RGR	112/106A	Go				Silicified Nûk with minor po along primary foliation
1956	RGR	112/106A	Lp	2			On icecap moraine from Black Nunatek. Massive sulphide with grey marble 7cm wide. No gossan
2001	RGR	111/96	Jf	1		700	Med-grained gneiss (biotite, qz/feldspar). Weak mineralisation (qz/feldspar) lineation
2002	RGR	111/96	Jf			700	Dark grey semi-quartzite, contains biotite. At contact with basement Qz formation

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
2003	RGR	111/96	Jf	1		700	Arenaceous schist, biotite, not mineralised. Q-Formation
2004	RGR	111/96	Jf			710	Arenaceous 2-mica schist + po and minor py. Q-Formation
2005	RGR	111/96	Jf			710	Tremolite and some biotite containing carbonaceous schist, scattered po. Q-Formation
2006	RGR	111/96	Jf	1		720	Medium-grained mica-rich schist with scattered po
2007	F	111/96	Jf			800	Semi-massive sulphide (po, minor py)
2008	RGR	111/96	Hg	1		830	Massive po/py, medium to coarse grained
2009	F	038/95	Tv	2		790	Massive po/py
2010	F	038/95	Lb			105	Semi massive/disseminated po/py in arenaceous shale + cordierite?
2011	F	038/95	Lb	1		100	Cordierite (?) schist + disseminated py, po and minor cpy
2012	F	038/95	Lb			100	Weakly buck-shot (BS) textured py in graphite/qz-rich 'breccia' with po
2013	F	038/95	Lb			90	Cordierite (?) schist + massive/semi-massive, fine grained py, minor po
2014	F	038/95	Lb	1		80	Black Shale with cm bands of massive fine grained py + scattered blebs of py
2015	F	038/95	Lb			80	Black Shale with disseminated, fine grained py
2016	F	038/95	Lb			110	Weakly buck-shot textured py in graphite/quartz-rich 'breccia' with po
2017	F	038/95	Lb			20	Cordierite (?) schist with dm. bands of fine grained py
2018	F	038/95	Lb		F5/P10	15	Graphite, cordierite (?) rich, 'hex' schist with massive po, buck-shot py and qz-eyes
2019	F	038/95	Lb	1			Massive py, po, cpy (50-60% sulphide)
2020	RGR	036/95	Ve	1			Hbl (?)-biotite schist + lenses of qz/feldspar. Tiny specks of po
2021	F	036/95	Tg	1		570	Qz/calcite vein in grey marble with actinolite, contains some coarse galena
2022	F	111/106A	Hm			740	Graphitic schist with semi-massive py/po (+ cordierite), qz-eyes
2023	F	111/106A	Lq				Biotite gneiss with py mineralisation
2024	RGR	111/106A	Ho			820	Fine grained biotite schist/shale + tiny specks of po

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
2025	RGR	111/106A	Ho	1		855	Fine grained biotite schist/shale + tiny specks of po
2026	RGR	111/106A	Ho	2	F1, P25	865	Fine grained shale/semi-pelite with abundant po/py
2027	RGR	111/106A	Gp	1		830	Dark grey, fine grained biotite shale/schist with abundant po/py
2028	RGR	111/106A	Gp	1	F1 P26	800	Dark grey graphitic shale with lenticular blebs of po/py
2029	RGR	111/106A	Fq	2		760	Strongly folded graphitic schist with elongated blebs of po/py
2030	RGR	111/106A	Fr	1		660	Dark grey graphitic schist with elongated blebs of po/py
2031	RGR	111/106A	Fs			595	Highly fissile, graphitic schist + elongated blebs of po/py
2032	RGR	111/106A	Jr	1		670	Graphite and biotite rich shale with minor specks of po/py
2033	RGR	205/61	Kz	1		705	Repr grab sample graphitic pelite + po/py
2034	RGR	205/61	Kz			720	Repr grab sample graphitic pelite + po/py
2035	RGR	205/61	Kz			690	Dark grey, well foliated shale/pelite + abundant po/py
2036	RGR	205/61	Kz			675	Dark grey, graphitic shale/pelite + po/py mineralisation
2037	RGR	205/61	Kz			660	Grey, well foliated shale and arenaceous shale. Minor or no sulphides
2038	RGR	205/61	Kz			645	Grey, well foliated micaceous shale/schist with py/po mineralisation
2039	RGR	205/61	Kz	1		630	Meta greywackes (mica-rich) and graphite/mica-rich shale. Minor py/po
2040	RGR	205/61	Kz			595	Medium-fine grained mica-rich shale/greywacke with minor or no po/py
2041	RGR	205/61	Kz	1		565	Medium-fine grained, well laminated mica-rich shale with minor py/po
2042	RGR	207/61	Li			755	Micaceous meta-greywackes with tiny specks of py/po
2043	RGR	207/61	Li			755	Mica/graphite rich schist with tiny specks of py/po
2044	RGR	207/61	Jh	1	F5 P20	715	Strongly folded meta-greywackes/mica-rich schist. No or minor sulphides
2045	RGR	207/61	Gh			690	Mica-rich arenaceous schist, well laminated, minor stringers + specks of po
2046	RGR	207/61	Ek			680	Biotite rich and graphitic schist. Weak po/py mineralisation

RTZ Mining and Exploration Limited

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
2047		207/61	Gm	1			Dark grey, micaceous and laminated meta greywackes with quite abundant po/py
2048	F	207/61	Mm	1		450	Dark grey graphitic schist with abundant po/py mineralisation
2049	RGR	207/61	Nn	1		470	Dark grey graphitic schist + disseminated/scattered py/po + cpy
2050	RGR	207/61	Nn			490	Dark grey graphitic schist + abundant py/po + cpy in fold hinge
2051	RC	111/96	Hg		F2		Loc. 3: Po ±cpy in 50m width gossan, calcite & pegmatite vein parallel to mineralisation
2052	RGR	111/96	Hl			830	Loc. 4: Banded siliceous sediments with po/py <2mm bands parallel to bedding
2053	RGR	110/96	No	1	F2	1010	Loc. 6: Gossan rich zone 40 x 200m, black siltstone, minor Py
2054	RGR	110/96	No	2	F2		Loc. 6 East: 100m east of 2053, po/py rich zone
2055	RGR	110/96	Op	1	F2		Loc. 6 East: B-horizon in schists py
2056	RGR	110/96	Op		F2		Loc. 6 East: B/C horizon (higher elevation) finely disseminated py, gossanous
2057	F	110/96	Qp	1			West flank of glacier, po + minor cpy in quartz, feldspar boulder
2058	RGR	110/96	Ss	1		745	Py rich breccia infill
2059	$RC_{1.5cm}$	110/96	Ss	1			Po/py rich gossanous rock
2060	$RC_{3.0cm}$	110/96	Ss				Po in black gossanous semi-pelite (30m from glacier)
2061	$RC_{1.0cm}$	110/96	Ss				Po in gossanous rock, near foot of glacier
2062	$RC_{3.0cm}$	110/96	Ss				Black po rich semi-pelite, minor cpy in fracture zone
2063	$RC_{1.5cm}$	110/96	Ss	1			Silicified semi-pelite containing fine grained po and minor py
2064	$RC_{3.0cm}$	110/96	Op				Minor py + cpy in a linear recessive unit, semi-pelite
2065	RGR	110/96	Oq				Silicified semi-pelite foliated having intense weathering colours
2066	RGR	110/96	Pr	1			Py rich and sulphur stained meta-pelite
2067	F	110/96	Io	1			Grey marble containing tremolite and dolomite high SG
2068	$RC_{0.6cm}$	110/96	Io	1	JC F7 No.1-2		Massive po and py. Minor jet black mineral haematite

