The Isua iron ore deposit at Isukasia, West Greenland

Peter W. Uitterdijk Appel

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April 1991

GRØNLANDS GEOLOGISKE UNDERSØGELSE
Ujarassiortut Kalaallit Nunaanni Misissuisoqarfiat
GEOLOGICAL SURVEY OF GREENLAND

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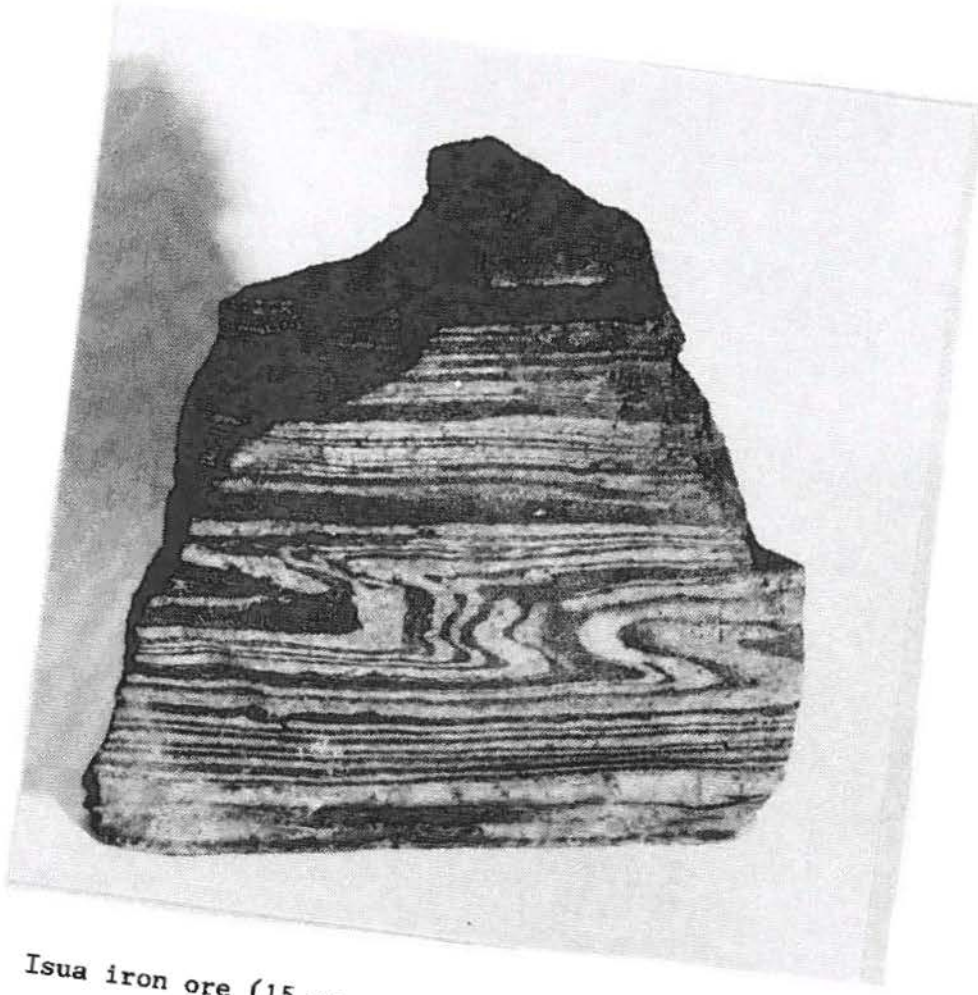

Isua iron ore (15 cm across)

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ABSTRACT

In the early Archaean Isua supracrustal belt in the Nuuk region, West Greenland a major iron ore deposit with an estimated tonnage of 1900 M tonnes grading 32.9 % Fe occurs.

The Isua iron ore deposit, which is found 150 km north-east of Nuuk, is only partly exposed. One third is exposed whereas two thirds are covered by the Inland Ice. The nearest fjord assessible for shipping is 85 km away from the iron ore deposit.

Drilling, bulk sampling for beneficiation tests have been carried out as well as fairly detailed investigations for hydropower.

INTRODUCTION

During the field season 1962 Kryolitselskabet Øresund A/S, Copenhagen, hereafter referred to as the Cryolite Company discovered a supracrustal belt at Isukasia at the edge of the Inland Ice about 150 km north-east of Nuuk (Fig. 1). The company carried out regional investigations including aeromagnetic surveys during the subsequent years. In 1965 the company found a strong magnetic anomaly and some lesser anomalies in the supracrustal belt at Isuakasia (Fig. 2). During the following years the company erected a small exploration camp with 5 to 6 houses at the Isua iron ore which was the name given to the deposit.

The Cryolite Company prospected the whole supracrustal belt superficially, and carried out a number of investigations on the Isua iron ore deposit, including detailed geophysics, limited diamond drilling, topographic and geologic mapping as well as investigations for hydropower.

The Isua iron ore deposit in the Isua supracrustal belt occurs about 1200 m above sea level. The nearest fjord is about 85 km away in straight line. The terrane between the deposit and the fjord is not very rough, but dissected by some steep valleys a feature which make road construction quite difficult.

This report is meant as an introduction and brief overview of the immense amount of work put into this project by the Cryolite Company. The complete set of reports from the company as well as all the drill cores are available for inspection at the Geological Survey of Greenland (GGU).

GENERAL GEOLOGY

The geology of the Nuuk region has been described by various authors, most recently by Kalsbeek & Garde (1989) and Friend et al. (1990). The reader is referred to the former for a detailed and up-to-date reference list. Some of the mineral occurrences of the Nuuk region have recently been described by Appel (1990a,b).

The oldest rocks in the Nuuk region comprise the Isua supracrustal rocks, which are of early Archaean, with radiometric age of 3760 Ma. The supracrustal rocks occur as enclaves in the Amîtsoq gneisses, which yield the same radiometric ages, and occur throughout large parts of the Nuuk region. The supracrustal enclaves range up to the largest, which is located at Isukasia, measuring about 30 km in length and up to 4 km in width (Fig. 1).

The Malene supracrustal rocks of mid-Archaean age occur as large abundant enclaves in the Nûk gneisses over an area of more than 30.000 km^2. The Malene

