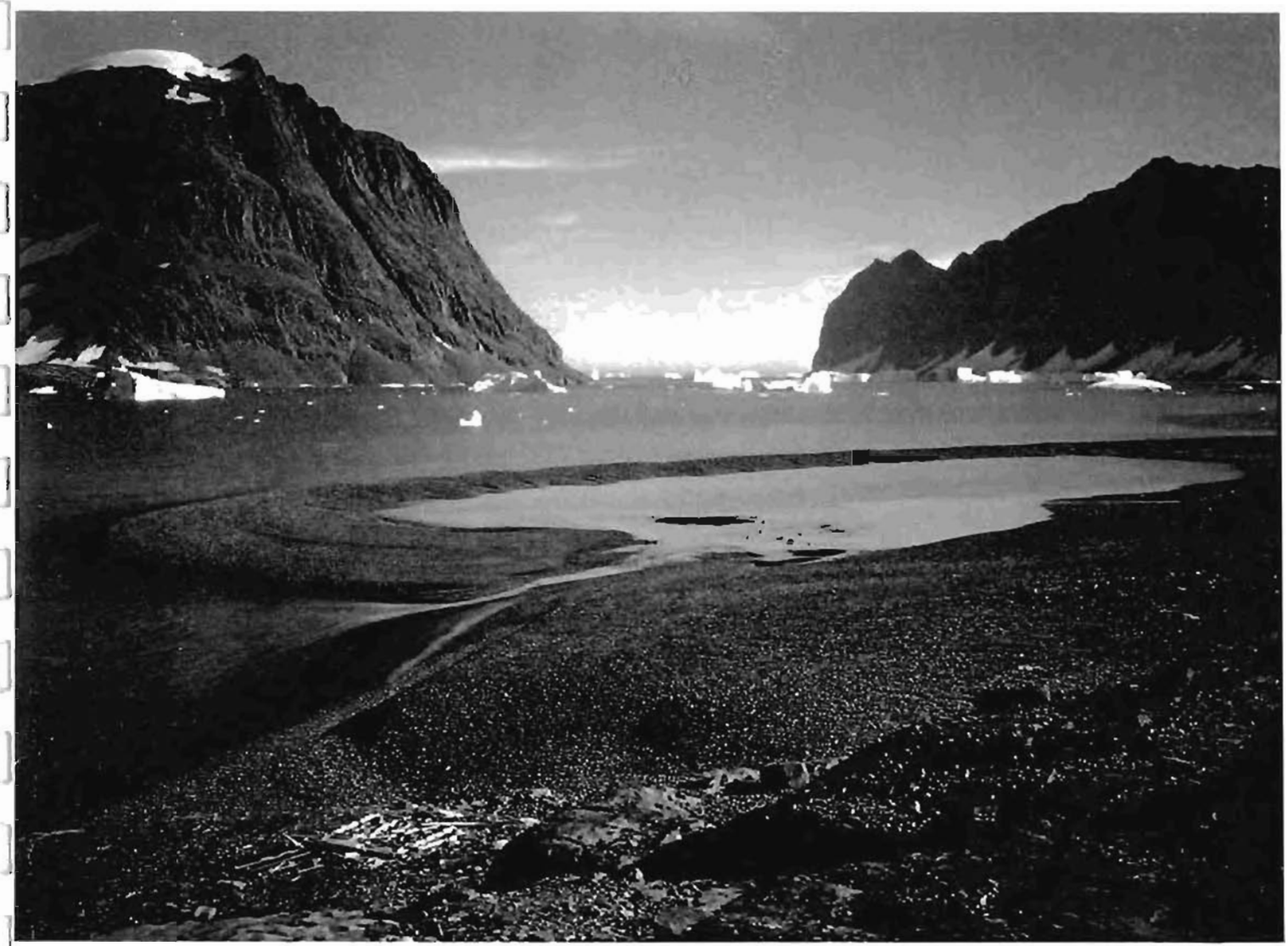
RECONNAISSANCE 1990

The Platinova-Corona Concession Area

Kangerlussuaq / Skærgården, East Greenland



Greenland Environmental Research Institute ©
Greenland Field Investigations

December 1990

PUBLICATION TYPE:	Report, GFU/RRV 90-10
PUBLICATION DATE:	December 1990
TITLE:	Reconnaissance 1990. The Platinova - Corona Concession Area Kangerlussuaq/Skærgården, East Greenland
AUTHORS:	Hans Christian Langager/GFI and Marie-Louise Lemgart/GERI
SEARCH KEY:	Kangerlussuaq, Skærgården, tailings disposal, infrastructure
CONTENTS:	Extent and results of field reconnaissance in the Kangerlussuaq/Skærgården area August 1990 petaining to physical and environmental conditions, in preparation for activities connected with exploitation of minerals - notably longterm disposal of waste rock and tailings.
STATUS:	Internal - may only be handed out after previous arrangement with the Mineral Resources Administration for Greenland.
ISBN/ISSN:	
INSTITUTION:	Greenland Field Investigations/ Misissueqqaarnerit Surveys and Resources Rosenvængets Alle 16 DK - 2100 Copenhagen Ø Telephone: +45 31 38 30 55 Telefax: +45 35 43 08 30
FILE NO.:	

RECONNAISSANCE 1990

The Platinova - Corona Concession Area

Kangerlussuaq/Skærgården, East Greenland

Greenland Environmental Research Institute

Greenland Field Investigations

December 1990

CONTENTS

Page:

RESUME 4

PINGAARNERSIORLUGU NAALISAGAQ 6

SUMMARY 8

1. INTRODUCTION 10

2. FIELD WORK 1990 15

3. DESCRIPTION OF THE AREA 17

3.1 Topography 17
3.2 Climate 18
3.3 Hydrology 21
3.4 Wildlife and vegetation 22
3.5 Navigation and transportation 23
3.6 Activities in the area 23

4. LONG-TERM DISPOSAL OF WASTE ROCK AND TAILINGS .. 24

4.1 1990 field reconnaissance for disposal in the area 24
4.2 Sødalen 26
4.3 Miki's Fjord 28
4.4 Vandfaldsdalen 30
4.5 Uttental Sund 33
4.6 Others 37

5. ENVIRONMENTAL EVALUATION OF THE RECONNOITRED DISPOSAL POSSIBILITIES 39

5.1 Introduction 39
5.2 Sødalen 40
5.3 Vandfaldsdalen 41
5.4 Uttental Sund 42
5.5 Miki's Fjord 42
5.6 Conclusions 43

6. INFRASTRUCTURE 44

6.1 Sødalen 44
6.2 Miki's Fjord 46
6.3 Skærgården 47

7. ENVIRONMENTAL EVALUATION OF THE RECONNOITRED INFRASTRUCTURE POSSIBILITIES 48

8. RECOMMENDATIONS 49

9. REFERENCES 50

FIGURE INDEX

Page:

Figure 1: Layout map, 1: 5.000.000 11

Figure 2: Sun up and down, Miki's Hus 14

Figure 3: Air temperature - Ammassalik - Aputiteq - Kap Tobin, 1921-1978 19

Figure 4: Annual precipitation Ammassalik - Aputiteq - Kap Tobin, 1971-1978 19

Figure 5: Monthly precipitation Aputiteq, 1971 -1978 20

Figure 6: Area/volume, Sødalen 27

Figure 7: Area/volume, Miki's Fjord 29

Figure 8: Topographical sections, Vandfaldsdalen 31

Figure 9: Area/volume, Vandfaldsdalen 32

Figure 10: Area/volume, Uttental Sund 36

SUPPLEMENTS

I: Location map, 1:250.000

II: Field work 1990, 1:50.000

III: Sødalen, 1:27.000

IV: Miki's Fjord, 1:27.000

V: Vandfaldsdalen, 1:27.000

VI: Miki's Hus, 1:27.000

VII: Skærgården, 1:27.000

VIII: Uttental Sund - north, 1:27.000

IX: Soundings in Miki's Fjord, 1:20.000

X: Uttental Sund, 1:20.000

Cover photo: Miki's Hus/Miki's Fjord against SSE - 16. august 1990

RESUME

I Skærgårds området ved Kangerlussuaq fjorden, midtvejs mellem Ammassalik og Ittoqqortoormiit på Grønlands østkyst, har der siden 1986 været udført efterforskning efter guld og platingruppe elementer.

Efterforskningen udføres af selskaberne Platinova Resources Ltd. og Corona Corporation, der oppebærer dels en forundersøgelses tilladelse mellem 66 og 69°N og dels to eksklusive koncessioner omkring Kap Edvard Holm og Skærgården.

Efterforskningen har hidtil været mest knyttet til Skærgården, hvor indsatsen løbende er intensiveret. I 1990 er boret godt 13.600 meter kerne op.

Den vedholdende og stigende interesse for Skærgårds områdets mineral potentiale har øget behovet for kendskab til de fysiske og miljømæssige forhold i området med henblik på en eventuelt kommende mineralvirksomhed.

Der blev derfor gennemført en indledende rekognoscering i området i perioden 7. - 21. august 1990. Rekognosceringen blev udført af Grønlands Forundersøgelser og Grønlands Miljøundersøgelser på vegne af Råstofforvaltningen for Grønland. Feltarbejdet omfattede dels rekognoscering til fods og dels pejling i Miki's Fjord med gummibåd og skib, og målet var især rettet mod en indledende identifikation af lokaliteter for langtids deponering af affald fra en mineralvirksomhed og for placering af infrastruktur anlæg under en udvindingsfase.

I rapporten beskrives rekognosceringen og de gjorte observationer samt en miljømæssig vurdering af de foreløbigt udpegede muligheder. Det fremgår bl.a heraf, at terrestisk deponering på en af disse lokaliteter, ved udvinding af den totalt forudsatte malmtonnage, vil medføre opdæmningshøjder mellem 50 og 100 meter. Marin deponering uden foranstaltninger, der afskærer deponeringsområdet fra omgivende havområder, vurderes miljømæssigt generelt som ikke attraktivt, og en inddæmning vil være forbundet med store og vanskelige anlægsarbejder på vand.

Udfra de på nuværende tidspunkt opstillede forudsætninger om eventuelle mineaktiviteter og den eksisterende viden vedrørende miljøforhold i området vurderes det, at der bør arbejdes videre med deponeringsmulighederne i Vandfaldsdalen og Uttental Sund. Denne vurdering skal på ingen måde ses som et udtryk for en fast stillingtagen og det vil være nødvendigt med en lang række undersøgelser inden den mest hensigtsmæssige deponeringslokalitet kan udpeges.

Koncessionshaverens indsats er koncentreret om geologisk påvisning af en brydeværdig forekomst, mens konkrete koncepter for etablering af en virksomhed ikke på nuværende tidspunkt er præsenteret. På denne baggrund havde rekognosceringen en overordnet regional karakter - og det videre arbejde, indtil koncessionshaveren præsenterer stedfæstede planer og sikrere størrelser på tonnager, bør rettes mod den generelle viden om klimatiske-, topografiske-, besejlings- og miljømæssige forhold i området. Detaljerede undersøgelser på enkelt lokaliteter bør udføres parallelt med koncessionshaverens konkrete planer.

PINGAARNERSIORLUGU NAALISAGAQ

Tunumi Kangerlussuup eqqaani qeqertani, Ammassallup Ittoqqortoormiillu akornanniittuni, 1986-miilli gultimik platinimillu ujarlerneqarpoq.

Ujarlerneq aatsitassarsioqatigiinnit Platinova Resources Ltd. aamma Corona Corporation-imit ingerlanneqarpoq, ilaatigut 66 aamma 69°N akornanni misissuinissamut akuerineqarsimasunit aammalu Kap Edvard Holm-imi qeqertanilu kisimik aatsitassarsiornissamut marlunnik akuersissuteqarfigineqarsimasunit.

Manna tikillugu qeqertat ujarlerfigineqarnerusimapput, ujarlernerlu annertusiartortinneqarsimalluni. 1990-mi ujarak 13.600 meterit sinnerlugit takissusilik qillerinikkut qaqinneqarpoq.

Atasuinnarmik qeqertani aatsitassaasinnaasut soqutigineqaleriartuinnarnerisigut, aatsitassarsiorfeqalersinnaanissaq eqqarsaatigalugu, nunap tamatuma pissusia avatangiisillu paaserusunneqaleraluttuinnarput.

Taamaattumik 7. - 21. august 1990-mi aallarnersaataasumik tamaani angalaarluni misissuineqarsimavoq. Kalaallit Nunaanni Aatsitassarsiornermut pisortaqarfik sinnerlugu tamaani angalaarlutik misissuisimallutik Kalaallit Nunaanni piareersaataasumik Misissuiffik aammalu Kalaallit Nunaanni avatangiisinik Misissuiffik. Suliassat ingerlanneqarsimapput ilaatigut pisuinnarluni angalaarnikkut ilaatigullu angallammik umiatsiamillu gummiusumik angallateqarluni Mikip Kangerluani itissusersiuilluni uuttortaanikkut, pingaartumik siunertaralugu nunap tamatuma aatsitassarsiorfiup perlukuinik sivisuumik uninngasussanik ilioqqaaviusinnaanerata paasilluarneqarnissaa aammalu aatsitassarsiornerup nalaani sukkut umiarsualiviliortoqarsinnaanera, aqqusinniortoqarsinnaanera il.il. paasiniarneqarsimalluni.

Nalunaarummi allaatigineqarput misissuilluni angalaarneq paasisallu aammalu periarfissaagallartutut uparuarneqartut avatangiisaasa qanoq issusersiorneqarnerat. Tassani ilaatigut allassimavoq, aatsitassap angissutsimigut missingerneqartup tamakkerluni piiarneqarnissaanut, tamaani nuna perlukunut ilioqqaavissaq 50 100 meterillu akornanni portussusilimmik qarmarneqartariaqartoq. Immanit avatangiisunit perlukoorfissaq immikkoortillugu qanoq iliuuseqarani imaanut perlukoornissaq, tamanut tunngatillugu avatangiisit tungaasigut kajungernassuseqanngitsutut oqaatigineqarpoq, imaanilu sapusiorluni sanaartornissaq ajornakusoortorujussuussaalluni.

Aatsitassamik piiaasinnaanermik aammalu tamaani avatangiisit pillugit maannakkut ilisimariikkat tunngavigalugit isumaqartoqarpoq, Qorlortorsuup qooruani Uttental Sund-imilu perlukunut ilioqqaavissaasinnaasumik ujarlerneq ingerlatiinnarneqassasoq. Taamatut isumaqarneq taanna aalajangernertut isumaqarfigineqassanngilluinnarpoq perlukunullu ilioraavissaq naleqquttoq nassarineqartinnagu, arlaleriarujussuarluni misissuinissaq pisariaqassaaq.

Akuersissummik pigisallip suliarinerusimavaa nunap sananeqaataasigut aatsitassamik piiaannarissamik paasiniaaneq, suliffiliaasinnaasumilli maannakkut erseqqissumik saqqummiussaqartoqarsimanngilaq. Tamanna tunngavigalugu nunap immikkoortuata pissusia pingaarnerutillugu angalaarluni misissuineqarsimavoq - suliassarlu ingerlaqqissappat, akuersissummik pigisallip pilersaarutivimmik saqqummiussinissaata aatsitassallu angissusiata qularnaallineqarnissaata tungaannut, tamaani silap pissusia, nunap ilusia, avatangiisit umiartorfiginegarsinnaaneralu paaseqqaartariaqassapput. Nunap immikkoortuini ataasiakkaani akuersissummik pigisallip pilersaarutivii malillugit misissueqqissaarneqarumaarpoq.