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
2069	$RC_{0.4}$	110/96	Jo	1	JC 7 No. 1-2		Adjacent to 2068, massive po and haematite
2070	$RC_{0.5}$	110/96	Ip	2			Umanak gneiss at base of chip sample zone (2070-2077)
2071	$RC_{0.5}$	110/96	Jp	2			Lower unit of Karrat, non homogeneous, Qz-Bi medium-cse, no sulphide, foliated
2072	RC_{2m}	110/96	Ip	2	F2 P24		Medium grained (finer than 2071) Qz rich, no sulphide
2073	$RC_{1.5}$	110/96	Ip	2	F2 P24		Schistose rock Bi rich, minor fault containing Qz
2074	$RC_{3.0}$	110/96	Ip	2	F2 P24		Lower as for 2073, upper 10cm Fe stained, semi pelite + arenite band
2075	$RC_{0.5}$	110/96	Ip	2	F2 P24		Gossanous rock + po semi pelite
2076	$RC_{0.5}$	110/96	Ip	2	F2 P24		Yellow stained po + py semi pelite/arenite. Sulphur rich
2077	F	110/96	Ip		JCF7 No.12		Along strike from pegmatite, breccia of qtz, tremolite clasts in matrix of po and py
2078	F	206/61	Re	1			Camp 2. Mârmorlik Fm white marble, po + cpy bands (±1cm)
2079	F	206/61	Ec				Camp 2. Nukavsak Fm. Large gossanous boulder, qz in po/py matrix
2080	F	206/61	Rc				Foot of Talus. Black Nûk, with bands of fine grained po
2081	F	206/61	Rc	1			Black Nûk, po/py possibly derived from zone 30m above base
2082	F	206/61	Sc	1			Silicified pelite containing minor po, py & cpy along preferred fabric
2083	F	206/61	Sf		F7/17&18		Meta pelite containing po and minor bornite as discrete veinlets along foliation planes
2084	RGR	206/61	Sf		F3/P1&2		Rep. Nûk sample next to tarn, S-rich and po in schistose rock, 200 x 50m zone
2085	$RC_{3.0}$	206/61	Rf	1			Brecciated vein trending 030° (mag) unit contained po nodule ±20cm
2086	F	206/61	Rf	1			30m width gossanous zone, massive po/cpy, silicified and carbonatised
2087	F	206/61	Rf				Silicic zone with up to 25/po/cpy (po>cpy) in qz flooded zone
2088	F	206/61	Rg			935	Po, cpy in silicic Nûk (brecciated) 20m width narrowing towards summit
2089	F	206/61	Th	2			Nûk schist from very rusty and sulphide rich cliffs, spotty po ±py
2090	F	206/61	Th				Composite float chip >50m of black shales very fissile very minor py

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation (m)	Brief Description
2091	F	206/61	Th				Highly silicified Karrat sediments containing po and minor cpy
2092	F	206/61	Kg				On lateral moraine, well silicified Nûk sediments strong abundant po and minor py high SG
2093	RC$_{5.0}$	110/96	Jj	1		675	Po and minor cpy in silicified Nûk sediments
2094	RC$_{3.0}$	110/96	Jj			650	Po in banded Nûk sediments, qz sweats, po in cleavage and augens
2095	RC$_{2.5}$	110/96	Jj	1		615	Nûk, Bi rich po in and around quartz zones, gossans not well developed
2096	RC$_{3.0}$	110/96	Jj	2		590	Silicic Nûk, po and cpy ±py associated with quartz
2097	RC$_{3.0}$	110/96	Jj	1		560	Semi-pelite at break in slope po ±cpy in more silicic patches
2098	F	207	Rm	1			Camp 3. Massive py (≥5%) and Mârmorilik rock prob from Surta Nunatak
2099	RC$_{3.0}$	206/61	Mo	2	F3 P23	670	S rich horizon (10m thickness max) py
2100	RC$_{1.5}$	206/61	Mo	1	JC F8 N1	670	Sulphur weathered black shale. Very minor po
2101	RGR	111/96	Jf	2	JC,F6,N16		Semi massive po and magnetite. 40m above basement contact
2102	F	111/96	Ig	2	JC,F6,N20	800	Massive po>>py>>cpy in phyllite
2103	RGR	111/96	Ig		JC,F6,N21		Massive po exhibiting an orange yellow fibrous weathering product, high SG
2104	F	111/96	Hh		JC,F7,N1	805	Semi pelite po rich bright green-orange colours
2105	RC$_{4.0}$	206/61	Mn		F3,P25		S rich horizon, well cleaved Nûk with minor py
2106	RC$_{1.25}$	206/61	Mn		8/N2,3/26	655	Rich sulphur weathering of black slate, po stretched along cleavage
2107	RC$_{3.5}$	206/61	Ln			505	As below, black graphitic shales
2108	RC$_{2.5}$	206/61	Ln			505	Gossanous zone adjacent to rounded knob, well cleaved, minor py
2109	F	206/61	Mn	1			Composite, cpy>po, py at base of most intense gossan zone
2110	RGR	206/61	Kp			740	Silicified Nûk sediments containing euhedral crustals and veinlets of po minor py
2111	RC$_{1.75}$	206/61	Hq	1	J F8,N6	710	Black shales showing intense S staining, very minor po
2112	RC$_{6.0}$	206/61	Gr				Fissile black shales, minor py

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
2113	$RC_{20.0}$	206/61	Gr		F3/37		Composite sample taken between 2 linear lakes minor po+py
2114	RGR	206/61	Gr		F8/7F3/36	660	Extremely silicified and brecciated adjacent to igneous dyke, semi massive po with minor py and chalcopyrite
2115	$RC_{6.5}$	206/61	Gr		F8/8	660	Representative sample of above, parallel to major lineament, sulphides <1%
2116	$RC_{12.0}$	206/61	Ho				Black fissile Nûk schist with S stains and very minor py along partings
2117	$RC_{3.0}$	112/96	Rm		5/36,37		Po in black fissile schist (5m wide horizon)
2118	RGR	112/96	Mo				Quartzose schist with minor po/py
2119	$RC_{3.0}$	112/96	Kq		4/12		Py + po in black graphitic schist, lineaments
2120	RGR	112/96	Kq		4/11		Regular bedded quartzose schists, very minor py
2121	$RC_{4.0}$	112/96	Nq				Py/po in arenaceous unit (fault zone)
2122	RGR	112/96	Pq				Stained gossanous rock, very minor po/py in graphitic schist
2123	RGR	207/61	Nl		6/2		Yellow/red cliff along NE-SW lineament, very minor po
2124	F	207/61	Rm				Py/po in yellow boulder, quartzose black schist
2125	RGR	112/96	Ql			660	Quartzose schist with py (in small valley)
2126	RGR	112/96	Gm			605	Silicified Nûk containing minor py in 2m wide zone with major lineament
2127	$RC_{3.0}$	112/96	Gm				Py in fissile schists, minor py in 3-4m high cliff
2128	F	112/96	Gp			585	Boulder of granitic rock, Mt, py, po massive (30%)
2151	RGR	111/106A	Hn				Graphitic schist with minor po/py
2152	RGR	111/106A	Go				Fine to medium grained siliceous schist with minor py (elongated)
2153	RGR	111/106A	Hs			630	Dark Grey graphite shale/pelite with tiny, elongated blebs of po/py
2154	RGR	207/61	Lh			760	Shale/meta greywackes with minor specks of py
2155	RGR	207/61	Lh			760	Brecciated and silicified meta-greywacke at contact with dolerite dyke

KARRAT GROUP PROJECT, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
2156	RGR	207/61	Lh			760	Coarse grained quartz at contact with dolerite dyke
2157	RGR	207/61	Lh			760	Medium grained porphyritic dolerite (dyke). Minor specks of py
2158	RGR	207/61	Oc			610	Dark grey, fine grained, well lineated biolite schist with scattered specks of py/po
2159	F	207.61	Tj			680	Carbonate 'conglomerate' Pyritic matrix
2160	F	207/61	Uj			680	Massive fine grained py in dolomite marble (Mârmorilik Form?)... Black Nunatek?

Stream Sediments

K91SS1		110/96	Pr				
K91SS2		110/96	Ot				
K91SS3		112/96	Mq				
K91SS4		206/61	Qe				
K91SS5		112/96	Pq				
K91SS6		206/61	Mm				
K91SS7		111/96	Fr				Sieved, low energy, very few fines. Slightly braided, max 1m wide
K91SS8		206/61	Hn				
K91SS9		206/61	Nl				Unsieved
K91SS10		112/96	Jq				
K91SS11		060/92	Hk				Unsieved, low energy, very few fines, 1m wide
K91SS12		060/92	Ll				Unsieved, medium energy, stream predominently restricted <2m wide

ALFRED WEGENERS HALVØ, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
1901	F	055/93	Lo			350	Meta pelite containing a 1cm wide vein of po and minor cpy
1902	F	055/93	Lo			360	Breccia boulder of silicified Nûk in matrix of calcite, cross cut by fine veining <3m of po
1903	F	055/93	Mo			390	Quartz pod with lensing of phyllite, with po rich veining at contact, trace cpy
1904	F	055/93	No			420	Silicified Nûk containing disseminated po and cpy
1905	F	055/93	Mo			365	Po rich graphitic shale
1906	F	060/92	Hk			595	Metapelite with high conc of po along parting
1907	F	060/92	Hk			600	Rounded boulder of breccia, clasts of black Nûk elongated <1cm in a matrix of po, minor cpy, high specific gravity
1908	F	060/92	Hk			605	Breccia boulder po shale, discrete veinlets of cpy
1909	F	060/92	Il			640	Breccia semi angular clasts of silicified Nûk with matrix of po, clast supported
1910	RGR	060/92	Li			880	Dark grey schist with po along partings, minor cpy
1911	$RCP_{3.0}$	060/92	Ll			850	Rusty weathered Nûk with minor po along partings
1912	F	060/92	Lm			780	Partly silicified Nûk with po along partings, minor cpy
1913	F	060/92	Lm			690	Silicified black shale with rich po concentrations along partings
1914	RGR	060/92	Lm			650	Shales and psammites adjacent to major dyke. Minor po along partings trace cpy
2201	F	055/93	Mo			395	Biolite schist with elongated po/py aggregates
2202	F	055/93	Mo			395	Dark grey mica schist with specks and laminae of po/py
2203	F	055/93	Mp			440	Mica schist with po/py mineralisation
2204	F	055/93	Lq			490	2-mica schist with minor po/py min. Biolite flakes characteristic
2205	F	059/92	Sb			920	Hexagonal quartz + schlieren of fine grained, dark grey meta greywackes. Po common
2206	F	059/92	Sb			915	Dark grey, fine grained mica schist + quartz lenses/veins. Dissem po. Minor cpy
2207	RGR	059/92	Qb			900	Mica schist, biolite flakes characteristic, weak po mineralisation