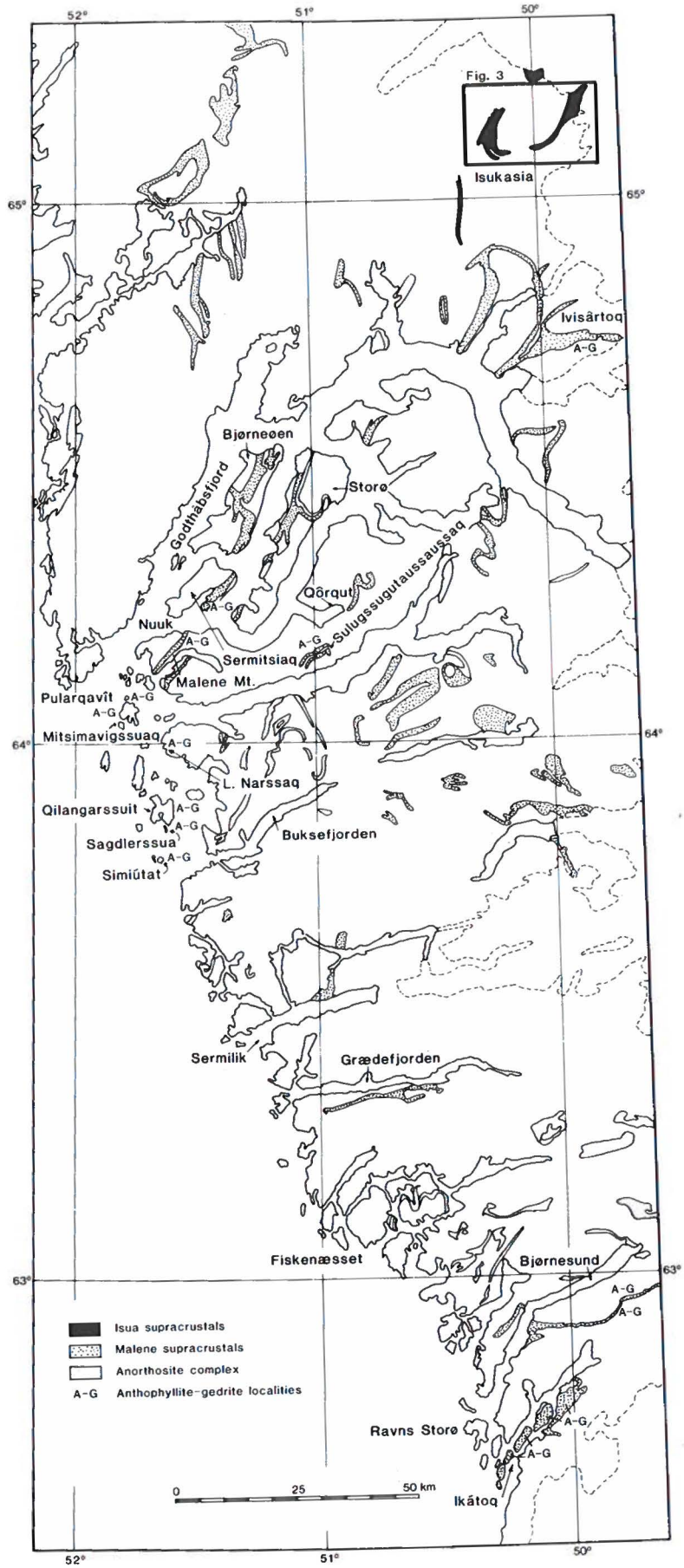


Fig. 1: Index map of the Nuuk region showing supracrustal enclaves and the anorthosite complex

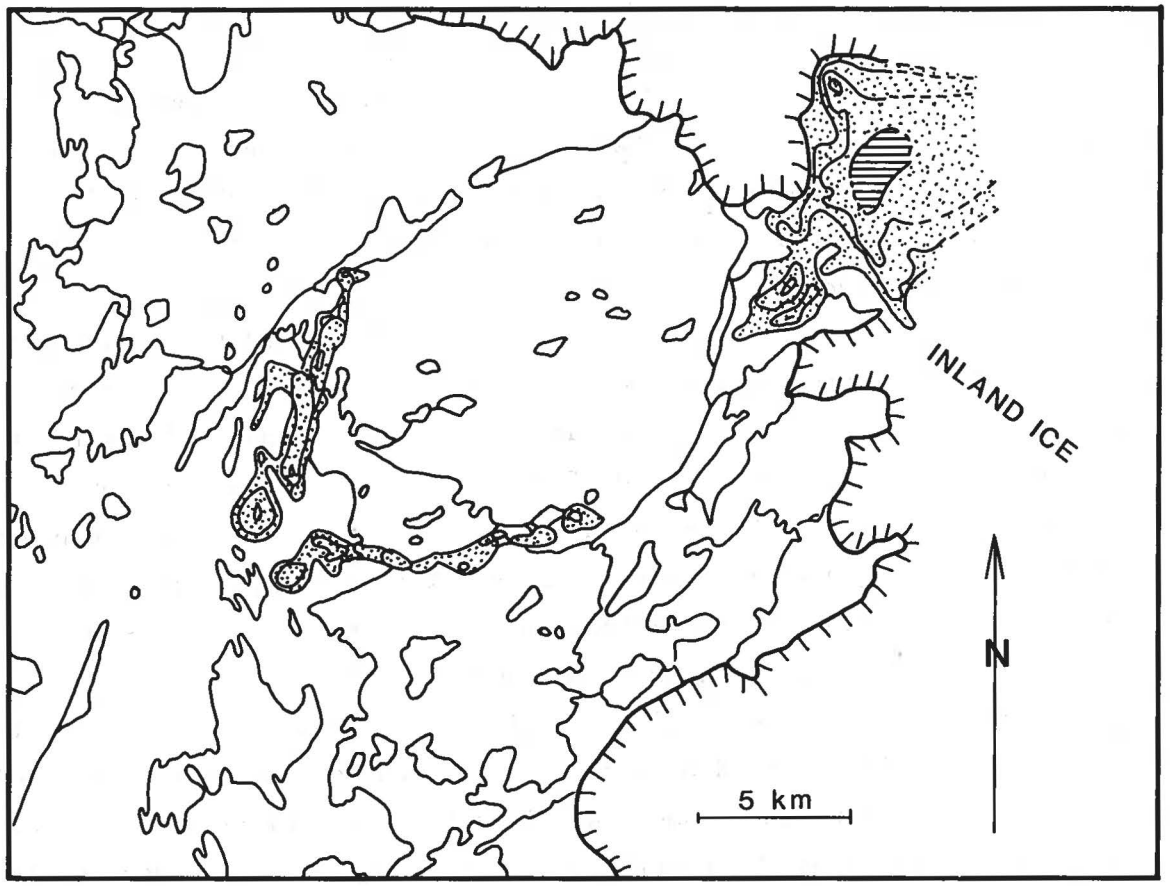


Fig. 2 Simplified aeromagnetic map, vertical component. Flight altitude 150–300m (493–986 ft), line intervals 500m (1644ft). Contour curves 500, 1000, 3000, and 12000 (ruled area) gammas, (Keto, 1970).

supracrustals and the Nûk gneisses were intruded by a major stratiform anorthosite complex, which displays a strike length of more than 200 km and an average width of less than 400 m (Fig. 1).

The youngest major rock forming event in the Nuuk region was the emplacement of the Qôrqut granite some 2500 Ma ago.

GEOLOGY OF THE ISUA SUPRACRUSTAL BELT

Nutman (1986) has presented a detailed account of the geology of the Isua supracrustal rocks (Fig. 3). The Isua iron-formation and associated sulphide occurrences have been described by Appel (1979, 1987, 1990a,b). The following is a brief account only. The stratigraphy is schematically presented in Fig. 4, from Nutman (1986).