SUMMARY

In the Skærgård area at the Kangerlussuaq fiord halfway between Ammassalik and Ittoqqortoormiit on the east coast of Greenland, exploration for gold and platinum group elements has been carried out since 1986.

This exploration is carried out by the joint venture of Platinova Resources Ltd. and Corona Corporation who are in possession of partly a prospecting licence for the area between 66 and 69øN and partly two exclusive concessions for the area near Kap Edvard Holm and Skærgården.

So far, the exploration has primarily been confined to Skærgården where the activities have constantly been intensified. In 1990 more than 13,600 m core has been drilled.

The continuous and growing interest in the Skærgård area's potential mineral resources has increased the need for knowledge of the physical and environmental conditions in the area with reference to possible future mining activities.

A preliminary reconnaissance was therefore carried out in the area in the period 7 - 21 August 1990. This reconnaissance was accomplished by Greenland Field Investigations and Greenland Environmental Research Institute on behalf of Mineral Resources Administration for Greenland. The field work comprised partly reconnaissance on foot, partly soundings in Miki's Fjord from a rubber dinghy and ship, and the aim of it was above all an initial identification of localities for long-term disposal of waste materials from mining activities and of a suitable location for the required infrastructure during the exploitation stage.

Described in the report are the reconnaissance and the observations made, along with an environmental evaluation of the possibilities singled out thus far. It appears from the report, among other things, that terrestrial disposal at one of these localities, if the totally estimated tonnage of ore is exploited, will result in damming heights of between 50 and 100 metres. From the environmental point of view, marine disposal without any measures for cutting off the disposal site from the surrounding sea territory are generally considered less attractive, and damming work at sea would involve extensive and difficult construction projects.

Based on the assumptions set up at the present time regarding possible mining activities and on the existing knowledge of the environmental conditions in the area, it is considered that the search for suitable disposal sites in Vandfaldsdalen and Uttental Sund should be continued. This view should in no way be seen as an expression of a fixed position, and a large number of investigations will be required, before the most suitable disposal locality can be singled out.

The concessionaire's work is concentrated on the geological presence of an economic deposit, whereas concrete concepts for the establishment of a mining activity have not as yet been presented. In view of this, the reconnaissance was of a general regional character - and the continued efforts, until the concessionaire comes up with localized plans and more reliable tonnage indications, should be aimed at the general knowledge of climatic, topographical, navigational and environmental conditions in the area. Detailed investigations at each of the localities should be carried out in parallel with the concessionaire's concrete plans.

1. INTRODUCTION

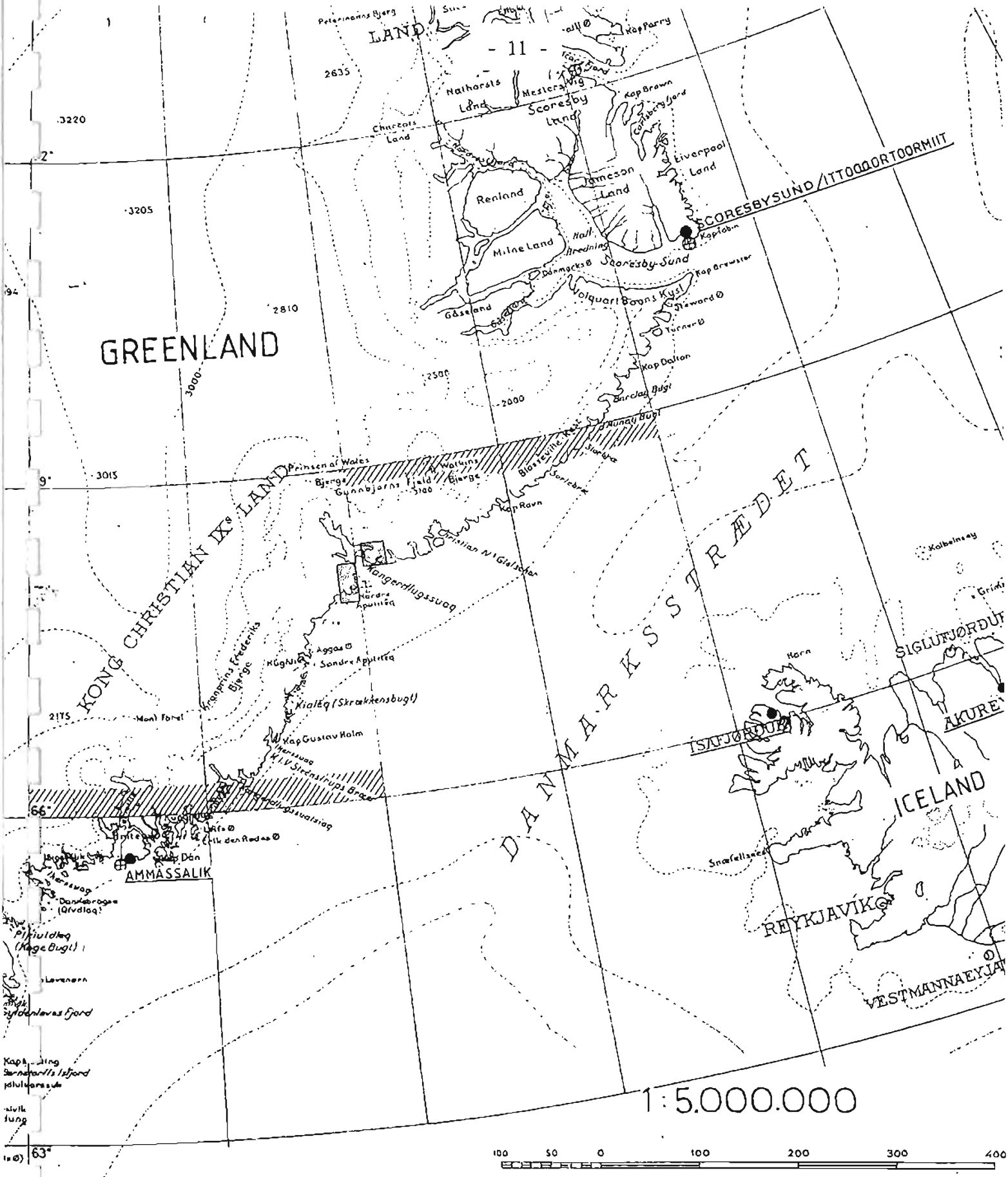
In this report a description is given of the field work and results of a reconnaissance in an area named Skærgården on Greenland's east coast, halfway between Ammassalik and Ittoqqortoormiit. This reconnaissance was carried out on behalf of the Mineral Resources Administration for Greenland by Hans Chr. Langager, Civil Engineer/Greenland Field Investigations, and Marie-Louise Lemgart, Civil Engineer/Greenland Environmental Research Institute.

The aim for this reconnaissance was to carry out a preliminary description of the natural physical and environmental conditions in this extended geographical area to establish the basis for a rational technical and environmental handling of the case. With the reconnaissance at this stage of exploration it is the intention to gain influence on especially the location of longterm disposal of tailings, the presence of which in the surrounding environment is of far greater extent than that of a producing mineral activity.

The background for launching a preliminary technical and environmental reconnaissance in this area is exploration activity, notably for gold and platinum group elements. This exploration was started in 1986, but has been intensified in 1990 by means of an extensive drilling programme with a total core length of just over 13,600 m.

Shown in figure 1 and supplement I are the area and the rights granted to the companies Platinova Resources Ltd. and Corona Corporation. The rights comprise a prospecting licence for the area between 66° and 69°N and two exploration concessions for Skærgården and Kap Edvard Holm, respectively. These rights cover any mineral with the exception of hydro carbons and radioactive elements and are at the present time valid until the end of 1991.

As the exploration activities so far have almost exclusively concentrated on the Skærgård concession, the technical/environmental reconnaissance in 1990 was limited to this area.



LEGEND:

69° 66° Prospecting Licence

Exploration Concession

Dybdekurver ..... Sea-contours

..... 100 meter

----- 200 "

- - - - 1000 "

Figure 1

The concessionaire's exploratory interest continues to be based on the geological prospects of economically viable deposits. The plans for location and design of technical plants are therefore completely open, and they will very much depend on the results of the ore-geological studies. The reconnaissance in 1990 should be seen in the light of this and the initial evaluations must be followed up at all times, and details have to be worked out by means of proper investigations at the same time as the concessionaire's concrete plans are being presented.

In addition to the concessionaire's camps, a hunters camp is shown in supplement I which from time to time is inhabited by hunters from Ammassalik. The hunters are responsible for the only local exploitation of the area at present.

- o -

The advance knowledge of the conditions in the Skærgård area is summed up in the following beginning with a survey of existing maps, aerial photos and meteorological registrations.

Maps:

Covering	Year	Scale	Contour interval	Note
The area	1933	1:250.000	50 m	(1)
Skærgården	1975	1: 20.000	12 1/2 m	(5)
Mikis Fjord	1979	1: 21.000	50 m	(7)
Mikis Fjord	1981	1: 40.500	50 m	(9)
The area	1988	1:500.000	200 m	(10)
Skærgården	1989	1: 20.000	100 m	(14)

Aerial photos:

Covering	Year	Scale	Notes
Section	1943	1: 40.000	
Section	1969	1: 26.000	Aerokort
Section	1972	1: 50.000	
The area	1973	1: 27.000	Colour, (4)
The area	1981	1:150.000	GI
The area	1987	1:150.000	GI

Meteorological observations:

Place	Period	Parameters	Notes
Skærgården	1945-47	Wind speed/ directions, atm. press., air temp., precipitation	Difficult of access - not with MI.
Aputiteq	1949-58	Wind speed/ directions, atm. press., air temp., RH, precipitation	Difficult of access - not with MI.
Aputiteq	1958-79	Wind speed/ directions, atm. press. air temp., RH, precipitation	Manned station - 3-hour intervals. With MI.
Aputiteq	1979-	Wind speed/ directions, atm. press., air temp., RH.	Aut. station - 3-hour intervals. With MI, possibly 6-month "gap" in 1979.

As the area is a widely well-known geological locality there is an abundance of literature on the scientific geological exploration of the intrusion carried out since 1930.

In 1989 a few observations were made in the area by Greenland Environmental Research Institute, cf. (13).

Shown in figure 2 is the sunrise and sunset during the year based on the geographical location on the geoid. Chosen as locality is Mikis House, centrally situated in the Skærgård concession area, and local topographical conditions have not been considered.

The marine limit is presumed to lie 25-50 metres above the present sea level.

It must be expected that permanently frozen zones will be encountered everywhere in the area. The extent of the coherent permafrost will however depend on exposition and topography.

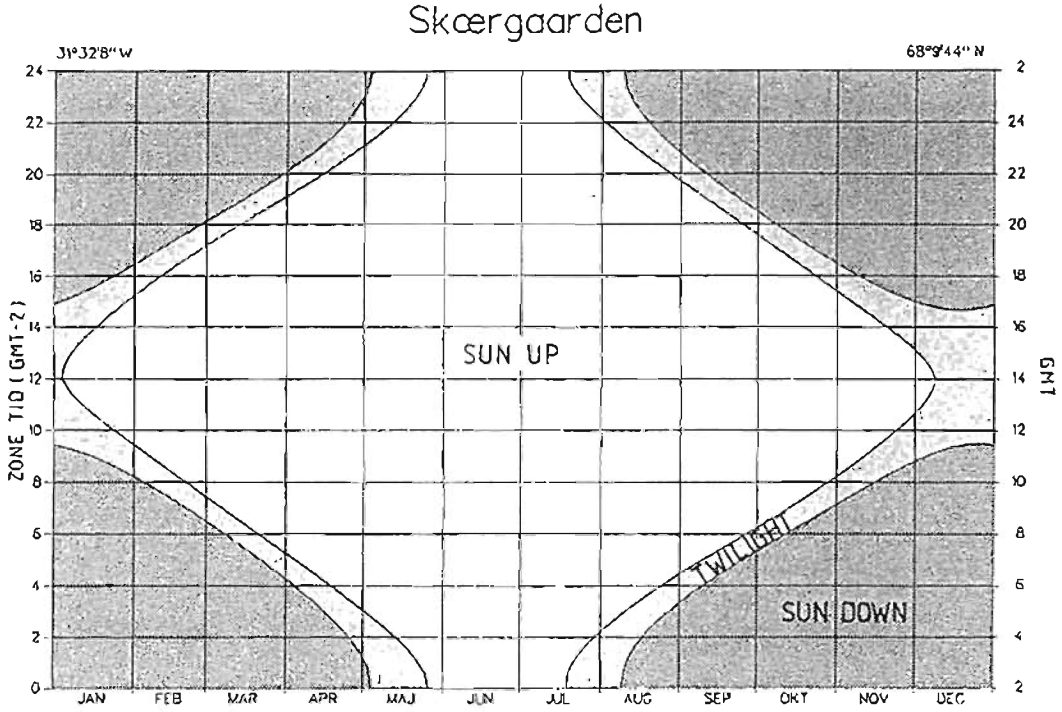


Figure 2

The time zone in the area is GMT-2, but for practical reasons the concessionaire uses GMT.

- o -

The report has been prepared by Hans Chr. Langager/GFU and Marie-Louise Lemgart/GM. Greenland Field Investigations have been responsible for the implementation and description of the reconnaissance, while Greenland Environmental Research Institute has been in charge of the environmental descriptions and evaluations contained in chapter 3 and chapters 5 and 7, respectively.

2. FIELD WORK 1990

Based on advance information from Bob Gannicott-/Platinova and an on-the-spot briefing by Tom Corbett/Site Manager about earlier and on-going exploration activities, the area was reconnoitred to establish the physical and environmental conditions in preparation for the establishment of an infrastructure and long-term disposal sites for the expected mining activities.

Prospective localities for infrastructure construction have been reconnoitred in order to determine areas/distances, exposure, accessibility, extent of terrain/blasting operations, soil conditions, water supply, etc.

Possible disposal sites have been reconnoitred with a view to establishing areas/volumes, drainage conditions, topography, damming possibilities, the existing biological environment, and the access to the area.

With the three field camps as point of departure, reconnaissance on foot and soundings from rubber dinghy and ship have been carried out in the area from 7 to 21 August 1990.

The transport to and from the area took place by a TwinOtter/DASH-6 plane from Akureyri/Iceland to the Sødalen Base Camp - whereas local camp moves etc. were accomplished with an AS 350-B1 helicopter. The planned support from the concessionaire and from Greenland Environmental Research Institute was given to the full extent, and no days were wasted due to weather conditions.

In supplement II the location of the field camps and the reconnoitred areas is shown.

The results are shown in supplements II-VIII. The stated water discharges in the field are estimated, as the volumes and the streams rendered proper measurements with propellers difficult. The values are therefore mostly an expression of the comparative amounts, while the uncertainty is greater when it comes to absolute figures. As water flows depend on both temperature (melting) and the actual precipitation occurrences (short response time), there is in addition to the seasonal variations a not inconsiderable variation within a 24-hour day-and-night period.

In preparation for a possible exploitation of the area near the estuary of Vandfaldsdalen, soundings have been made with a recording echo sounder from a rubber dinghy on 15 August. The sounding equipment was calibrated with a plumb bob down to 11 metres, and the positions have been based on natural fixpoints. The sounding was carried out at falling water in the course of a four-hour period symmetrical around the expected mean water. As the depth figures are not adjusted to the unknown mean water level a later determination of this level may result in adjustment of the depths in the order of magnitude 0-±1/2 m. The seabed is very smooth with silt as the predominant component, but sand and gravel is found at low depths near land. The result of the sounding is shown in supplement IX.