ALFRED WEGENERS HALVØ, GREENLAND (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
2208	F	059/92	Qb			830	Coarse hexagonal quartz with fragments of dark grey schist, weak po mineralisation
2209	F	059/92	Qc			780	Coarse hexagonal quartz with fragments of dark grey schist, weak po mineralisation
2210	F	059/92	Oc			760	Dark grey graphitic shale. Strong po mineralisation, trace cpy
2211	RGR	060/92	Lk			935	Well foliated quite arenaceous shale, lamallae of tiny po locally
2212	RGR	059/92	Mc			905	Weakly po mineralised mica schist
2213	RGR	059/92	Md			630	Dark grey, highly graphitic and po/py mineralisation, shale at contact with dolerite dyke

TASIUSSAQ BUGT, GREENLAND

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
1915	RGR						Qavdlundot Island: Red schist (Bi, Qz) graphite?? seen in felsic rock
1916	RGR						Qavdlundot: Pegmatite (Qz-F-Flurite)
1917	RGR						Qavdlundot: Qz-Bi schist in extensive gossan (50 x 200m minimum)
1918	RGR						Nutarmiut: Qz-mica schist, risty weath no sulf
1919	RGR						Nutarmiut: Alt'd mica
1920	RGR						Pagussat: Qz mica schist/gneiss
1921	RGR						Uigorolerssuaq: Qz mica schist
1922	RGR						Nutarmiut: Schist/gneiss continued semi-massive po
1923	RGR						Nutarmiut: Purple/red medium grained qz gneiss
1924	RGR						Uigorolerssuaq: Gossanous 2 mica gneiss, graphite
1925	RGR						Pagussat:
1926	RGR						Pagussat: Medium grained Qz/F gneiss with scattered blebs of graphite very minor po

KARRAT GROUP, GREENLAND - KARRAT ISLAND DISTRICT (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
1927	RGRF						Gossanous boulders in talus po in Nûk rocks
1928	HS						Qeqertarssuaq sandstone, finely banded qz-Bi schist (80% qz) laminated Bi
1929	HS						Nûk Formation below amphibolite - Qz, Bi schist
1930	HS						Nûk Formation near shoreline medium grained qz, Bi schist
1931	HS						Hornblende schist/amphibolite medium grained
1932	RGRF						Silicified Nûk/Qeq containing abundant po, po xtals up to 4m sulphides -10%
1933	RGRF						Silicified Nûk/Qeq containing 5-10% po high SG
1934	RGRF						Weathered semi massive po and qtz po -50%
1935	HS						Coarse grained amphibolite
1936	HS						Psammitic Nûk formation qtz rich
1937	HS						Coarse grained Nûk formation Biotite and graphite abundant, qtz lensing
1938	HS						Ultramafic. Large biotite crystals and mafic xenoliths in a fine grained weathered groundmass
1939	HS						
1940	RGR						
1941	HS						
1942	HS						
1943	HS						
1944	RGR				F8/29		Qing: black graphitic schist, massive po/cp + act?
1945	RGR				F8/30		Qing: white sulphate mineral overlying massive, and relict frags
1946	RGR				F8/32+32		Qing: massive + conglomerate po-cp (50:50) sulphide matrix
1947	RGR						Qing: disrupted black Bi schist containing massive po-cp (Act?)
1948	TS						Qing: poorly sorted conglomerate with subrounded clasts. Completely replaced matrix po-cp

KARRAT GROUP, GREENLAND - KARRAT ISLAND DISTRICT (2603)

Sample Number GR...	Sample Type	Aerial photo number	Graticule location	Analysis code	Photo number	Elevation	Brief Description
1949	RGR						River o/c - black schist, po parallel to partings (spotty)
1950	RGR						Graphitic rich rusty stained Nûk immediately adjacent to massive po vfg po noticed
1957	RCH_{2m}						Representative chip sample at location 1950, secondary sulphate observed in minor po
1958	HS						Micaceous phyllite - schist of Nûk formation
2544							
2545							
2546							
2547							
K91SS13							

APPENDIX 4

Pearson Product Moment Correlation and Spearman Rank Correlation

Pearson Product-Moment Correlation

214 total cases of which 208 are missing

	AGPPM	PBPPM	CUPPM	AUPPB	FE%	NIPPM	MOPPM	ZNPPM
AGPPM	1.000							
PBPPM	0.018	1.000						
CUPPM	0.489	-0.037	1.000					
AUPPB	0.249	0.009	0.423	1.000				
FE%	0.557	-0.067	0.328	0.218	1.000			
NIPPM	0.392	-0.027	0.257	0.072	0.590	1.000		
MOPPM	0.565	0.478	0.440	-0.301	0.194	0.716	1.000	
ZNPPM	0.185	-0.010	0.037	-0.027	0.205	0.237	0.662	1.000