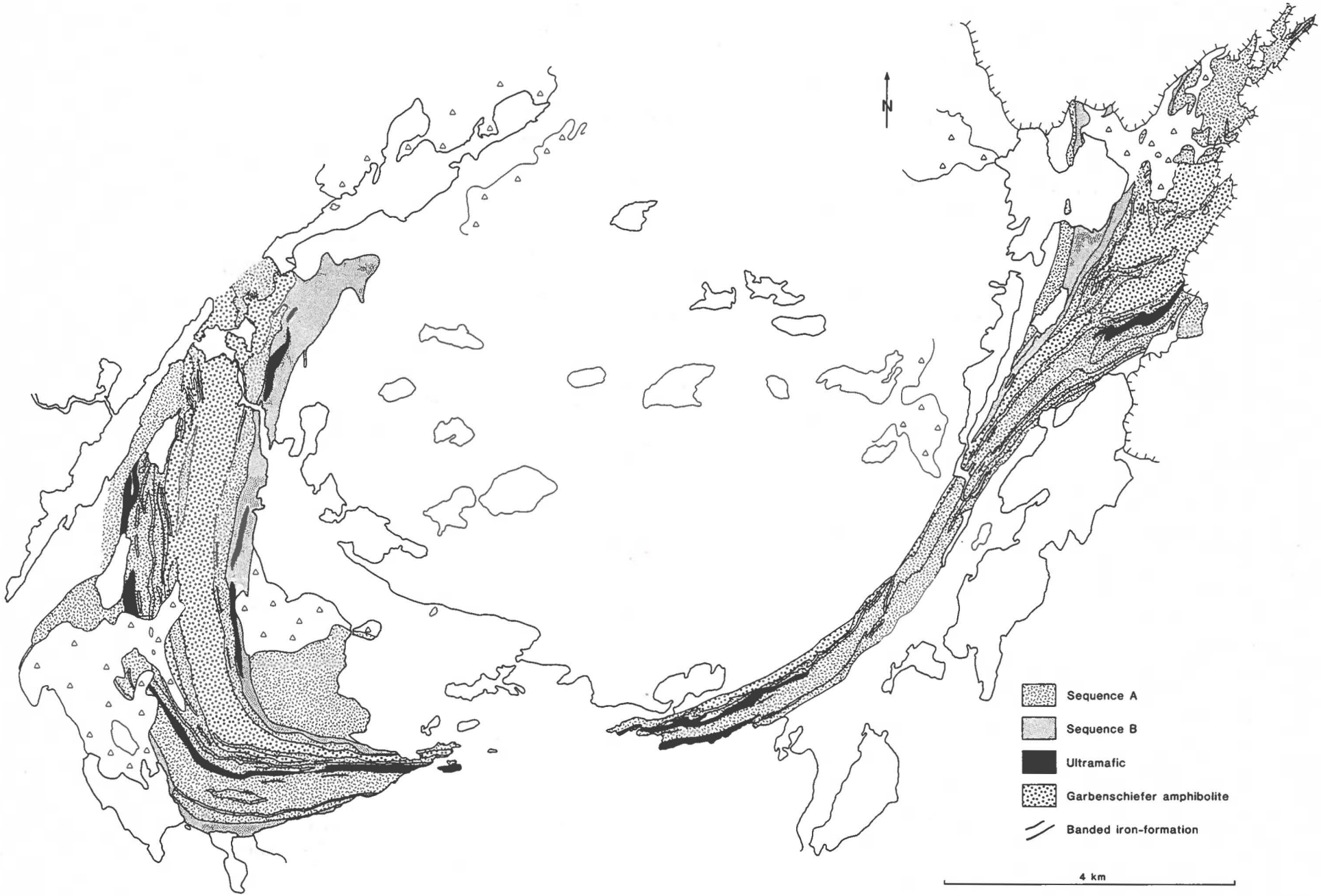
The Isua supracrustal rocks consist mainly of banded to massive amphibolites with interlayered metasediments. A few of the amphibolites display well preserved pillow structures. The massive and banded amphibolites represent deformed and metamorphosed pillow flows, mafic tuffaceous horizons and intrusive basic sills. The metasediments comprise acid rocks some presumably of rhyolitic origin whereas others represent chemical precipitates such as chert, now appearing as quartzites. The quartzites are locally fuchsite stained and one of these fuchsite stained quartzites assay 4.6 % barium. An up to several metre wide conglomerate is found, consisting of quartzite (metachert) pebbles embedded in a quartz carbonate rich matrix, with minor magnetite and tourmaline. Some staurolite-bearing schists are presumed to represent metapelites. Ultramafic pods and lenses occur frequently within the amphibolite. The origin of these ultramafics is still debated.

The Isua supracrustal belt at Isukasia hosts a number of mineral occurrences beside the iron-formation. Copper sulphides mainly chalcopyrite and cubanite occur as thin stringers and as disseminations in banded amphibolites as well as in sulphide facies iron-formation (Appel, 1979, 1990b). Furthermore insignificant galena occurrences have been found.

After deposition the Isua supracrustals have been repeatedly folded and metamorphosed under amphibolite facies conditions.

GEOLOGY OF THE ISUA IRON-FORMATION

The Isua iron-formation is a classic banded iron-formation with several well developed facies types. The iron-formation occur generally in up to a few



From Nutman, 1986.