In connection with Greenland Environmental Research Institute's marine biological programme in the area, the investigation ship "Adolf Jensen" was used for sounding of Miki's Fjord. The aim was to identify any thresholds and to get an impression of the depths in order to establish the volumes. The soundings were fitted into GM's current programme and hampered by icebergs, and the work consequently stretched over the days 14, 16 and 18 August. Some of the sounding lines have been entered in supplement IV while the resulting depth curves are shown in supplement IX.

As it will be seen, no proper thresholds have been found and this is corroborated by the hydrographical profile measurements made by GM. The depths decrease evenly towards the head of Miki's Fjord, only interrupted by (presumably) morainal ridges that protrude across the fiord from both north and south. Glaciers are observed to the south of the fiord (north-exposed), whereas on the north side they have melted (receded) from the fiord environment. Seabed samples collected by GM from 120 - 200 m depth consisted of fine matter, mainly silt.

During the sounding it was found that the tidal movement in Miki's Fjord was very irregular, as variations of upwards of 3-4 m seemed to appear, rather then the expected 1-2 m. This may be due to stowage, resonance, etc.. When read in the same time zone the tide in Kangerlussuaq appeared to be approx. 1 1/4 hour ahead of the tide in Ammassalik.

If the indications of time from the Ammassalik tide table (GMT-3) are to be used directly in the Kangerlussuaq area (GMT) a delay of approx. 2 hours would seem to appear.

In connection with the transport from Skærgården to Miki's Fjord, depths were read along a single line out through Skærgårdsbugten. The depths are shown in supplement X.

3. DESCRIPTION OF THE AREA

3.1 Topography

The area between Skærgården and Sødalen is of alpine nature with several steep mountains reaching up more than 1000 m above sea level and local glaciers where nunataks loom high above the ice. The highest peaks are Wagers Top and Gabbro Fjeld, situated 1280 m and 1267 m above sea level, respectively.

About 40 per cent of the area delimited by Uttental Sund, Kangerlussuaq, Watkins Fjord, Miki's Fjord and Sødalen is covered by glaciers.

On account of the steep mountains, most of which slope down to sea level, and the intervening glaciers, the area is difficult to negotiate. Exceptions are the Skærgårdshalvø area just south of Forbindelsesgletscher, Vandfaldsdalen and Sødalen down to Miki's Fjord.

The only ice-free valley areas are Sødalen and Vandfaldsdalen.

Sødalen is a relatively wide and flat area, where the bowl-shaped valley from Sø 91 and some 2 km to the south is covered with gravel and small stones. Both straight south and straight north of the lake there are major morainic deposits.

Vandfaldsdalen is 500 - 600 m wide, 3.5 km long, and the bottom of this valley slopes more than Sødalen. In the lower areas of it there are fluvial deposits, primarily with sand. The same applies to the areas where the larger tributary streams join the main stream. In the uppermost reaches of the valley there are extensive morainic deposits.

Other major morainic areas are found in continuation of the Basisgletscher, Forbindelsesgletscher and Dobbeltgletscheren.

Shown in figure 8 is a topographical section from Miki's Fjord up through Vandfaldsdalen to the glacier, as well as a cross section of the valley.

3.2 Climate

Through the many expeditions to the area, the Kangerlussuaq region above all has become known for its extreme winds and the very varying weather conditions from one place to the other. A proper registration of the meteorological conditions has only been performed in the period 1945-47 when there was a weather station on Skærgårdshalvø. On the Aputiteq island some 40 km to the southwest, the climatic conditions have however been registered by a manned station in the period 1958-1979.

At the present time it is expected that data from Aputiteq give the best impression of the climatic conditions in the Skærgård area. It should however be remembered that Aputiteq is right on the coast, whereas the Skærgård area is situated some 10 km up the Kangerlussuaq, and that the climatic conditions in here are presumably of a more continental nature.

Data covering the period 1921-1978 from Aputiteq are shown in figures 3 and 4 together with data from Ammassalik about 350 km to the southwest and from Kap Tobin about 400 km to the northeast.

The annual mean temperature at Aputiteq is -5°C or so, with max. temperatures in summer of approx. +15°C and winter temperatures down to -30 to -35°C. The annual mean precipitation over eight years is roughly 800 mm.

Shown in figure 5 are the precipitation and the mean temperature at Aputiteq from the period 1971-78, distributed on the months of the year. It appears that the precipitation is greatest in June and in August and September, and that all three months have a positive mean temperature. It should however be noted that there is a considerable standard deviation of the precipitation during all months.

Based on the temperature it is evaluated that some 500 mm of the yearly precipitation (63%) is in the form of snow.

The very powerful wind "Piteraq", described from the Kangerlussuaq area, is a wind which blows from the Inland ice, reaching some 100-200 km out into Denmark Strait. Velocities between 80 and 90 knots are not uncommon in connection with simultaneous low-pressure passages.

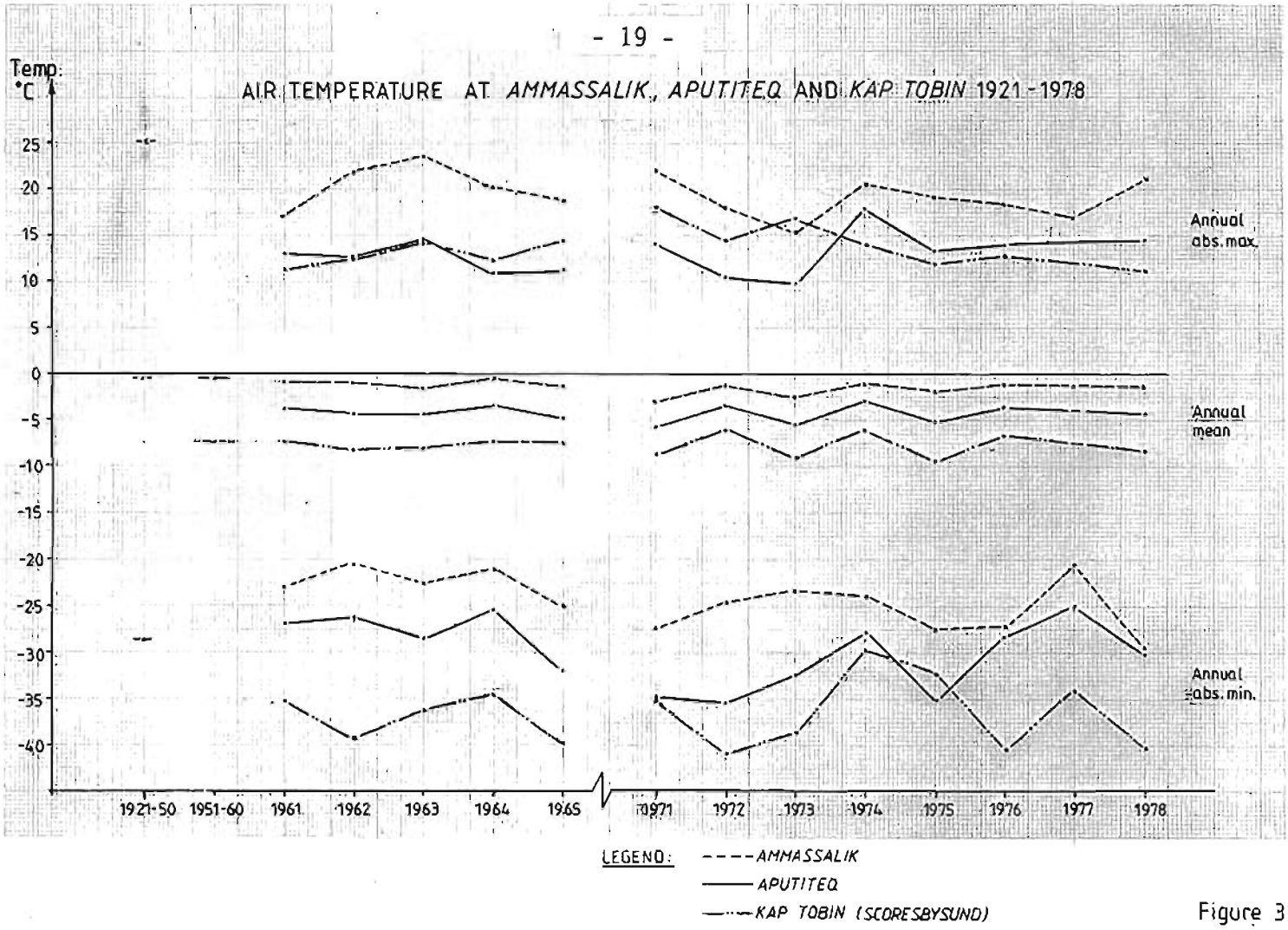


Figure 3

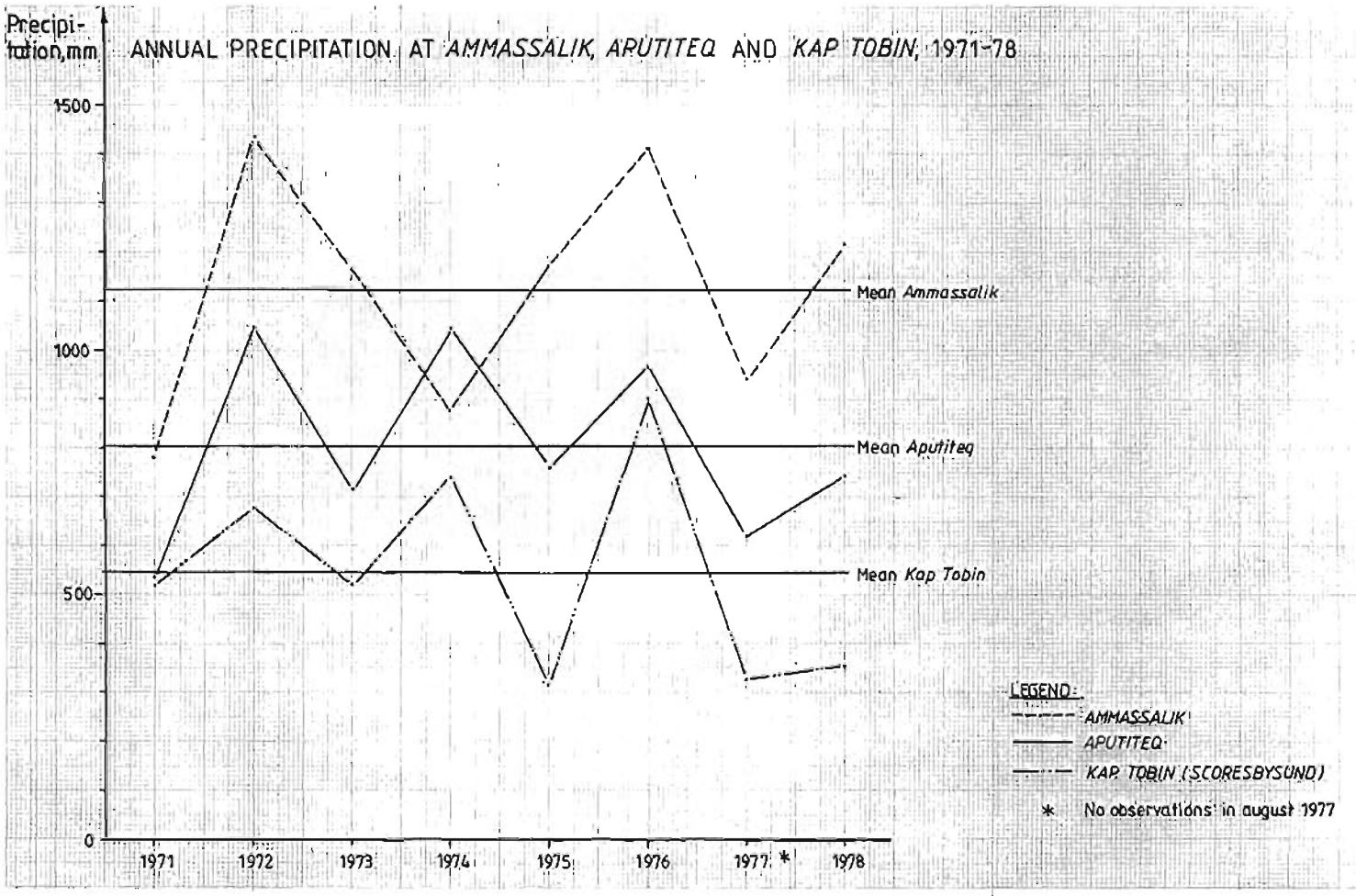


Figure 4

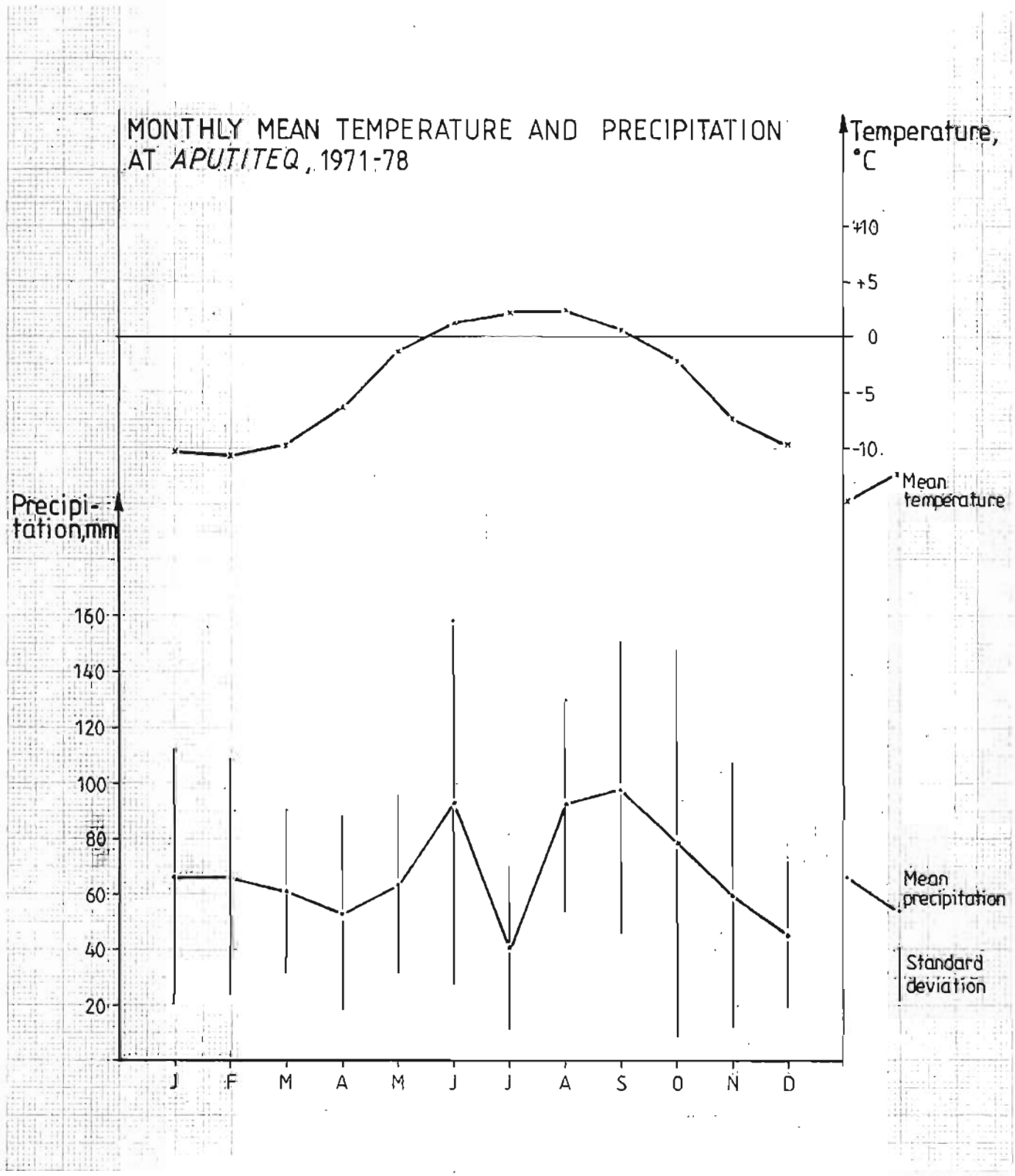

MONTHLY MEAN TEMPERATURE AND PRECIPITATION AT APUTITEQ, 1971-78
Temperature, °C
+10
+5
0
-5
-10
Mean temperature
Precipi-tation, mm
160
140
120
100
80
60
40
20
Mean precipitation
Standard deviation
J
F
M
A
M
J
J
A
S
O
N
D

Figure 5

To obtain a more accurate picture of the climatic conditions in the Skærgård area, which is of great importance for an evaluation of technical and environmental aspects in connection with mining, it will be necessary to establish weather stations in the region.