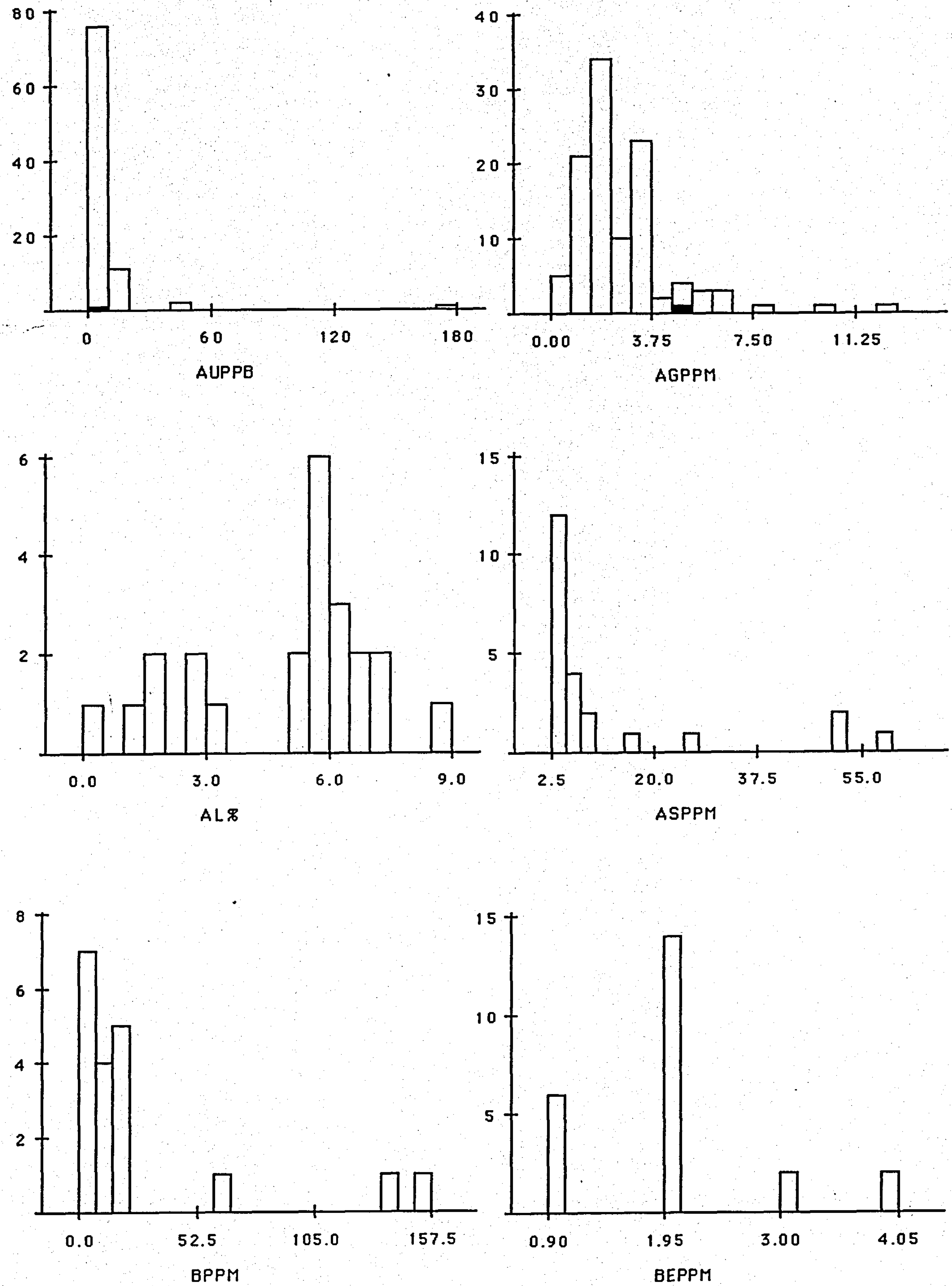
Spearman Rank Correlation

214 total cases of which 208 are missing

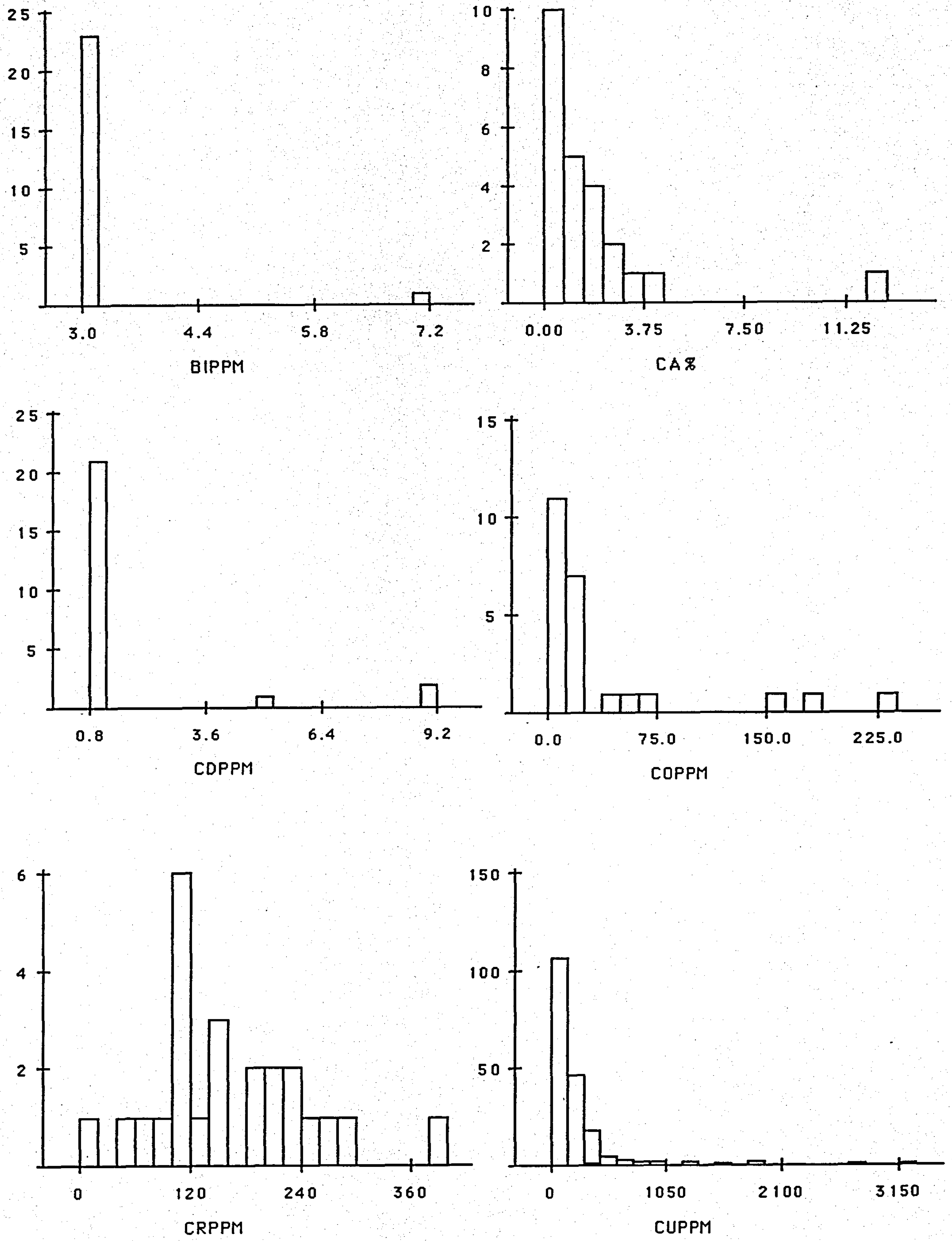
	AGPPM	PBPPM	CUPPM	AUPPB	FE%	NIPPM	MOPPM	ZNPPM
AGPPM	1.000							
PBPPM	0.125	1.000						
CUPPM	0.310	0.244	1.000					
AUPPB	0.277	0.208	0.147	1.000				
FE%	0.440	0.084	0.671	0.058	1.000			
NIPPM	0.329	0.194	0.675	0.106	0.681	1.000		
MOPPM	0.584	0.639	0.518	-0.478	0.643	0.625	1.000	
ZNPPM	0.191	0.407	0.513	0.043	0.403	0.561	0.477	1.000

APPENDIX 5

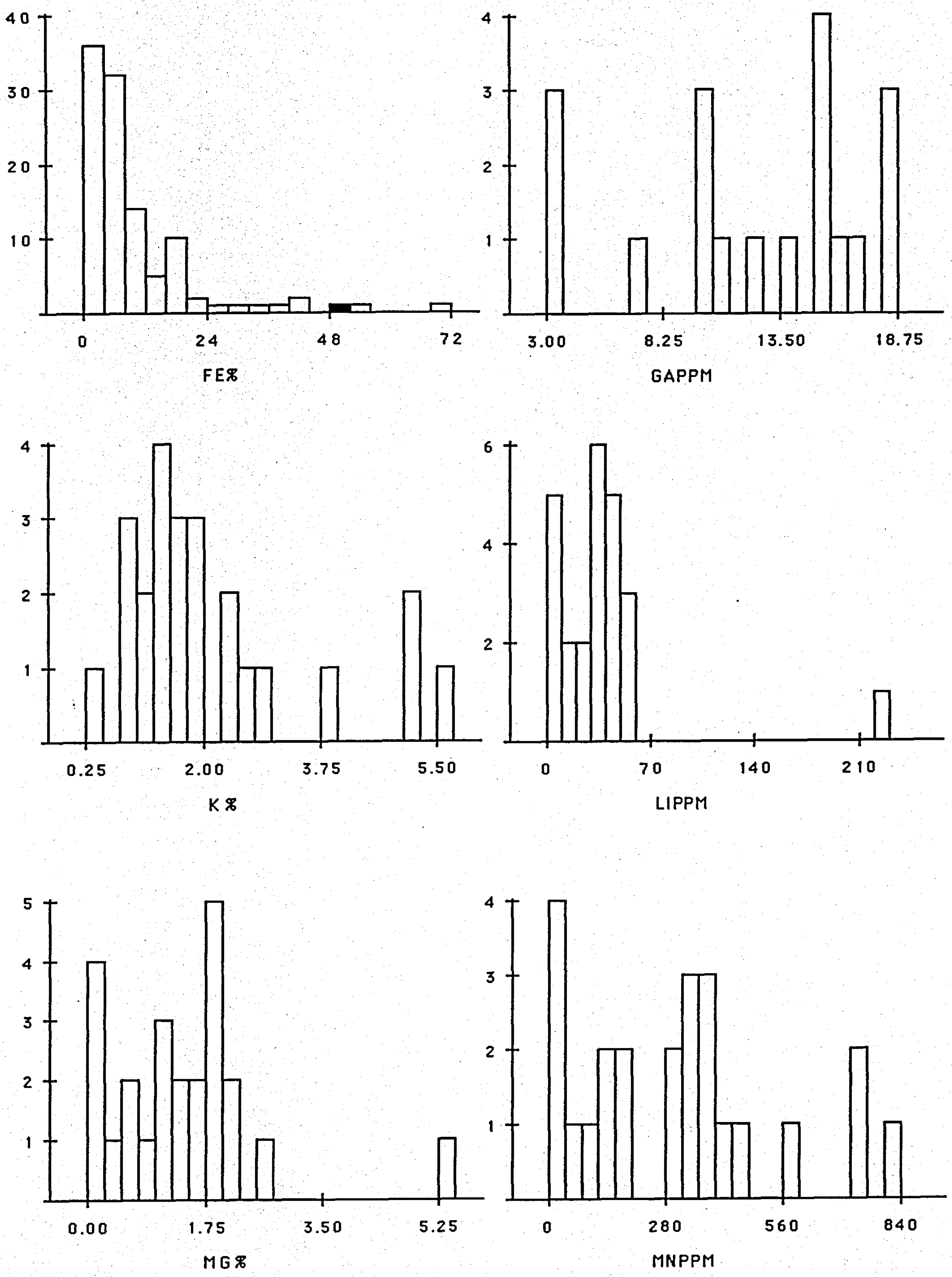
Elemental Histograms for 1991 Karrat Rock Samples analytical data