Fig. 3

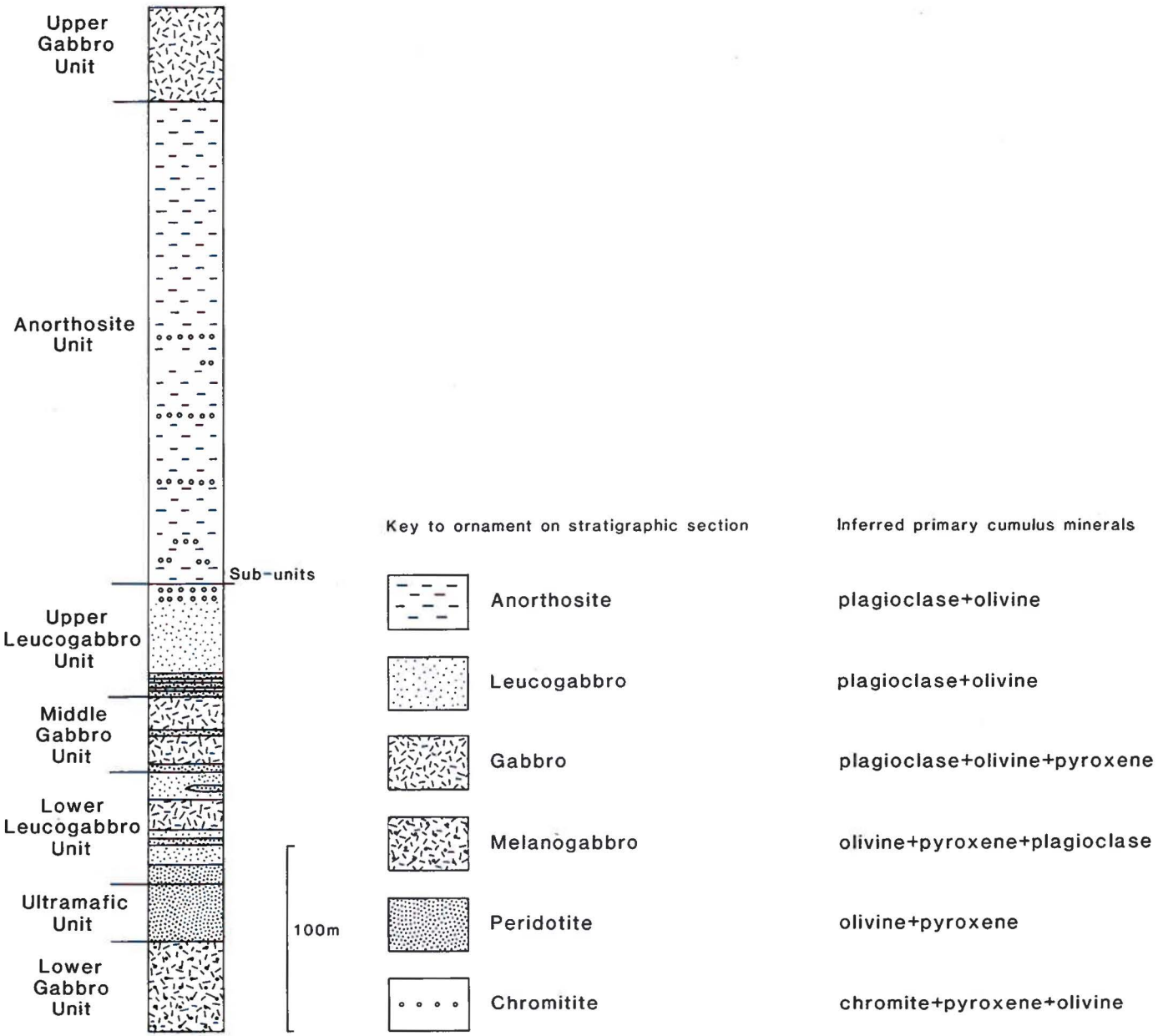

Upper Gabbro Unit
Anorthosite Unit
Sub-units
Upper Leucogabbro Unit
Middle Gabbro Unit
Lower Leucogabbro Unit
Ultramafic Unit
Lower Gabbro Unit
100m
Key to ornament on stratigraphic section
Inferred primary cumulus minerals
Anorthosite
plagioclase+olivine
Leucogabbro
plagioclase+olivine
Gabbro
plagioclase+olivine+pyroxene
Melanogabbro
olivine+pyroxene+plagioclase
Peridotite
olivine+pyroxene
Chromitite
chromite+pyroxene+olivine

Fig. 4

tens of metres thick horizons with can be traced intermittently for hundreds of metres. The most common facies type is oxide facies followed in decreasing order of abundance by silicate facies, carbonate facies and sulphide facies. There appears to no regular distribution pattern of the different facies, they occur as fairly restricted occurrences irregularly distributed throughout the area. It is presumed that the precipitation of the different facies of iron--formation governed by small differences in pH and Eh took place in small restricted basins.

Oxide facies iron-formation consists of magnetite bands alternating with quartz (metachert) bands. The bands vary in width from less than a millimetre to several tens of centimetres. The magnetite bands consist mainly of fine-grained magnetite with varying amounts of quartz and amphiboles. The quartz bands consist mainly of fine-grained quartz dusted with magnetite and with varying amounts of amphiboles. Intraformational breccias or flat pebble conglomerates are quite abundant in oxide facies iron-formation. Hematite quartz banded iron-formation is found outcropping in the easternmost part of Isukasia. The hematite outcrop is minor, but larger amounts may occur under the Inland Ice. The hematite is quite clearly an alteration product from magnetite.

The main oxide facies occurrence is the Isua iron ore body found in the extreme eastern part of the supracrustal belt (Fig. 2). This iron ore body appears on a "peninsular" partly surrounded by the Inland Ice, and geophysical investigations followed by diamond drilling (see below) showed that two thirds of the iron ore body is situated below the Inland Ice.

Silicate facies iron-formation has been found in two types.

A. The most common type consists of magnetite-rich bands alternating with grunerite-rich bands. This type of iron-formation is found in up to tens of metres thick horizons, which can be traced with intervals for hundreds of metres. The magnetite-rich bands consist of fine-grained magnetite with subordinate amounts of grunerite, whereas the silicate bands consist of medium- to fine-grained grunerite with very small amounts of magnetite.

B. Of lesser volumetric importance is a silicate facies type consisting of massive medium-grained actinolite with magnetite as thin bands as well as up to 0.5 cm sized grains disseminated throughout the rock. This type of iron-formation is found as metre wide bands traceable for tens of metres along strike. Some of these rocks are anomalous in gold with up to 1 ppm Au (Appel, 1990a).

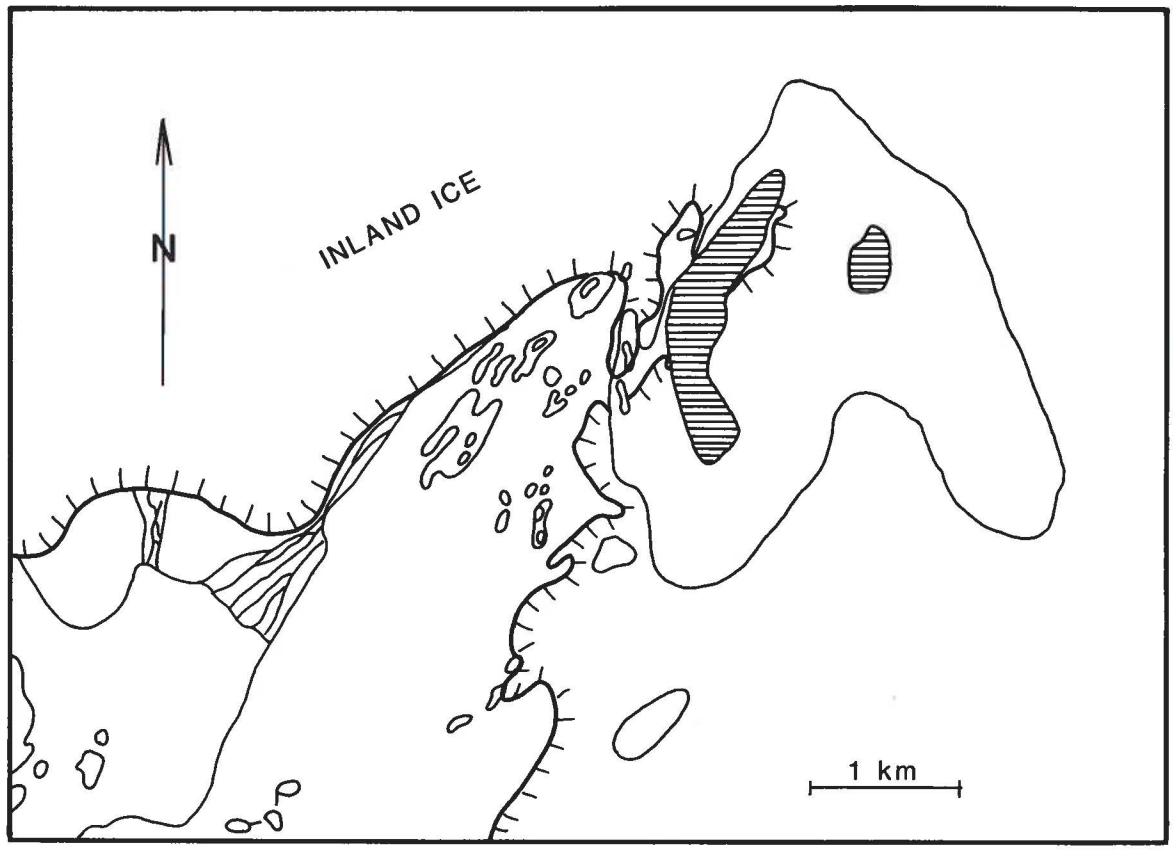


Fig. 5 Simplified magnetic map of the Isua iron ore field. Contour curves 10000 and 40000 (ruled areas) gammas (Keto, 1970).