3.3 Hydrology

In the Skærgården-Sødalen area about 40% of the territory is covered with glaciers, most of which are in direct communication with Kangerlussuaq, Watkins Fjord, Uttental Sund or Miki's Fjord. Certain lesser mountain glaciers have their run-off down steep mountain slopes, while only a small part of the glaciers' ablation reaches the large streams.

There are three largish lakes in the area, all of them measuring about 1 square km. One of the lakes is drained through Sødalen to Miki's Fjord, while the other two icy lakes, "Issøerne", flow in the direction of Watkins Fjord.

Sødalen and Vandfaldsdalen are the only major icefree low-lying areas.

Vandfaldsdalen has a hydrological catchment area of 20 square km, about one quarter of which is covered with glaciers, primarily in the catchment area's northeastern and northwestern parts.

Based on precipitation measurements at Aputiteq which have been corrected for the more "continental" location of the area, and where an evaporation of approx. 10% has been taken into account, the annual run-off from the catchment area is estimated at approx. 14 million cubic metres. This figure should be considered as a very general estimate which is subject to a great deal of uncertainty. The balance of the glaciers has not been considered, for example, which is of great importance for the run-off in the area.

In connection with the reconnaissances made, the water volume in Vandfaldselven and tributaries was estimated at a few points (cf. supplement V).

These values indicate that there is a not inconsiderable run-off below ground.

If Vandfaldsdalen should turn out to become one of the alternative places for disposal of tailings, measures must be taken to prevent that large volumes of water come into contact with the disposal site. In order to take the most appropriate steps and to evaluate the spread of pollutants it is therefore vitally important to map out the hydrological conditions. To achieve this, it will be necessary to register such parameters as precipitation, run-off, temperatures and glacier balances in a number of years.

3.4 Wildlife and vegetation

Animal life ashore is not very abundant, and there are only two terrestrial mammals, the polar bear and the polar fox (11). Nine species of birds have been identified as breeding in the Kangerlussuaq region (11), of which the redpoll, the snow bunting and the grouse are the only ones who depend entirely on food from dry land. Also lower animals on land are but sparsely represented. Pink-footed geese were observed at the head of Miki's Fjord.

In connection with GM's background studies of the marine environment in the area, net fishing was carried out where Vandfaldselven flows into Miki's Fjord. Three migrating 30-45 cm long arctic chars were caught here. The stream though has not been studied very closely, so it is not possible to say anything about the size of a potential population at this moment. As there is a waterfall some 500 m from the mouth of the stream which the chars probably do not negotiate, a potential population is not considered to constitute a fishing resource.

The marine life is far more abundant than the life on land, as described in the GM 1990 report concerning the marine sampling in the area (17).

Generally speaking, the vegetation in the area is sparse and poor in species. The most luxuriant vegetation is found on the slopes near Sødalen and in Vandfaldsdalen. Reindeer moss is quite common, whereas snow moss only was observed in a few places. Among the higher plants observed were Broadleafed Willowherb (Chamaenerion latifolium), Mountain Sorrel (Oxyria digyna), Common Harebell (Campanula gieseckiana), Alpine Hawkweed (Hieracium alpinum) and others.

3.5 Navigation and transportation

The Skærgård region can only be navigated during a limited period of the year. Normally it will be possible to sail to this area in August-October in ships that have been specially strengthened for transportation in areas with ice. During the remaining part of the year the area can only be reached by air.

Air transport will normally be handled by planes, as the distance from Iceland, Ammassalik and Scoresbysund is so great that the use of helicopters must be limited to local transportation jobs in the area.

At Sødalen, where the runway is 625 m long, it is possible to land with a Twin Otter. In the winter season when there is an unbroken expanse of ice on the fiords, planes can land directly on the sea ice.

3.6 Activities in the area

Kangerlussuaq is a good spot for hunting marine mammals, and hunters and their families from Ammassalik travel the 400 km to their settlement on Skærgårdshalvø. Normally they leave Ammassalik in August/-September and remain at Skærgården for a year or so. The hunters existence is first of all based on seals, but polar bear hunting and whaling also play an important role.

The area was also used as habitation for the hunters in the distant past. Many old settlements and graves have been found, primarily in the area near the Skærgårdshalvø and Miki's Fjord (15).

Geologists have been interested in the area since the 1930'es. The interest has primarily been focused on the Skærgård intrusion. Both Danish and foreign institutions and mining companies have investigated the area.

In 1982 an airstrip was built in Sødalen.

4. LONG-TERM DISPOSAL OF WASTE ROCK AND TAILINGS

4.1 1990 field reconnaissance for disposal in the area

As mentioned in chapter 1, an essential aim of the reconnaissance at this time, where the concessionaire has not yet presented concrete plans for possible exploitation, was a preliminary evaluation of the area in preparation for disposal of waste products from mining and processing of the potentially economic ore tonnage.

As the knowledge of the ore and of the mining method is limited to the facts that identification cannot be carried out in situ and that endeavours will be made to keep overbreaking at a minimum, it is assumed that the amount of waste rock will be insignificant in relation to the processed volume. Consequently, disposal problems will hereafter only be considered to relate to tailings from processing.

During the reconnaissance, the following factors were used as basis for the evaluation of the localities' suitability as disposal sites:

- topography, in order to define volumes
- geotechnical and engineering-geological conditions with respect to damming and natural seepage below terrain
- hydrology, to establish the natural water balance
- climate, to define the impact of installations and the natural transportation of materials
- vegetation and wildlife.

In addition to the above, other factors may be of significance, e.g. the presence of relics of the past, the influence on other activities (hunting, recreation), and inherent values (aesthetic, scientific, resources that are uneconomic at this time).

With direct relation to the exploration, the following factors have been used:

- estimates and information about the potential form, location, tonnage etc. of the deposit
- distance and elevation in relation to the deposit.

As a processing method for the extraction of commercial products from the potential ore is as yet unknown, chemical aspects were disregarded during the reconnaissance.

A 2 m thick orebody with an extension of 15 sq. kilometres (2 g/t Au cut-off) and a density of 3.9 t/m3 was chosen as starting point. This will provide an in-situ tonnage of some 120 million tonnes.

With a swell factor of 65% this will correspond to app. 50 million cubic metres of mined ore with a density of roughly 2.4 t/m3.

It is estimated that extraction of concentrates will produce a loss of volume of 5-7% and a weight loss of 15%. As a result of the crushing and sorting, the swell factor for the filled-in tailings will be put at 35% in relation to the unmined ore. The quantity of solid tailings has therefore been calculated to be 38 million m3, or 100 million tonnes with a density of 2.6 t/m3. The water content of the tailings is put at 70% whereby the total amount of tailings is estimated at 335 million tonnes, or 265 million m3 with a density of 1.3. As it is expected that the main part of the water content will be recirculated, the total volume of tailings is put at 45 million m3.

In the determination of the volume required for long-term disposal, a safety margin will have to be added to the total amount of tailings. As the establishment of this margin however involves a number of factors which are not known at the present time, this evaluation will not be made here, and accordingly we are now envisaging a total volume for long-term disposal of tailings of 50 million m3 - and we remind you that this is the total disposal volume, as the amount of waste rock has been put at zero.

With a daily production of 10-15,000 tonnes, the assumed ore tonnage will be enough for 20-30 years of mining.

In connection with the evaluation of the volume capacity of the individual localities, the tailings surface is assumed to be horizontal, and in case of terrestrial disposal it is assumed that damming will be established through the successive building of gravitation embankments where tailings will be part of the building material.

Below follows a description of the localities evaluated during the reconnaissance. The environmental observations and evaluations are all gathered in chapter 5.

4.2 Sødalen

This locality is shown in supplements II and III, and an area/volume curve behind a 50 m high damming from elevation 50 to elevation 100 is depicted in figure 6.

Re the area/volume curve it should be noted that the topographical basis is very slender (50 m curves) and that Sø 91 has been included without depth. This is to be on the safe side, and later studies here may reveal an increase of the locality's potential volume. That the upper limit of the damming has been put at elevation 100 is due to the fact that the Inland ice is encountered at this level at the snout of the Sødalengletscher.

The chosen place for damming is topographically and foundationwise very suitable, with outcropping bedrock for a 50-metre dam with a final crest length of approx. 900 metres. Great quantities of natural building materials (clay/silt, sand, gravel, moraine, blocks) are present at Miki's Fjord as well as at Sødalengletscher.

Stated below are a number of factors - observed during the field reconnaissance - that among others will be included in a later evaluation of Sødalen as disposal site:

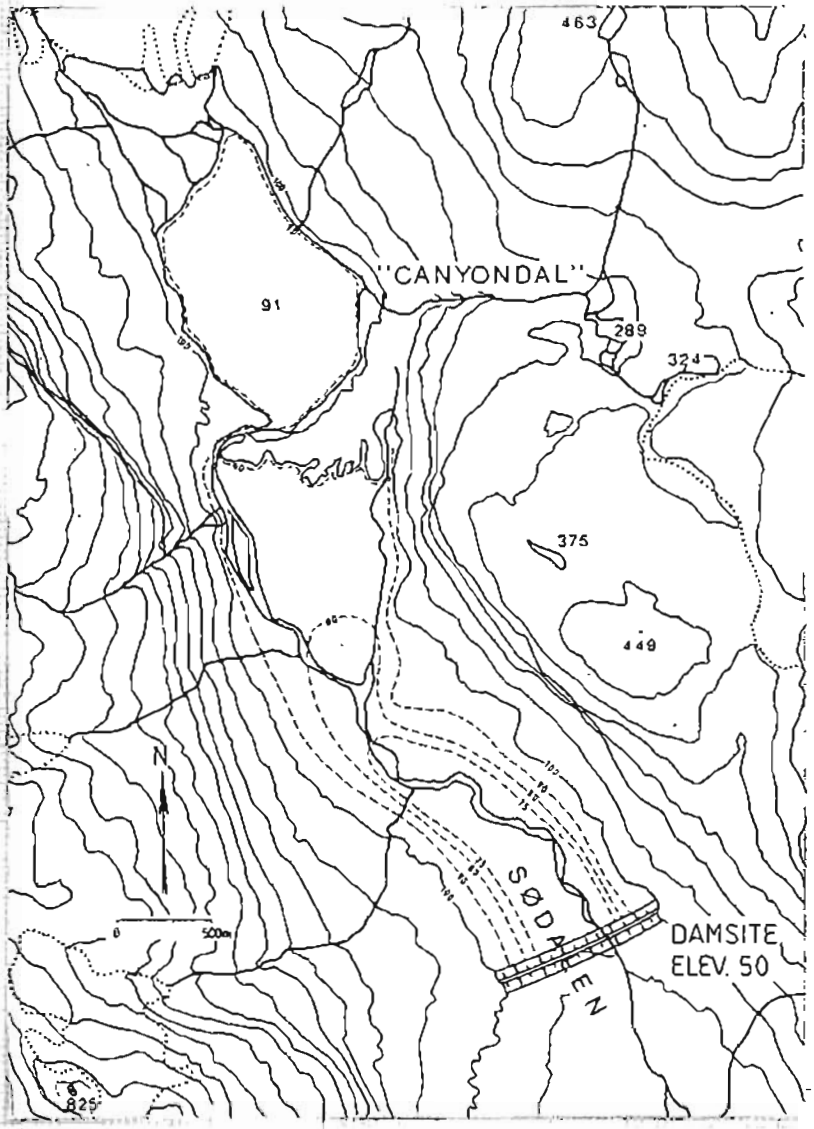
- the delimitation to the north consists of an branch of the Inland ice which for quite a long time will constitute a risk of either advanced or increased inflow of water

- the north-south going valley shape involves the risk of canalization of winds and also increased accumulation of snow

- the distance from the deposit is of the order 10-15 km under conditions which to ensure continued operation may necessitate the building of extensive tunnels

- it is expected that extensive canalization work will have to be made, to control the natural flow of water through the valley which in addition to the precipitation drains an approx. 25 sq. km. large sector of the Inland ice

- Sødalen offers a possibility of placing the future infrastructure here, as the only natural summer airstrip in the area was established here in 1982.