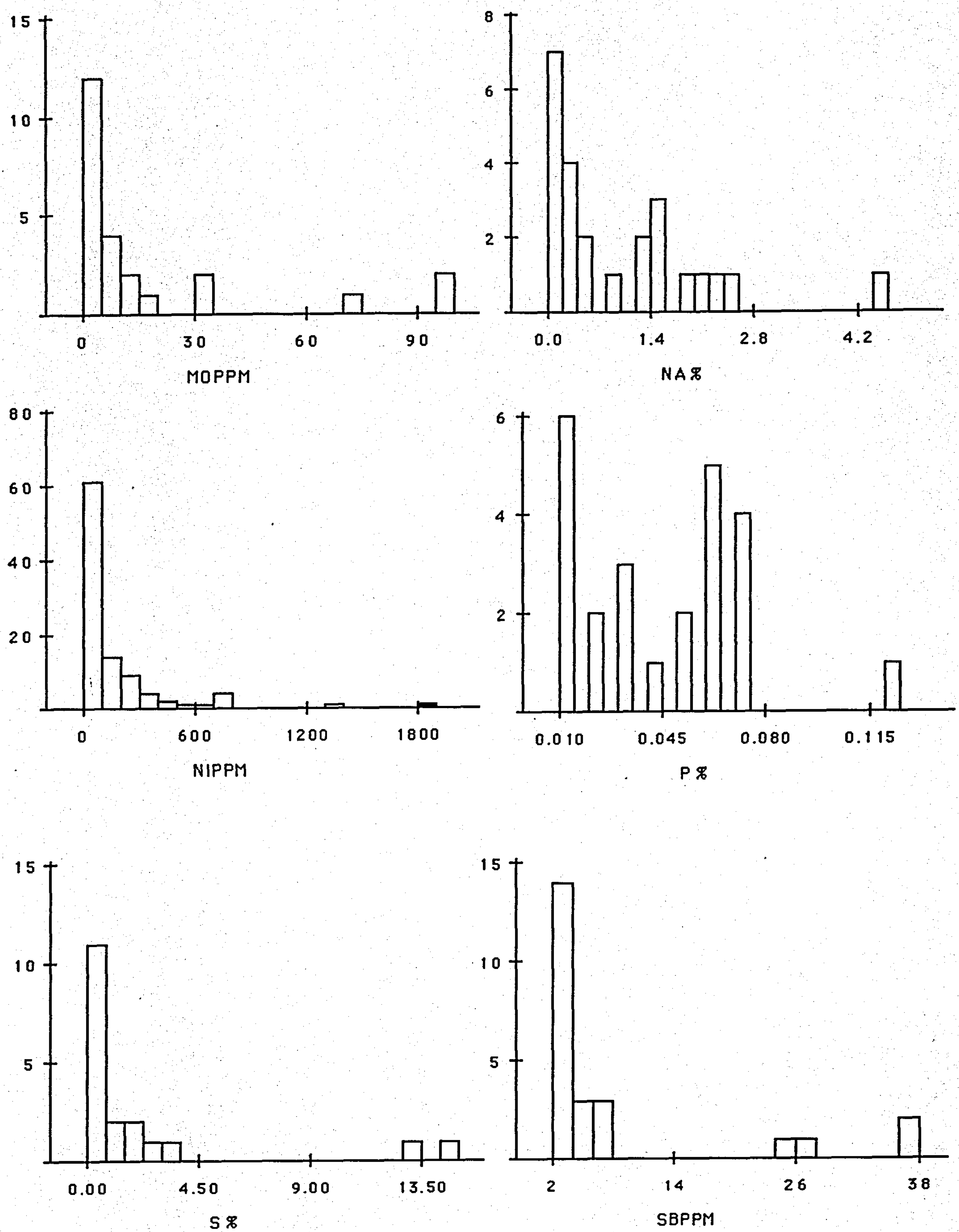
Histograms Page 1
Au, Ag, Al, As, B, Be



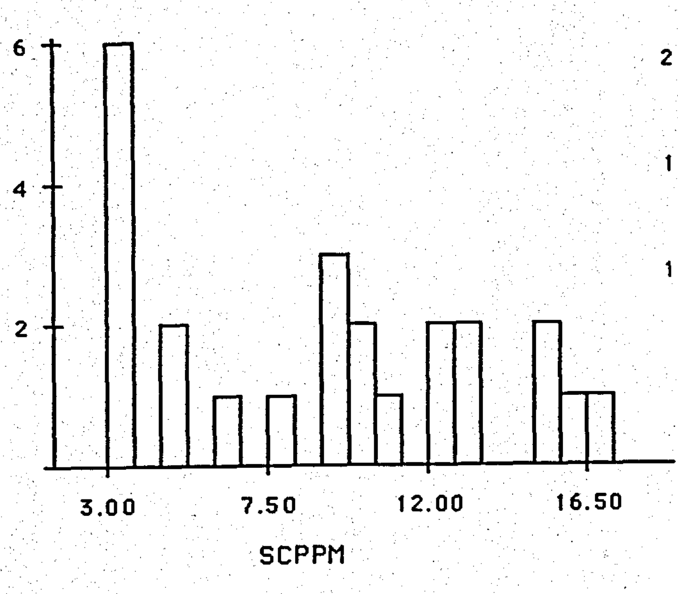
Histograms Page 2
Bi, Ca, Cd, Co, Cr, Cu