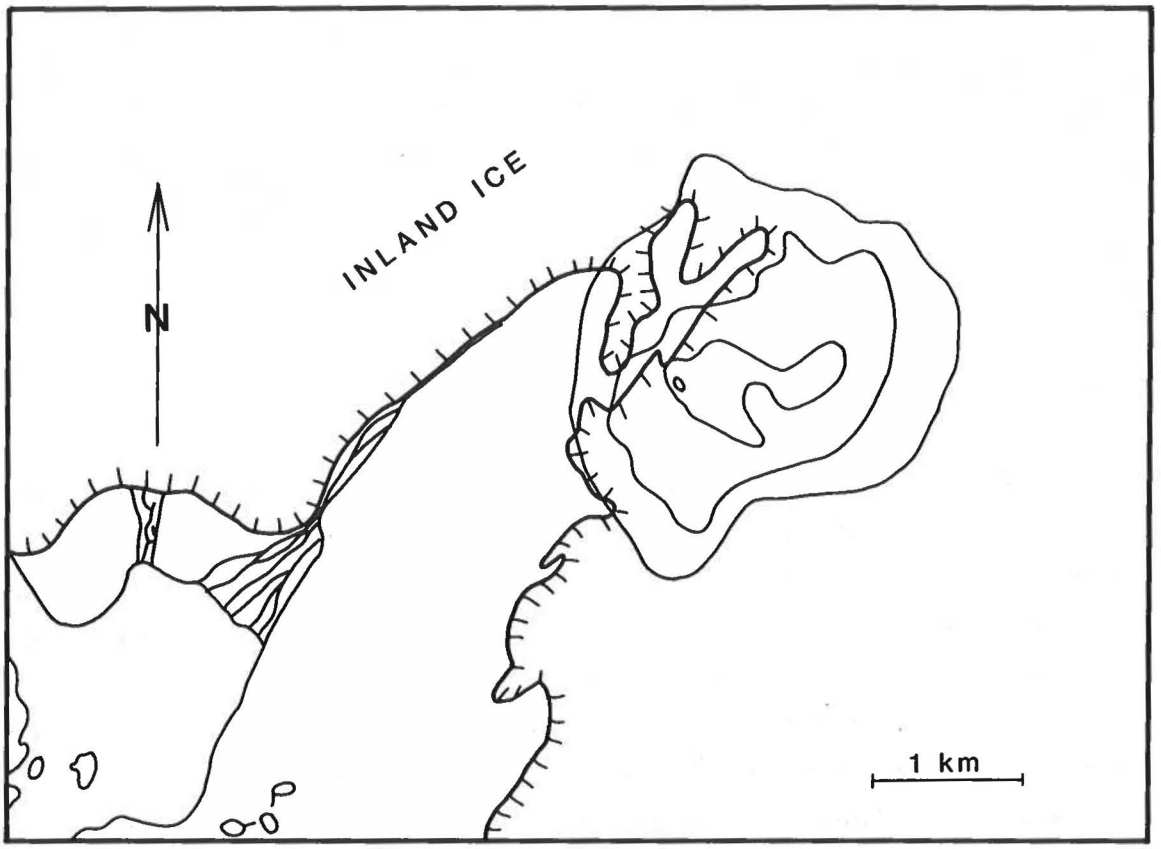


Fig. 6 Simplified gravity map of the Isua iron ore field. Contour curves 1, 4, 7 and 9 mgals (Keto, 1970).

Carbonate facies iron-formation forms horizons up to about 5 metres wide, traceable with intervals for hundreds of metres. It is a dark brown rock with mm-thick magnetite bands alternating with siderite bands up to tens of centimetres thick. Graphite, pyrrhotite and lesser amounts of chalcopyrite are found disseminated in the horizons of carbonate facies iron-formation.

Sulphide facies iron-formation is not common at Isukasia. The few horizons consist of iron-silicates, magnetite, pyrrhotite and chalcopyrite. Pyrrhotite-rich horizons are up to several metres wide, but only traceable for a few tens of metres along strike.

GEOPHYSICAL INVESTIGATIONS

Geomagnetic survey

The Cryolite Company carried out airborne geomagnetic surveys. These investigations resulted in the discovery of the main Isua iron ore body, but disclosed also a number of magnetic anomalies along the general strike of the Isua supracrustal belt. These anomalies were later found to correspond to smaller outcrops of iron-formation.

The Cryolite Company also carried out a ground magnetic survey over an area measuring 17 km^2 measuring 28 000 points with variable point and line spacing. The maximum readings were above 250 000 gammas over outcrops of iron-formation.

The results of the magnetic survey is presented in the simplified map in Fig. 5.

Gravimetric survey

The Cryolite Company carried out a gravity survey over an area of 12 km^2. The survey outlined a residual gravity anomaly with a size of about 5 km^2, which coincides quite well with the magnetic survey. The peak anomaly found was 9.0 mgal. The gravity anomaly is shown on a simplified map in Fig. 6.

Southeast of the gravity anomaly shown on Fig. 5 is an even stronger anomaly with peak values up to 11.7 mgal. This anomaly has not been explained.

Seismic soundings

For corrections of the gravimetric data, seismic soundings were made on the Inland Ice in order to determine the thickness of the ice. The soundings were made over an area of 7.5 km^2. The maximum thickness of the Inland Ice covering the iron ore was found to be 550 m.

DIAMOND DRILLING

The Cryolite Company carried out a diamond drilling programme as well as a bulk sampling programme at the Isua iron ore body during the field season 1971. The drilling was undertaken by Suomen Malmi OY, Finland.

13 diamond drillings with a diameter of 46 mm were drilled. A simplified drill log is presented in the appendix. Five of the drill holes were made where the iron ore body outcrops, whereas the remaining were drilled from the Inland Ice. The thickness of the Inland Ice at the drill sites ranged from 14.60 to 215.70 m.

Several drillings had to be terminated earlier than planned, because the drill string froze in the hole. However, one hole was terminated due to ice movement.

The following statistics have been supplied by the company:

Drill crew: 1 foreman, 1 maintenance man and 12 drillers in three shifts.