463
"CANYONDAL"
91
289
324
375
449
N
500m
SØDALEN
DAMSITE
ELEV. 50
825

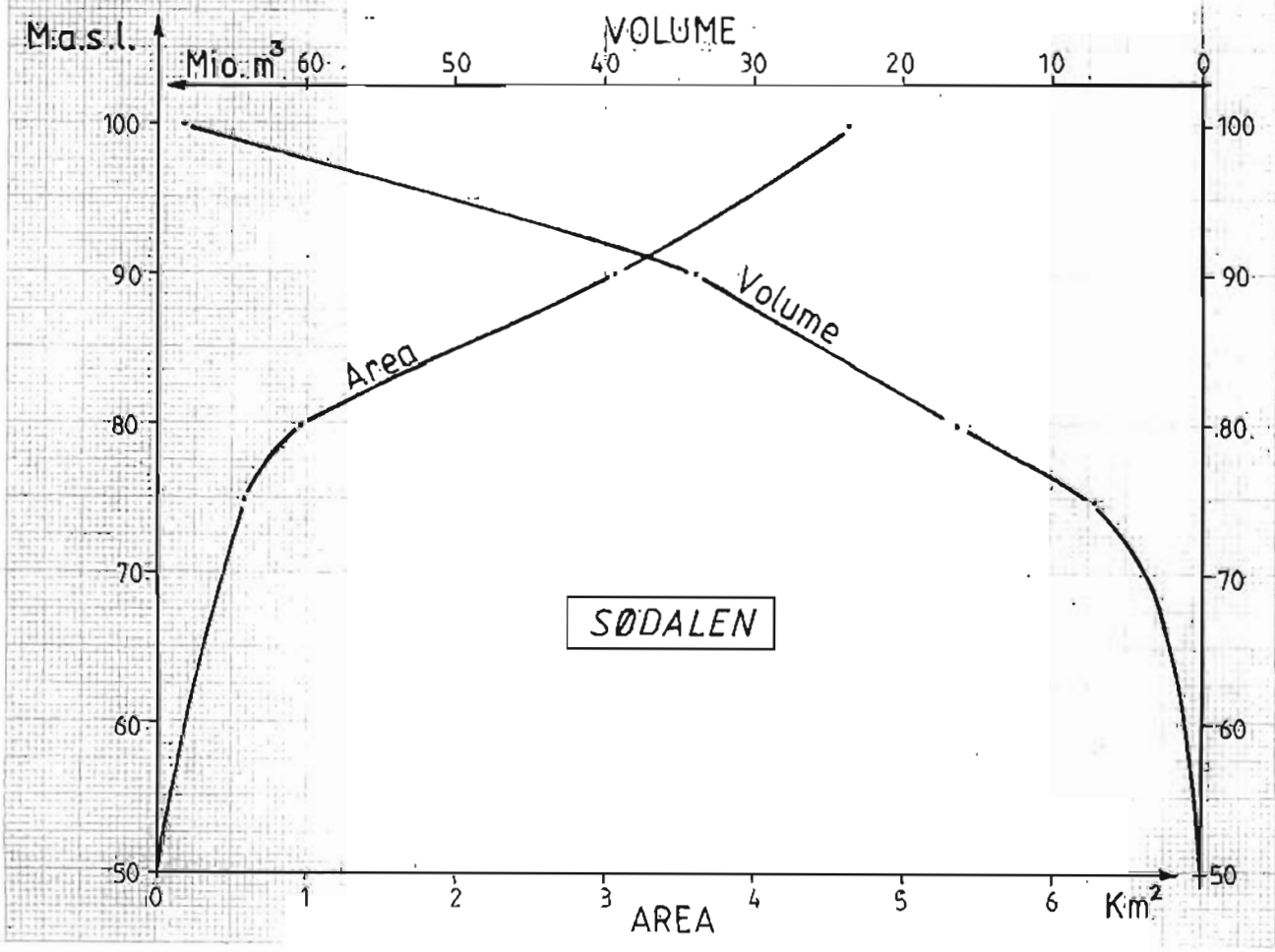

M.a.s.l.
VOLUME
Mio. m³
60
50
40
30
20
10
0
100
90
80
70
60
50
Area
Volume
SØDALEN
0
1
2
3
4
5
6
Km²
AREA

Figure 6

It should be pointed out that the list is far from complete - the composition of the tailings has for example not been included, as chemical conditions were not studied during the reconnaissance.

4.3 Miki's Fjord

In order to evaluate disposal in Miki's Fjord, longitudinal soundings have been carried out with the purpose of identifying any natural thresholds and calculating the potential volume, as well as transverse soundings in a potential threshold area. Furthermore, GM has collected samples of the fiordbed and carried out hydrographic profile measurements of the water's temperature, density and salinity (17).

As it appears from supplement IX, no proper thresholds have been entered, it should however be noted that the "threshold sounding" was hampered by icebergs, as illustrated in supplement IV. The stranded icebergs went down almost 100 m below the sea level (measured), but as there were several icebergs to the east of the potential threshold area, and as there was nothing in the hydrographic profiles to indicate horizontally separated bodies of water, the registered soundings are interpreted, as shown.

On entering Miki's Fjord, some considerably shallower areas were found in a couple of places to the south of Vandfaldsdalen (depths of 156 and 167 m), and this raised speculations about a possible threshold at this point. For practical reasons, this possibility was however not explored further.

Figure 7 shows an area/volume curve for the eastern part of the fiord, delimited to the west by the line shown in supplement IX. The line represents an imaginary damming from 100 m water depth, by means of which a volume of more than 300 million cubic metres would be sealed off. From the figure it furthermore appears that a dam from the fiordbed up to a water depth of barely 70 metres would seal off a volume in the order of 50 million m3 in an artificially created threshold fiord.

It must however be considered an extremely difficult job technically to design, build and control such a dam on what has been found to be a soft bottom (clay/-silt - down to an unknown depth) with dynamic loads from extremely voluminous icebergs.

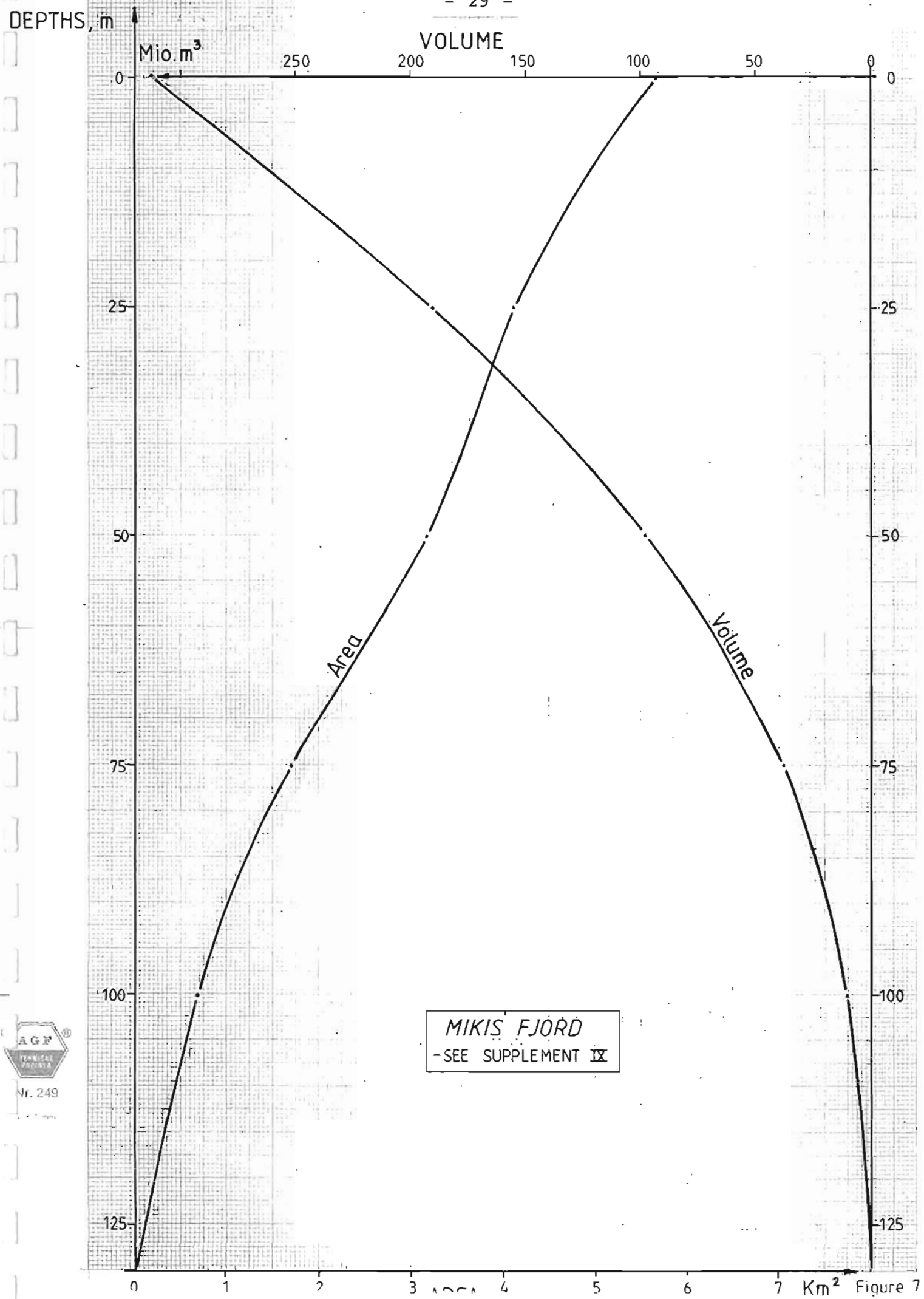

DEPTHS, m
VOLUME
Mio. m³
250
200
150
100
50
0
0
25
50
75
100
125
Area
Volume
MIKIS FJORD
-SEE SUPPLEMENT IX
0
1
2
3
4
5
6
7
Km²

Figure 7

Little is known of the hydrodynamic conditions in the fiord which is freely exposed to the Denmark Strait and moreover receives both precipitation and ablation. Some strong tidal movements (upwards of 3-4 metres) were however noted which might point to wind stowage and/or oscillation phenomena, possibly in connection with calving icebergs or the active glaciers on the south bank and at the head of the fiord.

4.4 Vandfaldsdalen

To examine the possibilities in Vandfaldsdalen for the disposal of tailings was the obvious thing to do, on account of the well-defined shape of the valley, the limited hydrological catchment area, its fine location near the deposit, and its fairly remote location in relation to the hunters settlement.

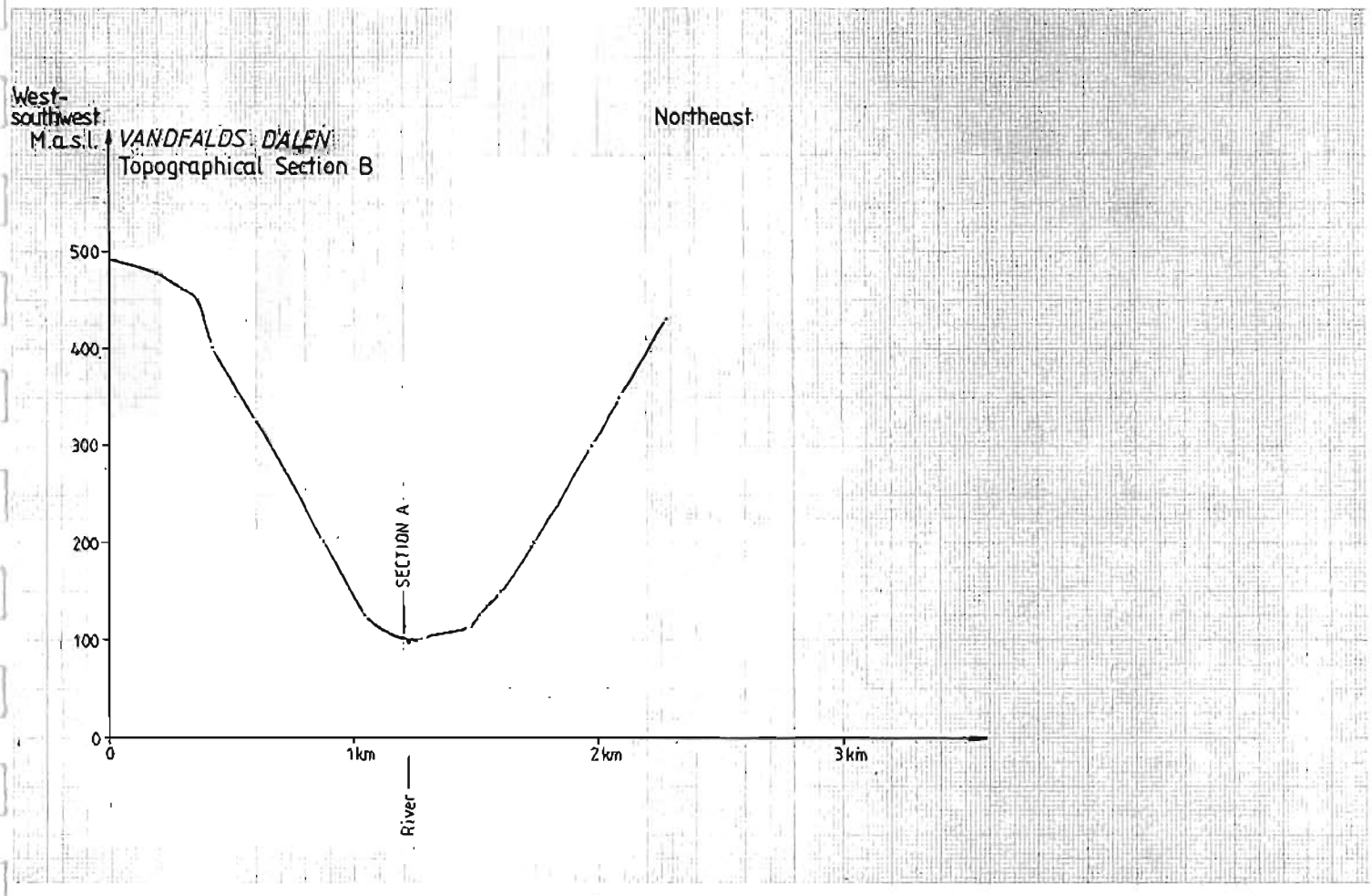
The locality and the hydrological catchment area appear from supplement II, the field observations made from supplements V and VI, and the volume calculations are finally shown in figures 8 and 9.

The volume calculations are based on damming at two alternative places with competent bedrock for the foundation. When damming to max. heights of 100 and 135 metres, respectively, the maximum crest lengths will be 860 and 1300 metres, respectively, behind which it should be topographically possible to store volumes of 49 and 132 million cubic metres.

The two examples of damming projects exclusively serve the purpose of demonstrating the potential volumes, and no attempt has been made to optimize the location or height based on the relationship between the obtained dammed-up volume/dam volume.

As mentioned under the initial assumptions, the total volume to be disposed of has been calculated at 50 million m3, and it will be seen that such a quantity can be contained. Two comments should however be attached to this statement. For one thing, the total volume of tailings in the assumptions has not been assigned any factor in connection with the establishment of the required volume for a "guaranteed" disposal - and for another, very large disposal heights have been used in the "lower" damming example.

Technical/economic evaluations will have to determine the most favourable model, and combination models with, say, damming from elevation 100 and returning of tailings to the mined areas are definitely conceivable.