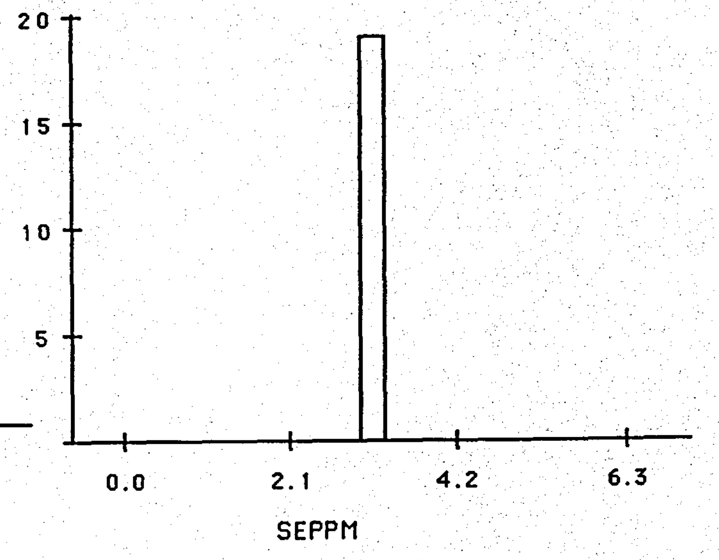


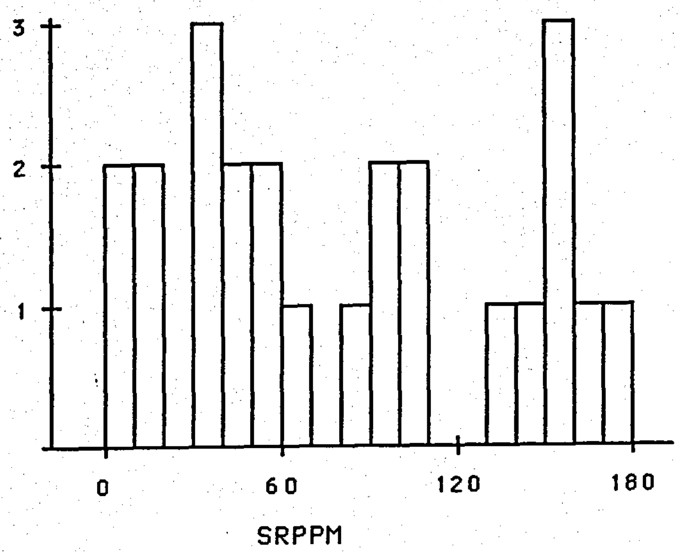
Histograms Page 3
Fe, Ga, K, Li, Mg, Mn

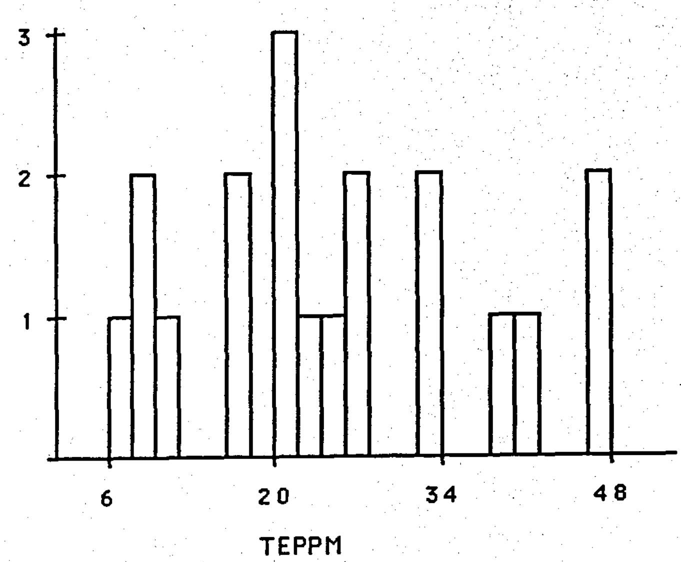


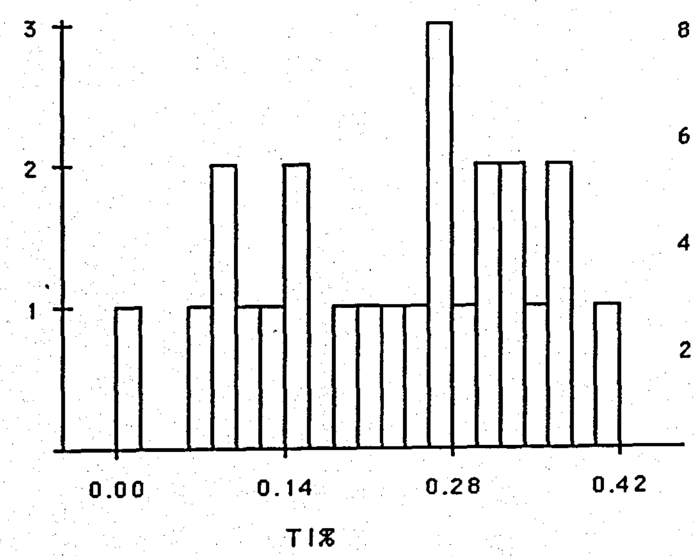
Histograms Page 4
Mo, Na, Ni, P, S, Sb

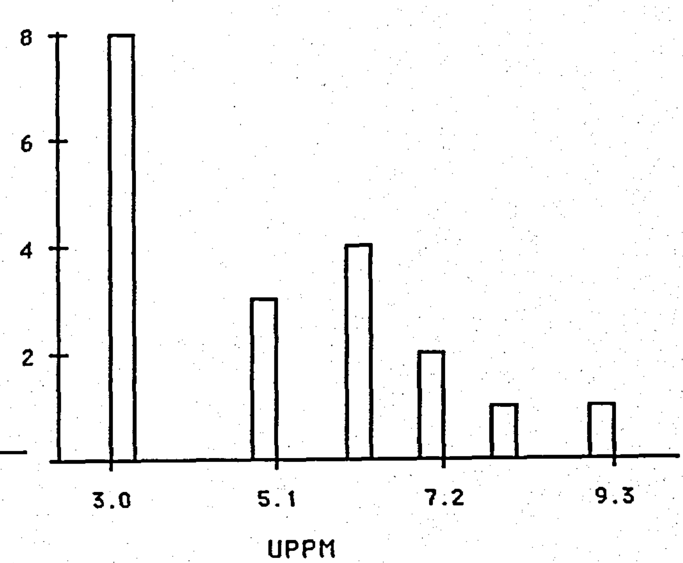




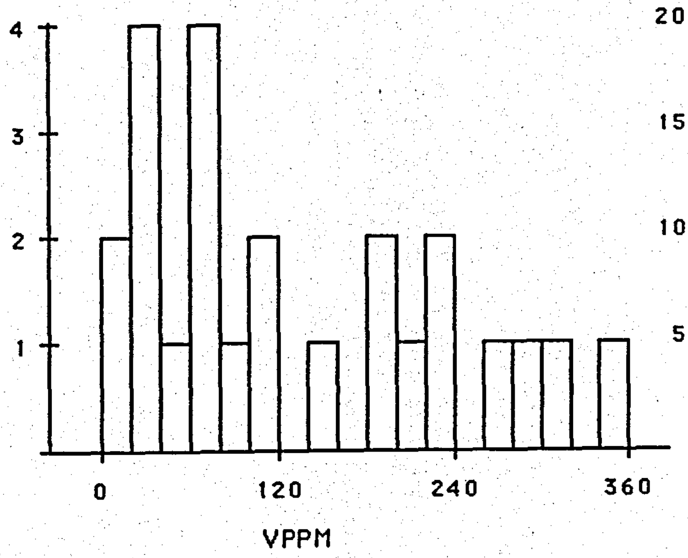


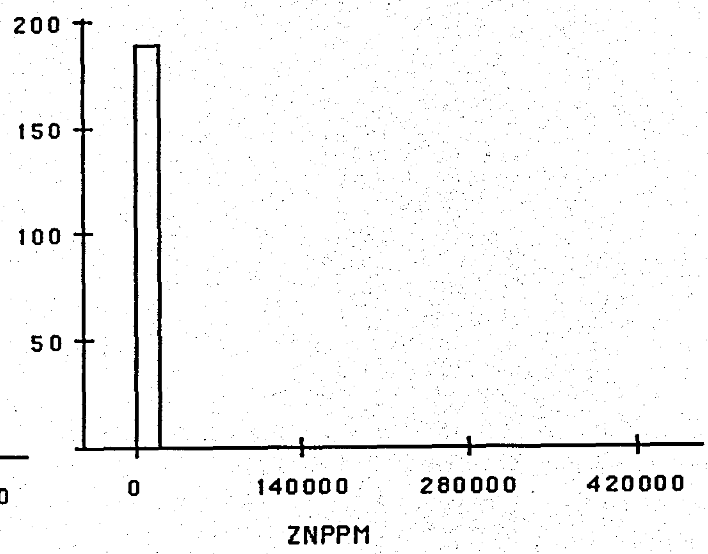






Histograms Page 5
Sc, Se, Sr, Te, Ti, U





Histograms Page 6
V, Zn

APPENDIX 6

Elemental Statistics for 1991 Karrat Rock Samples analytical data

Summary statistics for **AU/PGEPPB**
NumNumeric = 19
Mean = 3
Median = 3
Standard Deviation = 0
Minimum = 3
Maximum = 3

Summary statistics for **AUPPB**
NumNumeric = 90
Mean = 8.1222
Median = 3
Standard Deviation = 19.150
Minimum = 3
Maximum = 176

Summary statistics for **PBPPM**
NumNumeric = 191
Mean = 33.435
Median = 20
Standard Deviation = 142.24
Minimum = -1
Maximum = 1970

Summary statistics for **AGPPM**
NumNumeric = 108
Mean = 2.5704
Median = 2.1500
Standard Deviation = 1.8012
Minimum = 0.60000
Maximum = 12

Summary statistics for **AL%**
NumNumeric = 23
Mean = 4.9865
Median = 5.7000
Standard Deviation = 2.2602
Minimum = 0.09000
Maximum = 8.6600

Summary statistics for **ASPPM**
NumNumeric = 23
Mean = 11.913
Median = 3
Standard Deviation = 17.080
Minimum = 3
Maximum = 58

Summary statistics for **BPPM**
NumNumeric = 19
Mean = 27.421
Median = 10
Standard Deviation = 43.317
Minimum = 5
Maximum = 151

Summary statistics for **BEPPM**
NumNumeric = 24
Mean = 2
Median = 2
Standard Deviation = 0.83406
Minimum = 1
Maximum = 4

Summary statistics for **BIPPM**
NumNumeric = 24
Mean = 3.1667
Median = 3
Standard Deviation = 0.81650
Minimum = 3
Maximum = 7

Summary statistics for **CA%**
NumNumeric = 24
Mean = 1.7050
Median = 0.87000
Standard Deviation = 2.5181
Minimum = 0.05000
Maximum = 12.480

Summary statistics for **CDPPM**
NumNumeric = 24
Mean = 1.8333
Median = 1
Standard Deviation = 2.3529
Minimum = 1
Maximum = 9

Summary statistics for **COPPM**
NumNumeric = 24
Mean = 40.458
Median = 16
Standard Deviation = 61.192
Minimum = 3
Maximum = 233

Summary statistics for **CRPPM**
NumNumeric = 24
Mean = 163.04
Median = 148.50
Standard Deviation = 86.753
Minimum = 12
Maximum = 397

Summary statistics for **CUPPM**
NumNumeric = 191
Mean = 238.73
Median = 125
Standard Deviation = 402.48
Minimum = 6
Maximum = 3240

Summary statistics for **FE%**
NumNumeric = 108
Mean = 10.284
Median = 6.2750
Standard Deviation = 11.859
Minimum = 0.48600
Maximum = 69.220

Summary statistics for **GAPPM**
NumNumeric = 19
Mean = 12.105
Median = 14
Standard Deviation = 5.1088
Minimum = 3
Maximum = 18

Summary statistics for **K %**
NumNumeric = 24
Mean = 2.1492
Median = 1.6100
Standard Deviation = 1.4488
Minimum = 0.27000
Maximum = 5.7000

Summary statistics for **LIPPM**
NumNumeric = 24
Mean = 38.792
Median = 33.500
Standard Deviation = 44.025
Minimum = 3
Maximum = 229

Summary statistics for **MG %**
NumNumeric = 24
Mean = 1.3875
Median = 1.4300
Standard Deviation = 1.1318
Minimum = 0.02000
Maximum = 5.4400

Summary statistics for **MNPPM**
NumNumeric = 24
Mean = 307.33
Median = 313
Standard Deviation = 236.61
Minimum = 3
Maximum = 825

Summary statistics for **MOPPM**
NumNumeric = 24
Mean = 17.729
Median = 4.5000
Standard Deviation = 28.492
Minimum = 0.50000
Maximum = 96