Number of drill holes	13
Max length of drill hole	383.80 m
Min length of drill hole, terminated due to freezing	31.10 m
Total length drilled	2718.90 m
Drilling through ice	937.90 m
Drilling through overburden	35.25 m
Drilling through rock	1745.75 m
Drill speed in ice	3.45 m per hour
Drill speed in rock	1.62 m per hour
Total drill speed incl. erection, moving and dismantling	1.39 m per hour
Consumption of diesel fuel inc. heating of drill fluid	12800.00 l
Per metre drill hole	4.70 l
Consumption of antifreeze	22.00 tons
Per metre drill hole	10 kg

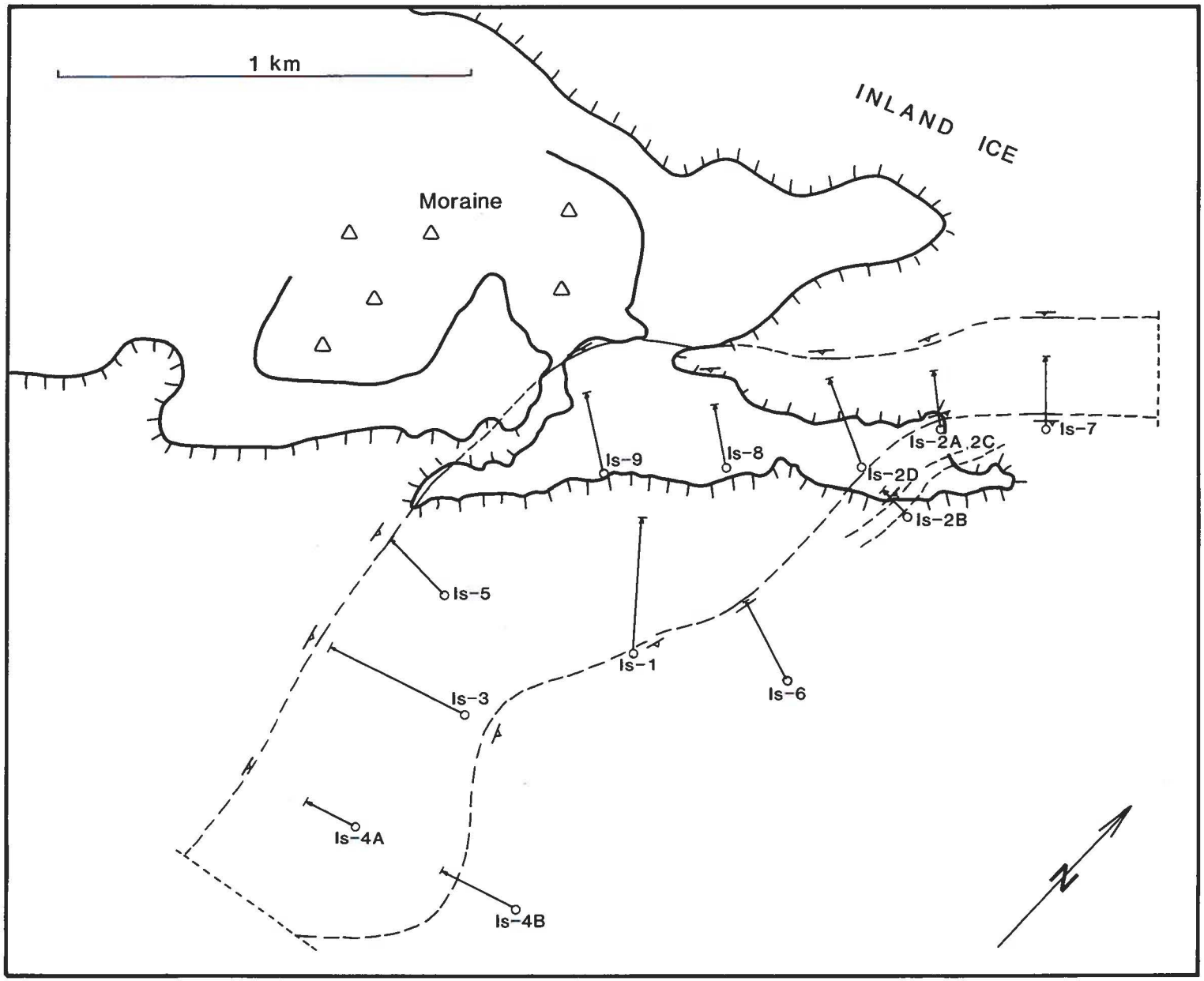


Fig. 7 Sketch map of the diamond drill site locations.

BULK SAMPLING

In preparation for large scale beneficiation tests a bulk sample of iron ore was collected at Isukasia. A total of 132 tons of iron-formation was sampled and packed in jute sacks. 29 tons were lifted by helicopter down to Godthåbsfjord; the remaining 103 tons are still at Isukasia.

ORE RESERVES

The ore reserves at Isukasia have been calculated in different ways. In 1971 L. Keto (Kryolite Company report 1971) calculated the total ore reserves to 1900 M tonnes with an average grade of 39 % Fe. It was thought that an estimate of 545 M tonnes of ore grading 32.9 % Fe could be mined in open pit, whereas the rest would have to be mined underground. A major part of the underground mining would have to be carried out under the Inland Ice.

According to the latest estimate by the Cryolite Company the ore reserves are in the order of 1900 M tonnes grading 32.9 % Fe.

MINE PLANNING

During 1975 and 1976 the Swedish consulting group SWECO and the arctic consulting group ACG carried out mine site planning for the joint venture between the Cryolite Company and Marcona Corporation.

These investigations comprised telecommunication studies, drill bit wear, and detailed topographic investigations and considerations as to entrance adits to the proposed iron ore mine. Proposals as to housing for miners, storage as well as assess roads have been made. For further details the reader is referred to the list of references. Different proposals as to how to get the concentrate/pellets down to the coast have been put forward, such as conveyer belt og pipe line.

MARKETING STUDIES

The Cryolite Company and Marcona Corporation had Utah International Inc. to carry out marketing investigations on a pellet production from the Isua iron-formation. This was done in 1979.

It was concluded that there was a strong oversupply of pellets at least up to 1980, and that there would not be much of a market for the Isukasia pellets, in spite of the considerably shorter shipping distances to Rotterdam for Isukasia pellets compared with Brazilian pellets.

LOGISTIC INVESTIGATIONS

The Cryolite Company produced a detailed topographic map in scale 1:10 000 in the eastern part of Isukasia. As a part of the topographic investigations, the exact location of the front of the Inland Ice was determined in order to determine whether the Inland Ice retreated or advanced.

The Cryolite Company also carried out detailed run-off measurements of the streams in the area. These measurements were meant as help to determine the potential for hydroelectric power at Isukasia.

GEOGRAPHIC SETTING

The Isua iron ore body is situated approximately 150 km northeast of Nuuk, the Capital of Greenland. The area in which the ore body occurs has been named Isukasia. The area lies generally between 800 and 1213 m above sea level. The ore body is located at and around the 1213 m summit, which is partly surrounded by the Inland Ice.

Isukasia is situated about 85 km in a straight line from the inner part of Godthåbsfjorden. This fjord is frequently partly filled by smaller ice bergs from calving glacier from the inner part of the fjord. This ice, however, will normally not pose problems for sailing with larger vessels in most of the fjord complex the year around.

The vegetation occurring in the Isukasia area is very sparse, with few and small bushes and lichens. At the iron ore body virtually no vegetation apart from lichens is found.

The climate is dry and strong winds from the Inland Ice blow almost all the year around. The temperatures during summer months lie between -5°to + 15°C. The average temperatures for the year is about -7°C. The annual precipitation is in the order of 30 to 40 cm. Detailed meteorological data have been recorded during several years; presently measurements are being made by Nunatek.