West-
southwest
M.a.s.l.
VANDFALDS DALEN
Topographical Section B
Northeast
500
400
300
200
100
0
0
1km
2km
3km
SECTION A
River

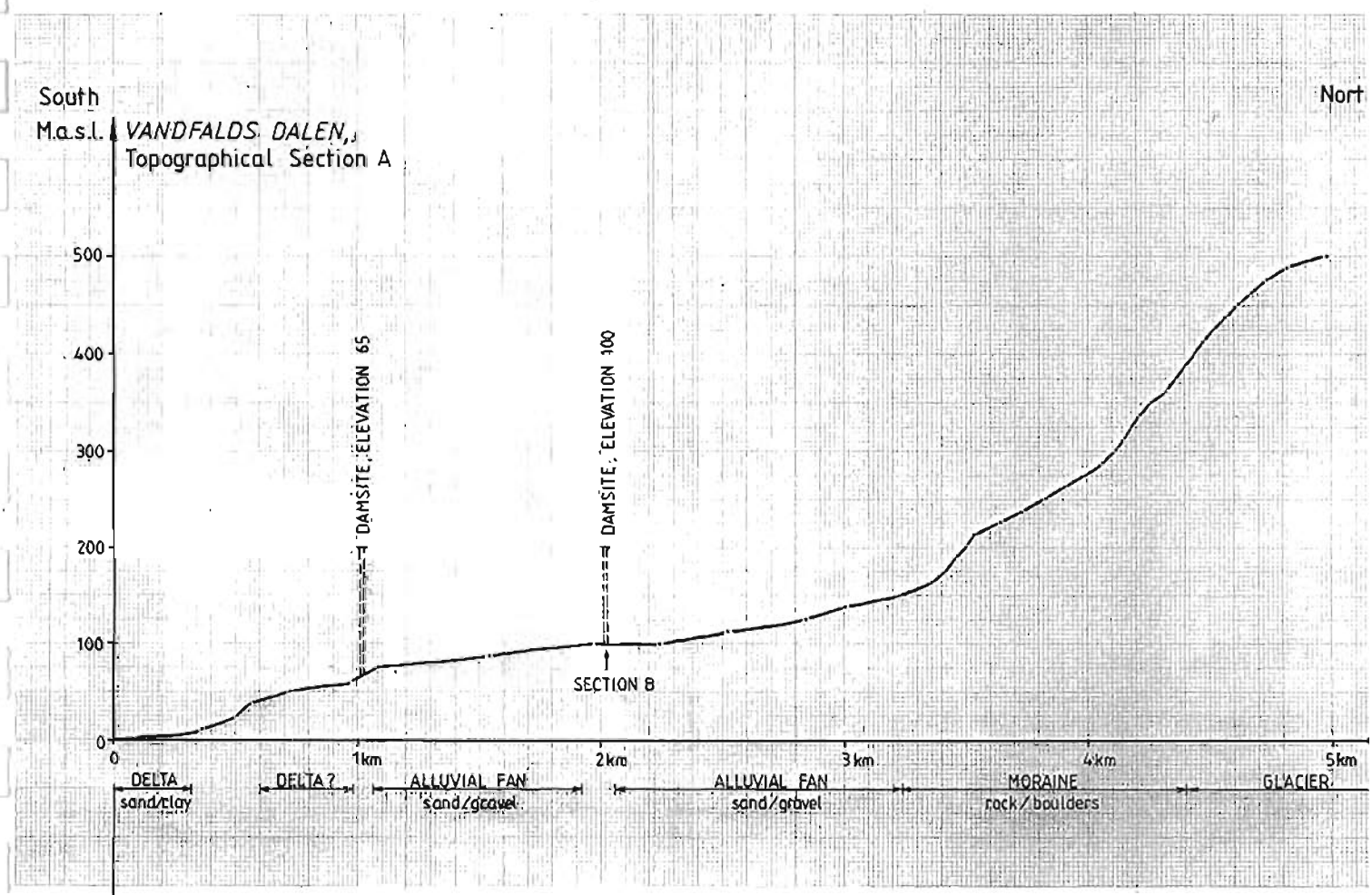

South
M.a.s.l.
VANDFALDS DALEN,
Topographical Section A
Nort
500
400
300
200
100
0
DAMSITE, ELEVATION 65
DAMSITE, ELEVATION 100
SECTION B
0
1km
2km
3km
4km
5km
DELTA
sand/clay
DELTA?
ALLUVIAL FAN
sand/gravel
ALLUVIAL FAN
sand/gravel
MORAINE
rock/boulders
GLACIER
MIKIS FJORD
VANDFALDS DALEN

Figure 8

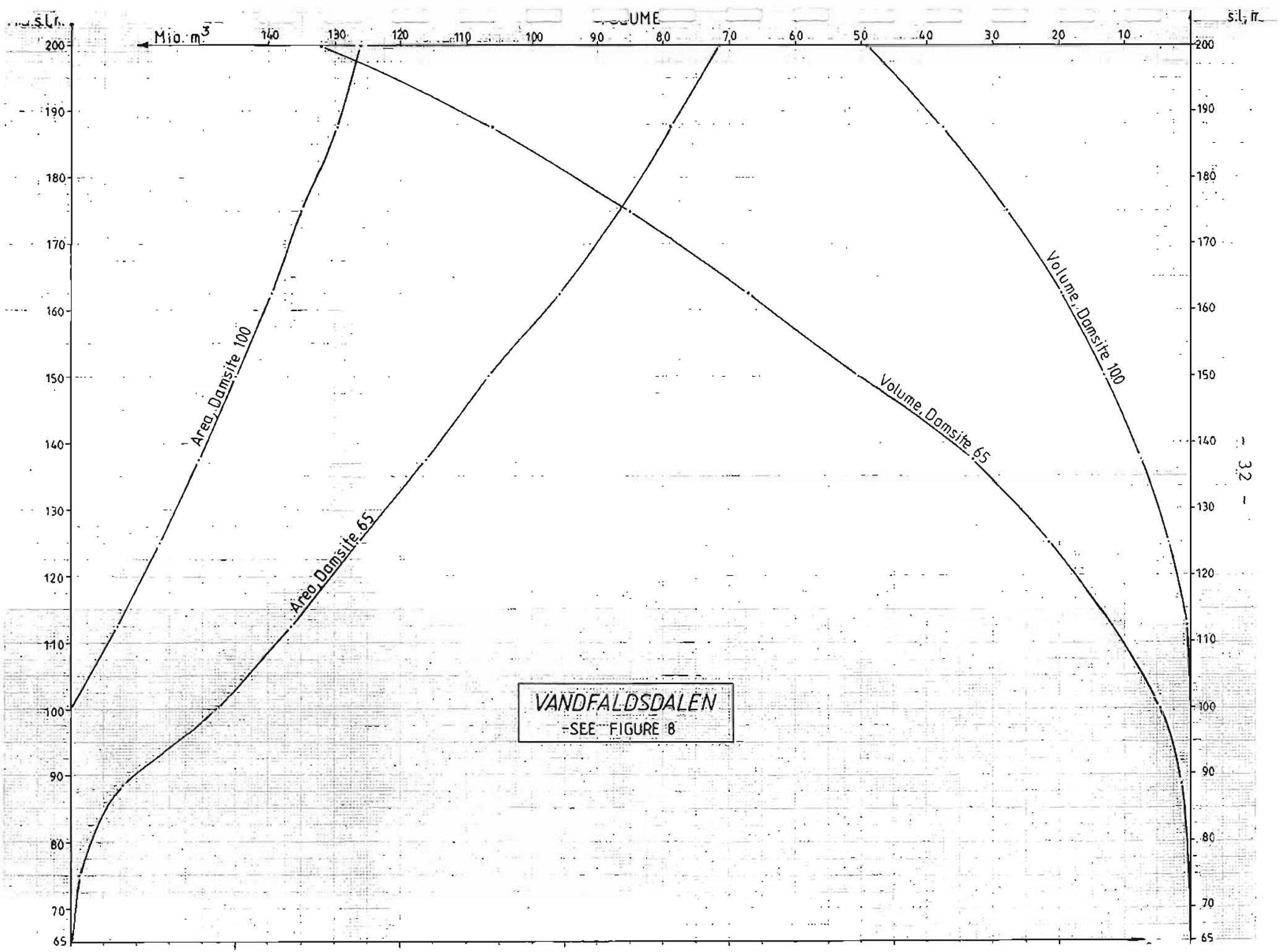

s.l.
VOLUME
Mio. m³
140
130
120
110
100
90
80
70
60
50
40
30
20
10
s.l. m
200
190
180
170
160
150
140
130
120
110
100
90
80
70
65
Area, Damsite 100
Area, Damsite 65
Volume, Damsite 65
Volume, Damsite 100
VANDFALDSDALEN
-SEE FIGURE 8

Figure 9

The hydrological catchment area is approx. 20 sq.km. big and the annual flow through Vandfaldsdalen is estimated at 14 million cubic metres. The physical conditions for draining these limited amounts of water in a controlled manner to Miki's Fjord without contact to a disposal site appears favourable with respect to the shape of the well-defined valley suitable for "roof gutter" draining around the larger part of the valley delimitation.

In addition to the problems mentioned above, a number of factors have been observed during the reconnaissance that will have to be included in a later evaluation of Vandfaldsdalen as a potential disposal site:

- accessibility and amount of natural materials suitable for construction work
- permeability of top soil and rock, to define seepage and foundation conditions
- wind regime and snow accumulation, to establish water balance and unintended transport of deposited material
- risk of snow and rock avalanches, to determine the safety and function of structures
- mass balance changes in the glacier at the head of the valley, to evaluate the risk of an advancement or increase of the water flow.

It should be pointed out that the list is far from complete - the composition of the tailings has for example not been included, as chemical conditions were not studied during the reconnaissance.

4.5 Uttental Sund

Damming possibilities have been studied at Uttental Sund with a view to exploitation of the volumes described by means of soundings in 1989 - ref. (13).

Uttental Sund is shown in supplements II and X, area/volume curves are depicted in figure 10, and the northern damming area at Watkins Fjord appears in supplement VIII.
From the volume curves it will be seen that the volume in the three bowls A, B and C from water depth 50 m and down is 12.5, 11 and 17.5 million cubic metres, respectively, while the total volume at A when dammed up against Watkins Fjord and at Strømstedet is 198 million cubic metres. Similarly, the total capacity at the south end of the sound, B + C, when dammed up against Kangerlussuaq and Strømstedet, is 161 million cubic metres.

In (13) it is stated that the limit for stable bottom water is at 20-25 m depth for area A, and at 30-40 m depth for area B + C, based on observations made on or around 1 September 1989. Below these levels, the volume of A, B and C is 64, 18 and 26.5 million m3, respectively.

Whether disposal should be carried out in the deep parts of Uttental Sund, with a risk of dispersion of the material, must be determined on the basis of extensive studies of the hydrodynamic system. If such a solution model is chosen, area A to the north is the most interesting. In order to contain the assumed total quantity of tailings under 50 m water, all three bowls must be "filled to the brim".

Based on the reconnaissance it should be noted that very varying conditions were observed during several crossings, with changing current directions and velocities, pronounced eddies at Strømstedet, and water level jumps.
The comparatively shallow water against Watkins Fjord and Kangerlussuaq prevents the passage of tall icebergs, but especially in the northern part of the sound there was a large concentration of small, flat icebergs. It was clearly glacier ice from Watkins Fjord.

The influx of fresh water to the sound came predominantly from glacier ablation. Finally, a local sealing expedition was observed in the area, and a collision with an inquisitive seal was only avoided in the nick of time.

If disposal of tailings in free water is not acceptable, a volume might conceivably be established through damming and arrest of the water flow. This can be accomplished in a northern reservoir, A, between Watkins Fjord and Strømstedet. A dam to the north must be capable of resisting very great impacts from the pressure of ice in Watkins Fjord, and the dimensioning and construction of it will be an exceedingly difficult job. In the same way, the building of a dam at Strømstedet would have to be done in very troubled waters where huge volumes of water are transported. Damming-up of the southern area B + C will entail the establishment of dams at Strømstedet and at the entrance to Uttental Sund from Kangerlussuaq. Here, too, the pressure of the ice will determine the dimensions, but the most severely exposed part of the dam will only be about 100 m of its total length of approx. 700 metres.

A solution of damming at Strømstedet, with a view to changing the function of Uttental Sund into two threshold fiords may be considered, as the construction of dams at Watkins Fjord and Kangerlussuaq on the face of it appears very difficult indeed, technically and economically.

Stated below are a number of factors observed during the field reconnaissance which among other things are to be included in a later evaluation of Uttental Sund as a possible disposal site:

- the building of a dam, if required, must be completed before disposal of tailings can be commenced

- to make the dam safe and to protect the surroundings from seepage of deposited material, the dam must be provided with systems controlling the water level in the disposal site

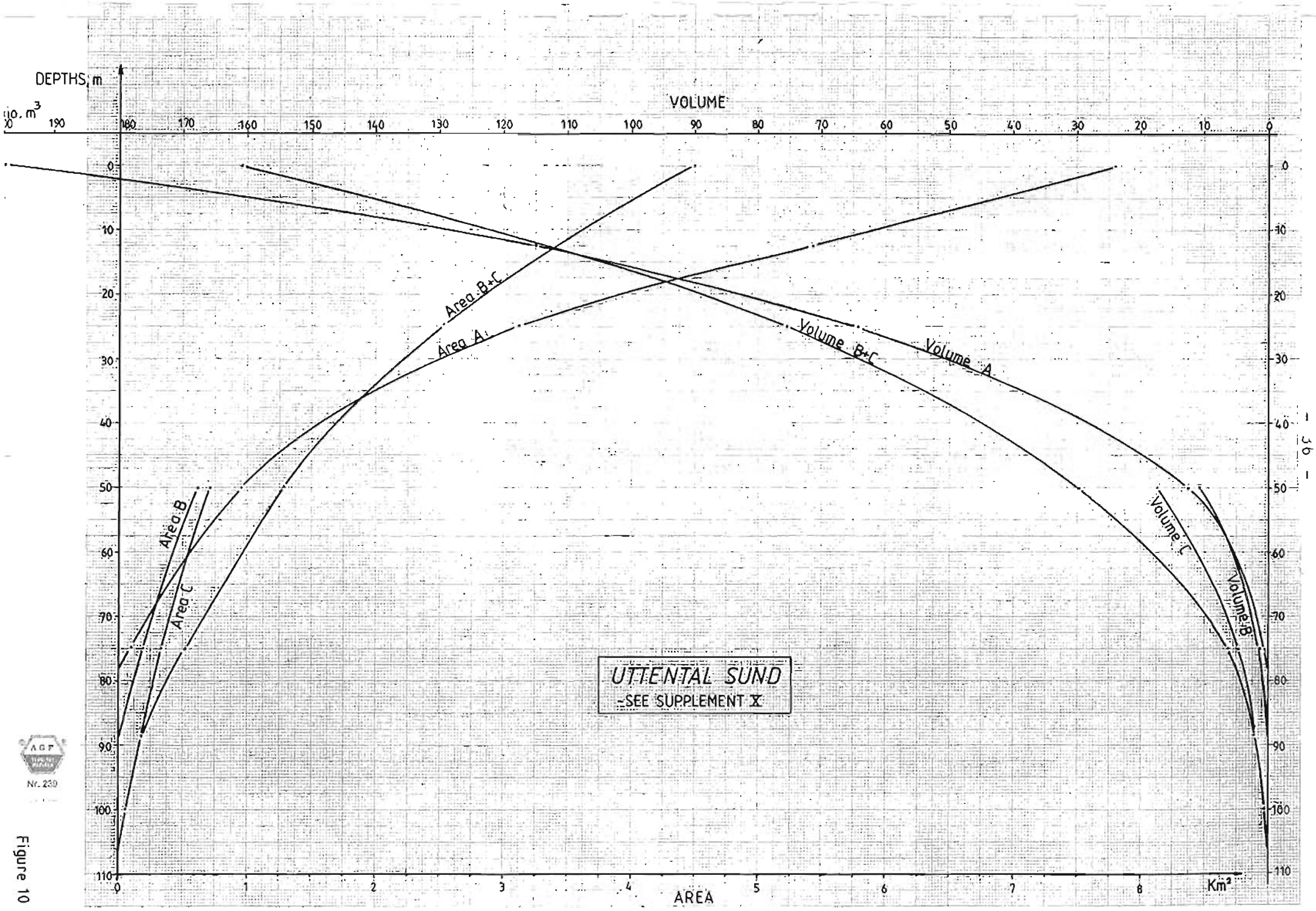
- deposited materials will be inaccessible, and it will be difficult to take steps to remedy an undesigned function of the disposal site

- changes in mass balance conditions for glaciers headed for Uttental Sund, their mechanical impact and possible reduction of volume of a disposal site or increase of the fresh-water influx. At present however the glaciers in question are local glaciers without connection to the Inland ice

- access to Uttental Sund will be stopped or extremely limited

- the basis of existence for the hunters community.

It should be pointed out that the list is far from complete - the composition of the tailings has for example not been included, as chemical conditions were not studied during the reconnaissance.