Summary statistics for **NA %**
NumNumeric = 24
Mean = 1.0283
Median = 0.50500
Standard Deviation = 1.0925
Minimum = 0.01000
Maximum = 4.5000

Summary statistics for **NIPPM**
NumNumeric = 98
Mean = 164.71
Median = 62
Standard Deviation = 274.90
Minimum = 5
Maximum = 1830

Summary statistics for **P %**
NumNumeric = 24
Mean = 0.04292
Median = 0.04500
Standard Deviation = 0.02836
Minimum = 0.01000
Maximum = [illegible]

Summary statistics for **S %**
NumNumeric = 19
Mean = 2.3011
Median = 0.58000
Standard Deviation = 4.1840
Minimum = 0.09000
Maximum = 14.750

Summary statistics for **SBPPM**
NumNumeric = 24
Mean = 8.3333
Median = 3
Standard Deviation = 10.561
Minimum = 3
Maximum = 36

Summary statistics for **SCPPM**
NumNumeric = 24
Mean = 8.8750
Median = 9
Standard Deviation = 4.6561
Minimum = 3
Maximum = 17

Summary statistics for **SEPPM**
NumNumeric = 19
Mean = 3
Median = 3
Standard Deviation = 0
Minimum = 3
Maximum = 3

Summary statistics for **SRPPM**
NumNumeric = 24
Mean = 80.917
Median = 70
Standard Deviation = 55.098
Minimum = 3
Maximum = 172

Summary statistics for **TEPPM**
NumNumeric = 19
Mean = 24.368
Median = 23
Standard Deviation = 12.393
Minimum = 6
Maximum = 47

Summary statistics for **TI %**
NumNumeric = 24
Mean = 0.22750
Median = 0.25500
Standard Deviation = 0.11019
Minimum = 0.01000
Maximum = 0.41000

Summary statistics for **UPPM**
NumNumeric = 19
Mean = 4.9474
Median = 5
Standard Deviation = 1.9571
Minimum = 3
Maximum = 9

Summary statistics for VPPM
NumNumeric = 24
Mean = 133.08
Median = 96.500
Standard Deviation = 104.92
Minimum = 10
Maximum = 355

Summary statistics for ZNPPM
NumNumeric = 191
Mean = 4415.0
Median = 118
Standard Deviation = 39205
Minimum = 5
Maximum = 434000

APPENDIX 7

A summary of the Taxation Laws relevant to exploration and exploitation in Greenland

A SUMMARY OF THE TAXATION LAWS RELEVANT TO EXPLORATION AND EXPLOITATION IN GREENLAND

Tax Liability is divided into full liability for residents of Greenland and limited liability for non-residents with an income in Greenland. Public and private limited companies resident in Greenland are subject to full tax liability, as are other entities such as charitable institutions and cooperatives. In the hydrocarbons and minerals sector, this status applies where a licensee under the Act is a public limited company domiciled in Greenland. An entity with full tax liability is subject to the principle of worldwide income liability, whereas an entity with limited liability is only taxed on the income which is the basis for that liability.

Public or private limited companies and other entities that are not domiciled in Greenland but which carry on business from a permanent establishment are subject to limited tax liability. In the hydrocarbons and minerals sector, this applies where a licensee under the Act is a non-resident of Greenland and operates from a permanent establishment.

A permanent establishment in the context includes any mine, quarry, or well where the extraction of mineral resources takes place or is attempted. Where exploration or prospecting is concerned, a permanent establishment normally will be deemed to exist only if the activity continues for a period of at least three consecutive months.

A licensee subject to limited tax liability may aggregate income and expenses from all its mineral resource activities in Greenland. This means that ring-fence rules do not apply to licensees under the Act.

Taxable income is computed for one income tax year at a time. The income year is the calendar year, although companies may apply to use a different income year. For companies with full tax liability, taxable income is computed on the principal of worldwide income.

For companies with limited tax liability, this consists only of the income and income base upon which the liability rests; for examples, a permanent establishment. Expenses may be deducted only if they relate to this income or income base.

Examples of taxable income for companies include income from all business activities, interest, dividends and royalties, as well as capital gains. Expenses that may be deducted include operating expenses, maintenance and insurance of certain assets, and interest on debt. Depreciation of plant and equipment may be deducted as a tax credit at any time during the life of the venture, thereby allowing accelerated depreciation if desired; depreciation is limited to the purchase price of the asset.

Other special deductions from taxable income may include dividends paid to shareholders, so that double taxation does not apply. Negative taxable income may be carried forwards to backwards under certain circumstances. In addition, the Landsstyre can allow special taxation benefits on direct investments in assets for mineral processing for adding value to mineral products where this investment exceeds the normal practices of mineral extraction.

In computing taxable income, both income and expenses are accrued according to normal accounting procedures. An exception to this is depreciation. Interest received and paid is charged on the data payable. Licensees under the Act also may deduct allocations made to secure an approved closure plan at the time such allocations are made.

For companies with calendar year accounts, a tax return and annual accounts must be filed by 1 March of the following year. Where a different tax year is used, the return and accounts must be filed within two months of the year end. In both cases, extensions may be granted by the tax authorities.

The relevant tax authority is the Inland Revenue Department of Greenland. In the event of a dispute arising over the computation of taxable income, the licensee has the right to appeal, with the ultimate decision resting with the Supreme Court of Denmark.

The Inland Revenue Department is responsible for the computation of tax for licensees under the Act. The tax rate is set annually by the Lansting. It consists of a home rule tax and a special home rule tax. For 1991, the rates for these taxes are 10% and 23% respectively, giving a total rate of 33% which is charged proportionally on the taxable income.

In addition to the base rate, a surtax of 6% is added. Accordingly, with the base rate for 1991 for example, the effective tax rate is 34.98%. The Landsstyre may grant exemption from the surtax under certain circumstances.

A credit will be allowed in the Greenland tax where the taxable income includes foreign income which is taxed abroad. However, this credit cannot exceed the part of the Greenland tax that is proportionally applied to the foreign income.

A tax assessment will be issued by the tax authorities eight months after the end of the tax year. Tax becomes payable two months from the issuing of the assessment. Hence, for companies using the calendar tax year, an assessment will be issued by 1 September of the following year, with tax becoming due on 1 November.

For more detailed information on licences and taxation readers are referred to "A handbook for Investors in the Mining and Petroleum Industries" prepared by the Mining Journal Research Services 1991.

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Kop. til GGU Schønwandt

ENERGIMINISTERIET
RÅSTOFFORVALTNINGEN FOR GRØNLAND
BILAG
23 JULI 1992
9232-36
001293

RTZ Mining and Exploration

RTZ GROUP

Your Ref: 9232-35 e.a
Our Ref: JC/sj

Sami El-Nasser
Ministry of Energy
Mineral Resources Administration
for Greenland
1 Slotsholmsgade
4th Floor
DK 1216
Copenhagen
DENMARK

21 July 1992

Dear Sami

Further to your letter dated 15 June 1992 regarding data inadvertently missing from the 1991 Karrat Concession Year End Report, the answers to your questions follow:

a) Only 24 lithogeochemical samples were analysed for a maximum of 32 elements by Inductively Coupled Plasma Mass Spectrometry, Atomic Absorption Spectrometry techniques and X-Ray Fluorescences techniques. The remaining samples analysed from the Karrat Concession were analysed for only 7 elements: Cu, Pb, Zn, Ni, Ag and total Fe by Acid Digestion/Atomic Absorption Spectrometry, and Au geochemically to lower limits of reporting. Any samples returning base metal values over 1% were assayed by appropriate evaluation techniques. The additional results are enclosed.

All analytical procedures were performed by Anamet Services of St Andrew's Road, Avonmouth, Bristol. Anamet Services is the trading name of RTZ Technical Services Limited (a wholly owned subsidiary of the RTZ Corporation Plc).

b) The stream sediment samples were initially sieved to -80# and analysed for 32 elements by similar analytical techniques to the lithogeochemical samples. The results enclosed are intended as an amendment to the report.

c) Lithogeochemical samples no. 1915-1926 were collected in the Tasiussaq area north of Upernavik outside of the 1991 Karrat Concession but within the RTZM&E prospecting licence. Only samples no. 1917, 1924 and 1926 were analysed by similar procedures as above with full analytical results enclosed. General island locations are given in the sample description in Appendix ~~1~~ 3.

I hope the information enclosed fulfils your requirements. Please feel free to contact myself or Colin Harris at any time, if we may be of any further assistance to you.