Permafrost is a phenomenon not usually appearing at these latitudes. However, the proximity to the Inland Ice produce high arctic conditions in the Isuakasia area. Hence permafrost has been found in the area, and particularly

the iron ore body suffers from permafrost. This counts only for the part of the iron ore which is exposed. The part hidden below the Inland Ice is not bound by permafrost.

CONCLUSION

Based on gravimetric and magnetic surveys combined with limited diamond drilling, the Cryolite Company estimated an iron-ore reserve of 1900 M tonnes with 32.9 % Fe. Two thirds of this is situated under the Inland Ice, whereas the remaining one third outcrops but is bound by permafrost.

The Isukasia area is situated 85 km in a straight line from the inner part of the Godthåbsfjord in a fairly uneven terrane with abundant lakes and some steep valleys.

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The listed references is only a small fraction of reports produced by the Cryolite Company. The complete set of reports is available for study at GGU.

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Simplified drill logs from the diamond drillings at Isukasia

ISUA - DRILL HOLE NO. 1

LOCATION: See Fig. 7
DIRECTION: North 46° West
INCLINATION: 45°

00.00m to 128.40m	- Ice
128.40m to 132.20m	- Moraine material, Gneissic boulders.
132.20m to 139.50m	- Magnetite-quartz schist
139.50m to 143.45m	- Greenstone
143.45m to 144.65m	- Magnetite-quartz schist
144.65m to 148.00m	- Greenstone
148.00m to 152.00m	- Magnetite-quartz schist
152.00m to 153.00m	- Greenstone
153.00m to 166.70m	- Magnetite-quartz schist
166.70m to 167.65m	- Greenstone
167.65m to 168.50m	- Magnetite-quartz schist
168.50m to 171.00m	- Greenstone
171.00m to 191.90m	- Magnetite-quartz schist
191.90m to 211.90m	- Magnetite-quartz schist
211.90m to 222.60m	- Magnetite-quartz schist
222.60m to 260.60m	- Magnetite-quartz schist
260.60m to 265.00m	- Greenstone
265.00m to 268.10m	- Magnetite-quartz schist
268.80m to 277.20m	- Magnetite-quartz schist
277.20m to 277.80m	- Greenstone
277.80m to 286.30m	- Magnetite-quartz schist
286.30m to 286.70m	- Greenstone
286.70m to 291.10m	- Magnetite-quartz schist
291.00m to 298.30m	- Magnetite-quartz schist
298.30m to 298.50m	- Greenstone
298.50m to 353.50m	- Magnetite-quartz schist

TOTAL DEPTH: 353.50 meters
STATUS: Hole abandoned due to ice movement.
CORE RECOVERY: From 132.00m to 138.00m - 96%
From 138.00m to 353.50m - 100%

ISUA - DRILL HOLE NO. 2A

LOCATION: See Fig. 7
DIRECTION: North 57° West
INCLINATION: 60°

00.40m to 05.00m	- Magnetite-quartz schist
05.00m to 07.85m	- A weathered surface zone consisting of silica sand.
07.85m to 21.55m	- Magnetite-quartz - chlorite - muscovite-tremolite schist.
21.55m to 22.00m	- Magnetite-quartz-chlorite schist
22.00m to 31.50m	- Magnetite-quartz-chlorite schist

TOTAL DEPTH: 31.50m
STATUS: Drill rods frozen in hole.
CORE RECOVERY: From 7.85m to 31.50m - 100%

ISUA - DRILL HOLE NO.2B

LOCATION: See Fig. 7
DIRECTION: South 85° West
INCLINATION: 45°

00.00m to 14.60m	- Ice
14.60m to 27.30m	- Magnetite-quartz schist
27.30m to 29.00m	- Greenstone
29.00m to 30.60m	- Quartz
30.60m to 31.60m	- Magnetite-quartz schist
31.10m to 36.00m	- Greenstone
36.00m to 38.10m	- Magnetite-quartz schist
38.10m to 41.00m	- Greenstone
41.00m to 44.10m	- Quartzite
44.10m to 45.50m	- Greenstone
45.50m to 50.65m	- Quartzite
50.65m to 68.00m	- Quartz-talc-muscovite schist
68.00m to 70.90m	- Greenstone
70.90m to 88.15m	- Magnetite-quartz schist

TOTAL DEPTH: 88.15 Meters
STADUS: Hole abandoned due to freezing, drill rods lost. Casing recovered.
CORE RECOVERY: Exellent

ISUA - DRILL HOLE NO. 2C

LOCATION: See Fig. 7

DIRECTION: North 57° West

INCLINATION: 60°

00.00m to 25.00m	- As for Drill Hole No. 2A
25.00m to 35.65m	- Magnetite-quartz-chlorite schist
35.65m to 39.60m	- Greenstone
39.60m to 62.30m	- Magnetite-quartz-chlorite schist
62.30m to 70.00m	- Greenstone
70.00m to 90.70m	- Magnetite-quartz-chlorite schist
90.70m to 91.25m	- Greenstone
91.25m to 102.80m	- Magnetite-quartz-chlorite schist
102.80m to 103.60m	- Greenstone
103.60m to 113.10m	- Magnetite-quartz-chlorite schist
113.10m to 113.90m	- Greenstone
113.90m to 114.40m	- Magnetite-quartz-chlorite schist
114.40m to 121.00m	- Greenstone
121.00m to 126.00m	- Magnetite-quartz-chlorite schist
126.00m to 131.80m	- Greenstone
131.80m to 147.00m	- Magnetite-quartz-chlorite schist
147.00m to 147.30m	- Greenstone
147.30m to 149.60m	- Magnetite-quartz-chlorite schist
149.60m to 151.00m	- Greenstone
151.00m to 177.75m	- Magnetite-quartz-chlorite schist
177.75m to 183.00m	- Black schist

TOTAL DEPTH: 183.00 Meters

STATUS: Hole Complete

CORE RECOVERY: 100%

ISUA - DRILL HOLE NO.2D

LOCATION: See Fig. 7

DIRECTION: North 70° West

INCLINATION: 45°

000.00m to 003.00m	- Sand and loose boulders of gneisses and magnetite quartz schist material.
003.00m to 047.80m	- Magnetite-quartz schist
047.80m to 062.60m	- Greenstone
062.60m to 159.60m	- Magnetite-quartz schist
159.60m to 161.10m	- Greenstone
161.10m to 170.30m	- Magnetite-quartz schist
170.30m to 179.50m	- Greenstone
179.50m to 188.60m	- Magnetite-quartz schist
188.60m to 192.50m	- Greenstone
192.50m to 202.00m	- Magnetite-quartz schist
202.00m to 202.60m	- Greenstone
202.60m to 212.40m	- Magnetite-quartz schist
212.40m to 218.90m	- Black schist