Nr. 239

Figure 10

4.6 Others

In addition to the localities described above, a number of other disposal sites have been considered:

- SKÆRGÅRDSBUGTEN. If the few soundings in supplement X represent a threshold, there is a naturally delimited volume between water depths approx. 60 and approx. 25.
  It is however of limited size (10 million m3), it is freely exposed to Kangerlussuaq and situated right next to the hunters settlement, and to the east it is delimited by morainic materials in front of the through melting receding Basisgletscher, the position of which will be unpredictable for a long time to come.

- BAY AT THE SOUTHEASTERN TIP OF KRAEMER Ø. The water depths, and hence the volumes, are unknown, but presumed to be of limited size (like Skærgårdsbugten?). If the bay is used, a dam will have to be established in connection with Mellemø and on account of the exposure to Kangerlussuaq which must be dimensioned to withstand considerable ice pressures. Access from Skærgårdshalvø will require crossing of Uttental Sund, and the locality is near the hunters settlement. Finally, the entrance to Uttental Sund between Kraemer Ø and Lille Mellemø will be blocked.

- THE EASTERN LITTORAL REGION OF KRAEMER Ø. No sites for terrestrial disposal of a size worth mentioning have been found here.

- THE AREA IN FRONT OF DOBBELTGLETSCHEREN. In this area, so difficult of access from the deposit, a bigger than expected glaciation was observed in an apparently active glacial environment. The terrain facing Uttental Sund and Watkins Fjord predominantly consists of permeable, loose materials that will provide no guarantee against seepage.

- ISSØERNE NORTHWEST OF SØDALEN. The situation of this area is disadvantageous in terms of the distance from the deposit and its elevation. The glacier cover to the south is considerable, and the lakes are only expected to be rather shallow. As the area is to some extent in the nature of a plateau, damming-up of it will require enormous amounts of building materials, but that would of course make large areas accessible. It should be noted that the area has only been reconnoitred from a helicopter.

As matters now stand, it is not recommended that further studies be made of the localities mentioned above.

5. ENVIRONMENTAL EVALUATION OF THE RECONNOITRED DISPOSAL POSSIBILITIES

5.1 Introduction

In contrast to the limited lifetime of a mining activity, the disposal of waste products is potentially capable of causing pollution of the environment for a long time to come.

It is therefore important that the localization, design and function of the disposal site are planned with an eye on a very long, and to the extent possible, maintenance-free functional period - that will be influenced by the natural conditions reigning there, e.g. climate, hydrology, currents etc.

In principle, forms of disposal where dams have to be built and streams diverted are considered to involve a greater risk of future maintenance than disposal forms taking advantage of natural physical delimitations.

The primary requirements to the function of an environmentally acceptable disposal site will be the following:

- to keep waste rock and tailings physically gathered within a defined area
- to prevent any physical and chemical influence on the surroundings
- it must be possible to control and monitor the function
- plans making it possible to intervene in case of any malfunction must have been worked out.

As the mining activities at Skærgården are in the opening stages at the present time, where natural and environmental conditions have only been cursorily reconnoitred, the following evaluation must only be considered as an initial assessment of the suitability of the localities for the disposal of tailings. New factors of significance may emerge in connection with future investigations.

Reconnaissance has primarily been carried out in four areas, where Sødalen and Vandfaldsdalen are terrestrial localities, while Miki's Fjord and Uttental Sund are marine sites.

As it is generally considered most acceptable from the environmental point of view to dispose of all the tailings at one place, the other localities mentioned in chapter 4 will not be studied in more detail, as they are not able to contain the 50 million m3 tailings assumed as the max. volume in this report. If it should turn out later that the volume of tailings will be considerably smaller, these localities should be reconsidered and reevaluated together with the four sites mentioned here.

Marine disposal without any measures designed to cut off the disposal site from the surrounding sea territories is not considered very attractive from the environmental point of view.

It should be noted that Eastern Greenland is comprised by the Paris Convention which establishes the limits for land-based discharge of substances into the sea.

5.2 Sødalen

Sødalen is situated some 10-15 km from the deposit, and this distance is 2-3 times greater than the distance to other disposal sites. A longer transport of tailings may involve a greater risk that pollution may spread, but this will primarily depend on factors having to do with the loading and transport of them.

Damming projects have in this report been localized at elevation 50 where there is bedrock. A disposal height up to 45 m will consequently be able to accommodate 50 million m3 of waste.

The valley is traversed by a stream that drains about 25 sq. kilometres of the inland ice, etc. On 8 August 1990 its water discharge was estimated at 2-3 m3/sec. Considerable volumes of water will therefore have to be collected and conducted away, as it is not considered safe to allow larger volumes of water to pass through a disposal site.

Vegetation and wildlife are sparse in Sødalen. During the work in the field, small birds, grouse, lower animal species and a solitary fox were observed. At the present time it is not considered that disposal of tailings will have a major impact on the terrestrial environment, apart from the aesthetic deterioration.

To the north the area is delimited by the Sødalengletscher which is part of the inland ice. If the glacier changes its balance, this may have a negative influence on a disposal site. Either a mechanical influence, if the glacier should enter into direct contact with a disposal site, or through increased melting resulting in larger volumes of water.

5.3 Vandfaldsdalen

Vandfaldsdalen, which is 400-600 m wide and about 3.5 km long, is delimited by steep mountain slopes on three sides. Sporadically the bedrock surfaces at the bottom of the valley which is otherwise covered by fluvial and morainic deposits or weathering materials.

As in Sødalen, vegetation and animal life is sparse. Only small birds and lower animals were seen during the field work, whereas no mammals were observed in the valley region. The stream is however likely to contain a small population of migrant chars, as three chars were caught in connection with net fishing where the stream flows into Miki's Fjord.

Damming projects have here been localized at elevations 65 and 100, respectively.

A disposal site starting at elevation 65 will necessitate a disposal height up to 85 m, whereas a disposal site at elevation 100 will require a height of 100 m, if 50 million m3 of tailings are to be contained.

Alternatively, it might be expedient to fill the tailings back into the mine. By and large, a return of the waste material to the mine is considered an environmentally acceptable alternative. There are however a number of factors that have to be studied in more detail, for instance the risk of seepage, risks during transhipment and transport etc., before a final position can be taken.

In Vandfaldsdalen, too, there is a stream which in the month of August had a volume of approx. 1.5 m3/sec. The stream drains an area of 20 sq. kilometres or so, one quarter of which consists of local glaciers. If the area should be chosen as disposal site, it will be necessary to change the course of the stream, so that the passage of water through the disposal site is reduced to a minimum.

5.4 Uttental Sund

Uttental Sund is made up of three bowl-shaped areas, the deepest one of which is about 100 m deep. These three bowls are bounded by thresholds at Skærgården, Strømstedet and Watkins Fjord, respectively.

A disposal in Uttental Sund will affect the marine environment. Just how extensive this influence will be will depend on whether the tailings can be dammed off and other factors, such as the chemical and physical composition of the tailings, prevailing currents, seabed topography, the presence of animal life, etc.

Based on the topographical conditions, some suitable places for dams have been indicated in chapter 4, but the technical aspects have not been delved into.

If a dam is placed at Skærgårdshalvø, it must be able to withstand the ice pressure from Kangerlussuaq, the disposal site will be near the hunters community, and navigation and transport in Uttental Sund will not be possible. A dam placed at Watkins Fjord must also be capable of withstanding enormous impacts from the ice pressure, whereas a dam at Strømstedet would have to be built in very troubled waters.

To how great an extent sealing and fishing will be affected by a disposal site in Uttental Sund we do not know at this moment. To clarify this, it will be necessary to study the marine mammals in the area.

5.5 Miki's Fjord

Soundings were carried out in the second marine locality, Miki's Fjord. These soundings along with hydrographical recordings do not appear to indicate that Miki's Fjord should be a threshold fiord. The damming of a disposal site in this area is at the present time not considered a viable possibility. Tailings disposal here would be completely uncontrolled as regards spreading of polluting particles and dissolved substances further upstream or downstream in the fiord. When the disposal have been concluded, a site may however be covered, and there will no doubt be a considerable amount of natural sedimentation. Icebergs will however be able to churn up the disposal site.

5.6 Conclusions

Based on the assumptions set up at the present time and our present knowledge of environmental conditions in the area, it is considered that the efforts to find suitable disposal sites in Vandfaldsdalen and Uttental Sund should be continued. This view should however in no way be seen as an expression of a fixed position in the matter. Extensive biological, chemical, physical and technical studies will be required, both on land and at sea, before the most suitable disposal site can be singled out.

6. INFRASTRUCTURE

The existing infrastructure in the area limits itself to the gravel airstrip established in Sødalen in 1982, about 4 km from the head of Miki's Fjord. Shiploads of goods and fuel are landed where conditions permit ships to call. Transport to and from Sødalen's airstrip and removal of goods in the area is exclusively performed with the support of helicopter. In the winter period fixed-wing aircraft are used for transports to and from Skærgården as well as internally in the area, using ad hoc runways on sea ice and glaciers.

The main problem would therefore appear to be whether Sødalen in an exploitation situation should be maintained as airstrip, with difficult access to it from the sea and a scattered infrastructure as the result, or whether it is possible to establish a more compact infrastructure in a more direct connection with the deposit. Whether such a possibility should be explored at the Skærgård side or near Miki's Fjord is an open question at this time.

In the sections below a description will be given of observations from the reconnaissance, and proposals will be submitted for a more detailed evaluation. Whether these proposals are technically/economically feasible and environmentally acceptable will have to be determined on the basis of future detailed investigations.

6.1 Sødalen

The existing airstrip is 625 m long and 15 m wide. The location of it appears from supplements II and III. An extension of the airstrip to, say, 1200 m, in preparation for exploitation activities can only be made by means of extensive earth and rock-excavation, as the strip in the longitudinal direction is limited by thresholds both to the south and to the north.

Establishing of a new 1200 m strip on the alluvial plain can geometrically be accomplished, but the earth work and canalization of the natural run-off will be extensive. Blasting operations outside of the actual airstrip will most likely also be required to provide the necessary clearance zones. As large amounts of snow will accumulate in the area, flooding will be common in the spring, and it must therefore be expected that the airstrip will require a lot of maintenance to allow operation around the year.

As the distance to the deposit is roughly 15 km, there must be reliable access all year from Sødalen to the areas where mining, processing and shipment take place. It is not considered expedient to establish a harbour near Sødalen.

In connection with the reconnaissance, the possibility of building a road in the terrain between Sødalen and Vandfaldsdalen has been studied for a start. A passage round the corner at the head of Miki's Fjord is a difficult manoeuvre, and as it appears from supplement IV, a short piece of road at elevation 200 has been entered as the only comparatively easy part. An alternative solution with filling a road embankment along the coast and around the corner is considered a very costly affair from a construction and operation point of view.

In the same way it is found that a road in the littoral region along the north side of Miki's Fjord will involve very heavy operating costs for the clearing of snow and avalanches from mountain sides with southern exposure. A tunnel between Sødalen and Vandfaldsdalen will be about 7 km long, with a 600-700 m thick overburden. A road through the length of Sødalen and along Miki's Fjord will be almost twice as long, and it is more or less expected that the operational advantages of a tunnel will offset the (maybe) higher construction costs.

Access by means of a road behind the mountain and across Issøerne and maybe onwards to the deposit site via the Gabbrogletscher has not been studied too closely, as the reconnaissance by helicopter proved that such a road will have to function as a freely exposed ice-road for a large part of the way which incidentally will be even longer than a road following the coast and with difficult passages en route.

At I.C. Jacobsen Fjord to the east of Sødalen, earlier reconnaissances have indicated good possibilities of establishing an airstrip in connection with a harbour. This solution is however considered uninteresting in connection with a mineral project at Skærgården.

As the initial costs for the establishment and operation of a reliable road connection between Sødalen and the Skærgård region are expected to be exorbitant, it is considered that the continued studies concerning the placing of the infrastructure should concentrate on options that are more directly connected to the deposit site. Operations in a mining situation are expected to be of such a magnitude that the use of a different infrastructure during the summer and winter periods will not be considered warranted.

6.2 Miki's Fjord

When the deposit is mined from the northeast side facing Miki's Fjord, an infrastructure in the area near the entrance to Vandfaldsdalen will be required, and a preliminary reconnaissance has been performed in this area with the result shown in supplement VI.

As it can be seen, a more detailed examination of the possibility of establishing a 1200-1500 long airstrip, combined with a harbour project in the area below Miki's Hus, is recommended. It is estimated that the lagoon is quite shallow and that it consists of sand, while the areas surrounding it mainly consist of washed-out moraine. To evaluate the volumes required for filling, a detailed sounding has been carried out, as shown in supplement IX. Material for filling may be taken from the immediate surroundings or be combined with the waste rock from the blasting of an exploration decline, if applicable.

At a plateau on the mountain immediately to the west of the proposed airstrip an area has been spotted where buildings can be put up. A similar area has been identified on the eastside of the stream from Vandfaldsdalen. As it can be seen, a road connection has been sketched in between the two areas and onward into Vandfaldsdalen in the direction of a potential disposal site. The proposed road layout will involve the establishment of two bridges.

The water supply to the two areas has likewise been entered, as water supply from Forbindelsesgletscheren will be a very stable source, the capacity of which can be increased by direct drawing of water from the glacier. The water supply to the area east of the stream can be obtained from higher-lying plateaus, for instance in connection with draining part of the natural influx to Vandfaldsdalen.

The possibility of locating a harbour at Eskimo Næs has been considered, as there are natural docking facilities for ships to the area here. However, as the headland has a very small hinterland within easy reach and furthermore contains a large number of relics of the past, this solution is not considered a very attractive one.

An infrastructure as the proposed one might also be of interest based on mining activities further to the west, if a connection is established via Forbindelsesgletscheren. Such a connection has not been considered very carefully, but several crossings of the area by helicopter seem to indicate that it is definitely a possibility.

6.3 Skærgården

As the case is with Miki's Fjord, the Skærgård side has also been reconnoitred for a possible infrastructure in connection with the mining of the deposit from this side. The area is generally more exposed to Kangerlussuaq, and the hunters settlement mainly owes its existence to the sea near the Skærgård peninsula. The result of the preliminary reconnaissance is shown in supplement VII. For further evaluation the spot shown in the supplement has been chosen as the site of a 1200-1500 m long airstrip. The locality has not been studied in great detail in the field, and it would not appear to be entirely favourable on account of its location on projecting moraine crests over what is presumably bedrock. The approach to it from the north is moreover difficult on account of the large moraine deposits in front of Basisgletcher.

Proposed as the possible site of a harbour is partly a location on the outer side of the airstrip, and partly two locations at rock outcrops, as shown. Whether the two positions in Skærgårdsbugten may be closed by ice, we do not know, but it does appear likely, and this would have a negative impact on the regularity of service to a harbour at these points. From the proposed airstrip via the proposed harbour sites and on to an area to be built up, the road marked with a dot-and-dash line has been reconnoitred, where the passage at the head of Skærgårdsbugten will have to take place on filling. The area proposed for camp etc. is today known as "the Swamps", a place where geological field teams traditionally pitch their summer camp. The water supply to this area can be taken from the stream, as illustrated.

On Kraemer Ø there are no obvious places for airstrips in the eastern part of the island near the coast, but the possibility of establishing one should not be ruled out, especially if damming of some kind is established across the entrance to Uttental Sund. On Kraemer Ø the construction work will predominantly be pure blasting operations with the costs that such operations entail.