Yours sincerely

Jim Coppard
Geologist

KARRAT 1991 - ROCK SAMPLE RESULTS - ADDITION

Sample No	Al %	As ppm	B ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Ga ppm	K %	Li ppm	Mg %	Mn ppm	Mo ppm	Na %
GR1904	5.23	5	62	1	-5	2.85	-2	162	288	16	0.92	34	2.05	750	-5	0.45
GR1911	7.28	-5	20	2	-5	1.62	-2	24	230	15	1.82	48	1.78	398	8	2.07
GR1946	3.07	50	138	4	7	0.71	9	73	157	18	1.44	229	1.77	734	72	0.29
GR2009	1.56	9	151	1	-5	0.68	-2	233	209	15	0.91	9	0.29	132	96	0.08
GR2026	5.97	5	18	2	-5	2.61	-2	23	132	18	1.14	24	1.67	454	-5	1.30
GR2029	5.70	-5	16	2	-5	3.90	-2	16	102	10	1.53	49	2.52	825	-5	0.97
GR2054	6.46	-5	-10	3	-5	1.59	-2	-5	110	10	1.43	31	1.80	320	8	2.49
GR2070	8.66	-5	-10	2	-5	0.58	-2	7	71	11	5.70	52	0.75	114	-5	1.52
GR2071	6.68	-5	-10	3	-5	0.47	-2	9	108	-5	3.86	49	0.62	77	-5	0.56
GR2072	1.87	5	-10	2	-5	0.61	-2	11	397	-5	1.21	23	0.64	163	-5	0.10
GR2073	2.98	-5	10	2	-5	3.11	-2	16	279	-5	1.56	55	2.19	574	-5	0.19
GR2074	2.87	8	10	2	-5	0.79	-2	11	202	7	1.41	49	1.51	304	-5	0.37
GR2075	5.94	-5	10	2	-5	0.95	-2	12	118	10	5.24	55	1.91	407	-5	0.34
GR2076	5.58	-5	-10	2	-5	0.41	-2	10	90	15	5.19	41	1.09	158	-5	0.35
GR2089	6.65	-5	-10	2	-5	1.45	-2	19	112	14	1.90	35	1.40	328	-5	2.35
GR2096	5.40	6	22	2	-5	1.90	-2	18	119	17	1.66	19	1.20	325	11	1.49
GR2099	6.25	-5	-10	2	-5	0.78	5	8	141	15	2.32	30	1.00	174	32	1.39
GR2120	6.34	15	12	1	-5	1.06	-2	11	183	18	1.91	33	1.80	306	12	1.59
GR2153	7.48	-5	17	2	-5	1.95	-2	19	156	12	2.60	34	1.46	372	5	197

NAL ICP VALUES

a	P %	S %	Sa ppm	Sc ppm	Se ppm	Sr ppm	Te ppm	Ti %	U ppm	V ppm
	0.06	3.22	5	16	-5	60	46	0.29	-5	108
07	0.06	1.02	-5	17	-5	135	26	0.36	6	214
	0.06	13.00	-5	12	-5	31	38	0.23	7	223
08	0.01	14.75	-5	5	-5	-10	32	0.19	-5	355
	0.06	1.71	-5	11	-5	172	32	0.27	5	110
07	0.07	1.31	5	10	-5	162	47	0.26	5	148
	0.07	0.72	-5	12	-5	151	25	0.33	8	222
2	0.07	0.10	-5	8	-5	92	6	0.41	5	77
56	0.12	0.15	-5	6	-5	36	8	0.27	-5	55
1	0.01	0.09	-5	-5	-5	18	11	0.09	-5	26
19	0.03	0.18	-5	5	-5	55	40	0.15	-5	38
3	0.02	0.39	-5	10	-5	46	17	0.30	-5	67
34	0.03	0.37	7	9	-5	54	21	0.14	-5	61
3	0.02	0.51	-5	9	-5	42	8	0.25	-5	60
35	0.06	0.54	7	13	-5	156	20	0.36	6	182
8	0.03	2.89	6	9	-5	150	23	0.08	6	85
39	0.05	0.58	-5	13	-5	108	16	0.35	9	318
5	0.05	0.54	-5	15	-5	80	20	0.32	6	194
7	0.07	1.63	-5	15	-5	105	27	0.30	7	277

KARRAT 1991 - ROCK SAMPLE RESULTS - ADDITIONAL ICP VALUES

Sample No	Al %	As ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Fe %	K %	Li ppm	Mg %	Mn ppm	Mo ppm	Na %	P %	Sb ppm	Sc ppm	Sr ppm	Ti %	V ppm
GR1956	0.81	20	1	-5	12.48	-2	6	41	55.19	0.91	13	5.44	391	4	0.07	0.04	24	-5	142	0.06	19
GR2101	0.09	50	-1	-5	0.05	-2	177	12	69.22	2.36	5	0.07	-5	5	-0.01	-0.01	36	-5	3	-0.01	10
GR2102	1.42	27	2	-5	0.18	9	53	252	19.01	1.48	-5	0.22	37	95	0.04	0.02	36	-5	14	0.21	284
GR2128	5.69	-5	4	-5	0.12	-2	43	184	19.68	0.27	-5	0.02	23	16	4.50	-0.01	5	-5	90	0.10	25
GR2160	2.52	58	1	-5	0.07	-2	7	220	40.01	2.81	8	0.10	7	31	0.19	-0.01	27	-5	35	0.13	36

KARRAT 1991 - STREAM S

Sample No	Au ppb	Ag ppm	Al %	As ppm	B ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Ga ppm	K %	Li ppm
K91SS1	12	-5	7.25	7	17	2	-5	1.65	-1	20	166	98	5.13	24	2.03	41
K91SS2	10	-5	6.37	19	15	2	-5	1.91	1	22	142	85	4.15	22	2.01	29
K91SS3	9	-5	4.49	46	17	2	-5	1.29	-1	20	117	73	4.16	23	1.51	34
K91SS4	-5	-5	6.30	22	20	2	-5	1.09	1	20	151	112	5.97	24	2.02	37
K91SS5	7	-5	6.08	28	17	2	-5	1.56	2	32	122	137	4.74	23	1.83	32
K91SS6	6	-5	6.44	12	13	2	-5	2.16	1	15	111	42	2.96	22	1.77	25
K91SS7	-5	-5	7.02	22	16	2	-5	2.04	1	32	128	100	4.27	25	1.65	41
K91SS8	5	-5	6.70	28	15	2	-5	1.70	1	26	132	155	4.39	24	1.94	34
K91SS9	6	-5	8.62	11	16	1	-5	1.98	1	20	144	230	3.71	26	2.27	38
K91SS10	-5	-5	5.48	52	14	2	-5	1.19	1	19	142	70	4.19	24	1.46	36
K91SS11	-5	-5	5.92	19	21	2	-5	1.84	-1	22	191	174	6.59	28	1.72	47
K91SS12	-5	-5	7.26	16	27	3	-5	2.27	-1	19	222	192	8.69	32	2.09	55

IMENT SAMPLE RESULTS

%	Mn ppm	Mo ppm	Na %	Ni ppm	P %	Pb ppm	S %	Sa ppm	Sc ppm	Se ppm	Sr ppm	Te ppm	Ti %	V ppm	Zn ppm
[illegible]	731	-5	2.14	76	0.07	16	0.07	-5	15	-5	121	29	0.57	134	140
[illegible]	700	-5	2.64	116	0.06	23	0.08	-5	11	-5	138	23	0.33	92	315
.10	554	-5	1.98	98	0.06	19	0.10	-5	8	-5	102	27	0.34	85	172
[illegible]	727	-5	1.74	75	0.06	16	0.16	5	14	-5	107	23	0.32	116	141
.16	885	-5	2.01	153	0.07	19	0.17	-5	11	-5	122	24	0.33	85	383
[illegible]	557	-5	2.61	98	0.06	16	0.06	-5	10	-5	135	26	0.28	72	239
.49	648	-5	2.34	214	0.06	19	0.10	-5	13	-5	138	31	0.35	94	529
[illegible]	696	-5	2.20	162	0.06	18	0.20	-5	11	-5	120	23	0.26	81	366
.10	966	-5	2.96	130	0.07	18	0.16	3	13	-5	130	24	0.28	81	652
[illegible]	479	-5	2.10	98	0.05	19	0.09	5	12	-5	96	25	0.37	96	144
.72	692	7	2.07	91	0.07	25	0.37	6	13	-5	103	31	0.35	147	156
[illegible]	999	6	2.45	89	0.11	24	0.36	10	16	-5	138	45	0.48	177	225

TASIUSSAQ BUGT ROCK S

Sample no	Au ppb	Ag ppm	Al %	As ppm	B ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Ga ppm	K %	Li ppm	Mg ppm
GR1917		-5	6.21	5	24	2	-5	0.85	-2	12	249	23	4.29	19	1.92	19	0.84
GR1922	5	1.9										127	12.8				
GR1924	5	0.8										2.0	3.0				
GR1926	<5	1.5										11	0.7				

SAMPLES

Mn ppm	Mo ppm	Na %	Ni ppm	P %	Pb ppm	S %	Sb ppm	Sc ppm	Se ppm	Sr ppm	Te ppm	Ti ppm	U ppm	V ppm	Zn ppm
67	-5	1.70	32	0.04	35	0.36	-5	6	-5	128	14	0.24	6	88	62
			189		5										83
			16		8										61
			16		4										14