TOTAL DEPHT: 218.90 Meters

STATUS: Hole Complete

CORE RECOVERY: 100%

ISUA - DRILL HOLE NO. 3

LOCATION: See Fig.7

DIRECTION: South 67° West

INCLINATION: 45°

000.00m to 145.65m	- Ice
145.65m to 147.20m	- Moraine
147.20m to 154.65m	- Magnetite-quartz schist
154.65m to 156.30m	- Greenstone
156.30m to 157.45m	- Magnetite-quartz schist
157.45m to 164.25m	- Greenstone
164.25m to 169.50m	- Magnetite
169.50m to 172.90m	- Greenstone
172.90m to 177.20m	- Magnetite-quartz schist
177.20m to 178.50m	- Greenstone
178.50m to 179.20m	- Magnetite-quartz schist
179.20m to 221.50m	- Magnetite-quartz schist
221.50m to 224.70m	- Greenstone
224.70m to 228.00m	- Magnetite-quartz schist
228.00m to 230.30m	- Greenstone
230.30m to 234.50m	- Magnetite-quartz schist
234.50m to 243.40m	- Greenstone
243.40m to 257.35m	- Magnetite-quartz schist
257.35m to 257.75m	- Greenstone
257.75m to 270.00m	- Magnetite-quartz schist
270.00m to 275.10m	- Greenstone
275.10m to 291.00m	- Magnetite-quartz schist
291.00m to 291.80m	- Greenstone
291.80m to 295.90m	- Magnetite-quartz schist
295.90m to 300.90m	- Greenstone
300.90m to 301.30m	- Magnetite-quartz schist
301.30m to 301.80m	- Greenstone
301.80m to 370.90m	- Magnetite-quartz schist
370.90m to 372.00m	- Greenstone
372.00m to 276.40m	- Magnetite-quartz schist
376.40m to 383.80m	- Greenstone

TOTAL DEAPT: 383.80m

STADUS: Hole discountnued due to servere drill hole conditions.

CORE RECOVERY: 100%

ISAU - DRILL HOLE NO.4A

LOCATION: See Fig. 7
DIRECTION: South 67° West
INCLINATION: 50°

000.00m to 130.75m - Ice
130.75m to 133.85m - Moraine gneissic and magnetite schist boulders.
133.85m to 153.70m - Magnetite-quartz schist

TOTAL DEPTH: 153.70 Meters
STATUS: Hole abandoned - Freezing problems, NaCl abandoned, used disel fuel 51 bbls, lost circulation, used all remaining fuel.
CORE RECOVERY: 100%

ISUA - DRILL HOLE NO.4B

LOCATION: See Fig. 7
DIRECTION: South 67°
INCLINATION: 50°

000.00m to 215.00m - Ice
215.00m to 219.00m - Ice and Moraine (drilled whit ice bit)

TOTAL DEPTH: 219.00 Meters
STATUS: Hole abandoned due to frozen drill rods.
CORE RECOVERY: No core recovered

ISUA - DRILL HOLE NO.5

LOCATION: See Fig. 7

DIRECTION: South 85° West

INCLINATION: 42°

000.00m to 073.00m	- Ice
073.00m to 082.50m	- Moraine - loose gneissic boulders.
082.50m to 089.70m	- Magnetite-quartz schist
089.70m to 094.80m	- Greenstone
094.80m to 125.05m	- Magnetite-quartz schist
125.05m to 130.40m	- Greenstone
130.40m to 147.20m	- Magnetite-quartz schist
147.20m to 149.50m	- Greenstone
149.50m to 168.00m	- Magnetite-quartz schist
168.00m to 179.45m	- Greenstone
179.45m to 181.45m	- Black schist

TOTAL DEPTH: 181.45 Meters

STATUS: Hole complete

CORE RECOVERY: 100%

ISUA - DRILL HOLE NO.6

LOCATION: See Fig. 7

DIRECTION: North 77° West

INCLINATION: 45°

000.00m to 195.00m	- Ice
195.00m to 200.00m	- Moraine
200.00m to 216.00m	- Quartzite
216.00m to 222.00m	- Magnetite-quartz schist
222.00m to 229.90m	- Greenstone
229.90m to 231.10m	- Magnetite-quartz schist
231.10m to 234.00m	- Greenstone
234.00m to 265.00m	- Magnetite-quartz schist
265.00m to 265.25m	- Chlorite

TOTAL DEPTH: 265.25 Meters

STATUS: Hole abandoned - Lost circulation produced high risk freezing conditions.

CORE RECOVERY: 100%

ISUA - DRILL HOLE NO.7

LOCATION: See Fig. 7

DIRECTION: North 50° West

INCLINATION: 60°

000.00m to 034.80m	- Ice
034.80m to 036.00m	- Moraine - loose boulders of gneissic and magnetite material.
036.00m to 036.50m	- Magnetite-quartz schist
036.50m to 042.60m	- Quartzite
042.60m to 043.80m	- Greenstone
043.80m to 044.70m	- Greenstone
044.70m to 047.80m	- Greenstone
047.80m to 072.60m	- Magnetite-quartz schist
072.60m to 074.20m	- Greenstone
074.20m to 102.60m	- Magnetite-quartz schist
102.60m to 104.90m	- Greenstone
104.90m to 117.60m	- Magnetite-quartz schist
117.60m to 120.00m	- Greenstone
120.00m to 182.65m	- Magnetite-quartz schist
182.65m to 184.35m	- Greenstone
184.35m to 240.30m	- Magnetite-quartz schist
240.30m to 242.85m	- Greenstone
242.85m to 255.75m	- Magnetite-quartz schist
255.75m to 257.75m	- Greenstone-black schist

TOTAL DEPTH: 257.75 Meters

STATUS: Hole Complete

CORE RECOVERY: 100%

ISUA - DRILL HOLE NO.8

LOCATION: See Fig. 7

DIRECTION: North 60° West

INCLINATION: 45°

000.00m to 002.80m	- Loose boulders of gneiss and magnetite-quartz schist.
002.80m to 011.90m	- Magnetite-quartz schist
011.90m to 013.20m	- Greenstone
013.20m to 039.55m	- Magnetite-quartz schist
039.55m to 040.55m	- Greenstone
040.55m to 067.80m	- Magnetite-quartz schist
067.80m to 068.80m	- Quartz
068.80m to 081.60m	- Magnetite-quartz schist
081.60m to 083.60m	- Greenstone
083.60m to 107.00m	- Magnetite-quartz schist
107.00m to 109.70m	- Greenstone
109.70m to 164.90m	- Magnetite-quartz schist
164.90m to 165.10m	- Greenstone

TOTAL DEPTH: 165.10 Meters

STATUS: 126.00 meters of drill rods frozen in hole. Not completed.

CORE RECOVERY: 100%

ISUA DRILL HOLE NO.9

LOCATION: See Fig. 7

DIRECTION: North 62° West

INCLINATION: 50°

000.00m to 002.00m	- Loose magnetite-quartz material.
002.00m to 032.80m	- Magnetite-quartz schist
032.80m to 038.50m	- Greenstone
038.50m to 049.25m	- Magnetite-quartz schist
049.25m to 052.50m	- Greenstone
052.50m to 109.50m	- Magnetite-quartz schist
109.50m to 120.20m	- Greenstone
120.20m to 146.20m	- Magnetite-quartz schist
146.20m to 148.10m	- Greenstone
148.10m to 200.00m	- Magnetite-quartz schist
200.00m to 204.80m	- Greenstone
204.80m to 218.20m	- Black schist

TOTAL DEPTH: 218.20 Meters

STATUS: Hole complete

CORE RECOVERY: 100%

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