7. ENVIRONMENTAL EVALUATION OF THE RECONNOITRED INFRASTRUCTURE POSSIBILITIES

In the establishment of the infrastructure, including a harbour, camp, roads, airport and processing plant in the area, there are environmentally two aspects that have to be evaluated. There is partly the risk of spreading substances that are foreign to the environment in connection with mining, transport and processing, and partly the interference with animal life in the area, with special emphasis on the marine mammals.

During the field work seals were observed in Miki's Fjord as well as around Skærgårdshalvø.

No environmental studies have been carried out as yet which have dealt with neither the spreading of substances nor disturbance of animal life. So at the present time it is not possible to come to a decision as to which sites would be best suited for the mentioned activities.

8. RECOMMENDATIONS

The reconnaissance in 1990 was carried out during an exploration stage where the concessionaire's main efforts were still concentrated on the demonstration of an ore tonnage of a sufficiently high grade, and where technical studies of the possibility of establishing an operation had only just been initiated.

This time of the exploration process was favourable for pursuing the main objectives of the reconnaissance:

- to establish the basis for a rational technical and environmental handling of the case on the public side, and to give the basis for a detailed definition of delimited investigations when more concrete plans appear

- to establish the basis for an influence on the location of tailings disposal in the area, the presence of which in the surrounding environment is of far greater extent than that of a mining operation.

- o -

In the period until the concessionaire submits his concrete plans it is recommended to improve one's general knowledge of the area:

- climate, i.e. processing of existing data, notably from Aputiteq, and commencement of registrations of the climate at representative positions in the area. In connection with water balances, precipitation is an important parameter

- topography, i.e. preparation of the basis for producing maps on a suitable scale of the areas covering the activities in question

- navigation, i.e. description of wave, tide and especially ice conditions from existing data

- environment, i.e. description of the existing natural environment.

When localized, concrete plans are submitted, detailed studies have to be made to safeguard the interests of society during and after an economically attractive mineral exploitation.

Finally it is recommended to carry out similar preliminary reconnaissance in the concessionaire's other holdings, when the exploration has reached the level of Skærgården.

9. REFERENCES

(1) Topographical maps of Kangerdlugssuaq area - 1:250.000. Geodætisk Institut, Denmark - 1941

(2) Provisional mean temperatures and mean atmospheric pressure in Greenland 1961 - 1965. Det Danske Meteorologiske Institut - 1967

(3) Grønlands klima i perioderne 1921-50, 1951-60, 1961-65. Det Danske Meteorologiske Institut - 1969

(4) Aerial photographs 1:27.000. University of Oregon - 1973

(5) Topographical map of Skærgården, East Greenland - 1:20.000. Geodætisk Institut, Denmark - 1975

(6) Geomorphological Observations at Kangerdlugssuaq, East Greenland. C.K. Brooks, Greenland Geoscience 1 - 1979

(7) Topographical map of Miki Fjord Area, East Greenland 1:21.000. (unpublished) - 1979

(8) Provisional mean temperature and total amount of precipitation in Greenland 1971-1978 (8 reports). Det Danske Meteorologiske Institut - 1973/1980

(9) The pre-basaltic sediments and the lower Basalts at Kangerdlugssuaq, East Greenland: their stratigraphy, lithology, palaeomagnetism and petrology. T.F.D. Nielsen et. al., Greenland Gescience 6 - 1981

(10) Geological map, Kangerdlugssuaq - 1:500.000. The Geological Survey of Greenland - 1988

(11) Tuusat, Forskning i Grønland no 1/2 - 1989. Dansk Polarcenter - 1989

(12) Tidevandstabeller, Grønland 1990. Farvandsvæsenet - 1989

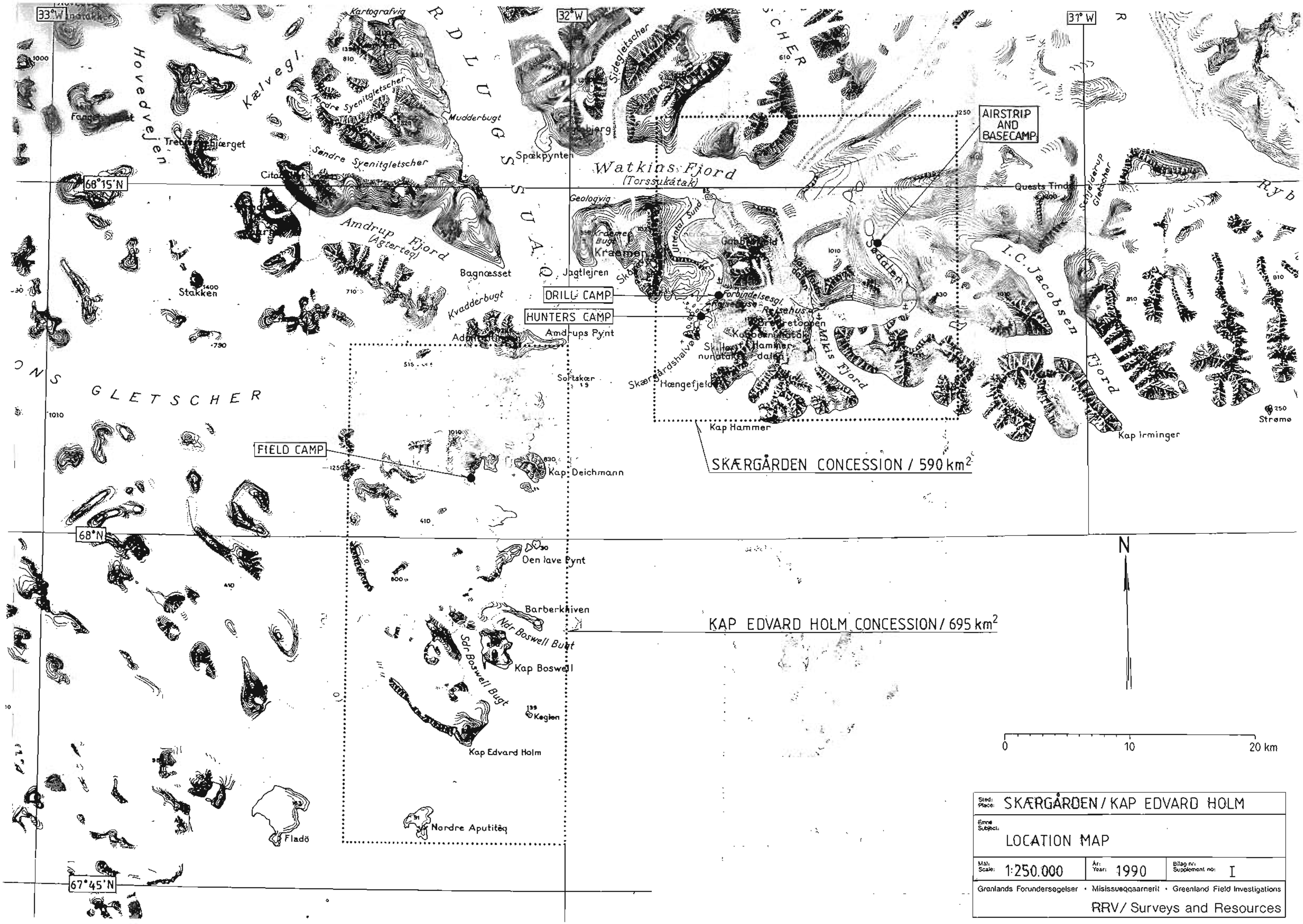
(13) Environmental observations in relation to a gold project in the Skærgården intrusion. Greenland Environmental Research Institute (unpublished) - 1989

(14) Geological Map of the Skaergaard Intrusion, East Greenland - 1:20.000. University of Oregon - 1989

(15) Report on archaeologic sites in the Miki's Fjord and in the area around the Skærgårdshalvø in East Greenland. The Greenland Museum (unpublished) - 1990

(16) Personal Communication: Tom Corbett/Watts, Griffis and McOuat Ltd. Robert A. Gannicott/Platinova Resources Ltd. Jon Olsen & Bo Rykov/National Survey and Cadastre, Denmark - 1990

(17) Baggrundsundersøgelser ved Skærgården, 1990 Grønlands Miljøundersøgelser - 1990



33°W
32°W
31°W
68°15'N
68°N
67°45'N
Kartografvig
Hovedvejen
Kælvegl.
Nordre Syenitgletscher
Søndre Syenitgletscher
Mudderbugt
Sidegletscher
Spækpynten
Watkins Fjord
(Torssukátak)
AIRSTRIP
AND
BASECAMP
Quests Tinde
Amdrup Fjord
(Agterteq)
Stakken
Bagnæsset
Jagtlejren
Geologvig
Kraemer
Uttental Sund
Forbindelsesgl.
I. C. Jacobsen Fjord
DRILL CAMP
HUNTERS CAMP
Kvadderbugt
Amdrups Pynt
Skærgårdshalvø
Hængefjeld
Mikis Fjord
Kap Hammer
Kap Irminger
Strømø
GLETSCHER
FIELD CAMP
Kap Deichmann
SKÆRGÅRDEN CONCESSION / 590 km²
Øen lave Pynt
Barberkniven
Ndr Boswell Bugt
Sdr Boswell Bugt
Kap Boswell
Keglen
Kap Edvard Holm
KAP EDVARD HOLM CONCESSION / 695 km²
N
0
10
20 km
Fladö
Nordre Aputitêq
Sted: Place: SKÆRGÅRDEN / KAP EDVARD HOLM
Emne Subject: LOCATION MAP
Mål: Scale: 1:250.000
År: Year: 1990
Bilag nr: Supplement no: I
Grønlands Forundersøgelser • Misissueqqaarnerit • Greenland Field Investigations
RRV/ Surveys and Resources

31°45' 31°40' 31°35' 31°10'

68°13'

68°10'

68°07'

WATKINS FJORD

GÆRTAULANGIVAQ

DOBBELTGLETSCHEREN

UTTENTAL PLATEAU

VIII

UTTENTAL SUND

KRAEMER Ø

DRILL CAMP

FORBINDELSESGLETSCHER

"ISSØERNE"

SØDALENGLETSCHER

"CANYONEN"

BASECAMP SØDALEN

BRECCIADALEN

RÅDDENTOPPEN

I.C. JACOBSEN FJORD

III

SØDALEN

VANDFALDSDALEN

CAMP FALDSØ-DALEN

V

MELLEMØ

LILLE MELLEMØ

LILLE IVNARMIUT

IVNARMIUT

SKÆRGÅRDEN

SKÆRGÅRDSBUGT

SKÆRGÅRDSHALVØ

VII

BASISGLETSCHER

DOUGLAS PLATEAU

ESKIMONÆS

MIKIS FJORD

VI

IV

KANGERDLUGSSUAQ

TINDEGLETSCHER

HAMMER GLETSCHER

N

MAGNETIC DEVIATION 1990 APP. 29°25'
DECREASING APP. 15½' PER YEAR

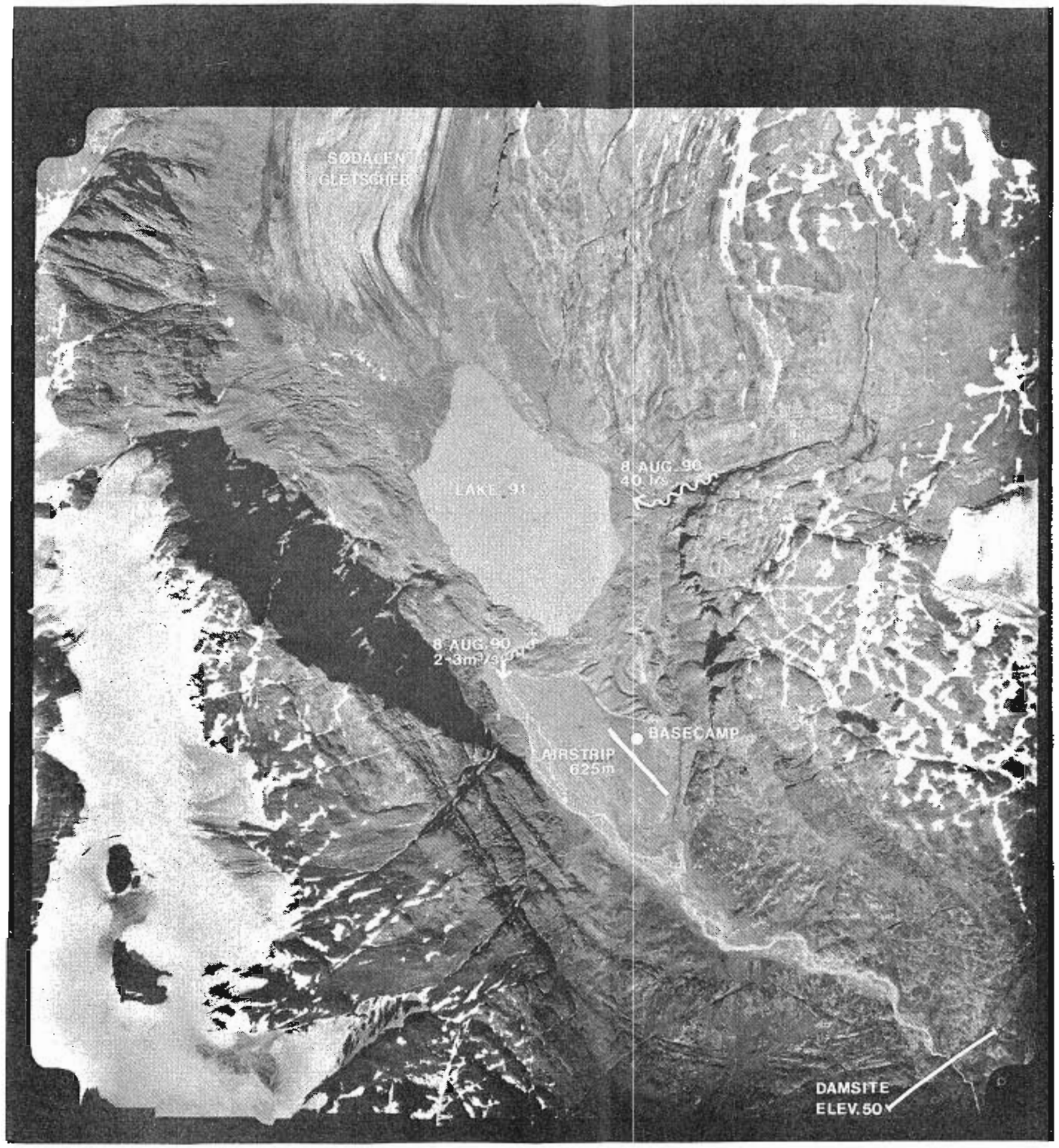
0 1 2 3 km

LEGEND:

- FIELD CAMP
- RECONNOITRED BY BOAT
- RECONNOITRED AREAS BY FOOT
- RECONNOITRED BY HELICOPTER
- III SUPPLEMENT III
- HYDROLOGICAL CATCHMENT AREA

Sted: Place: SKÆRGÅRDEN		
Emne: Subject: FIELD WORK 1990		
Mål: Scale: 1:50.000	År: Year: 1990	Tillæg nr.: Supplement no: II

Grønlands Forundersøgelser • Mineraloppegaarneriit • Greenland Field Investigations
RRV/ Surveys and Resources



N

0 1 2km

PHOTO NO. 3227
23. AUGUST 1973
-SEE REFERENCE (4)

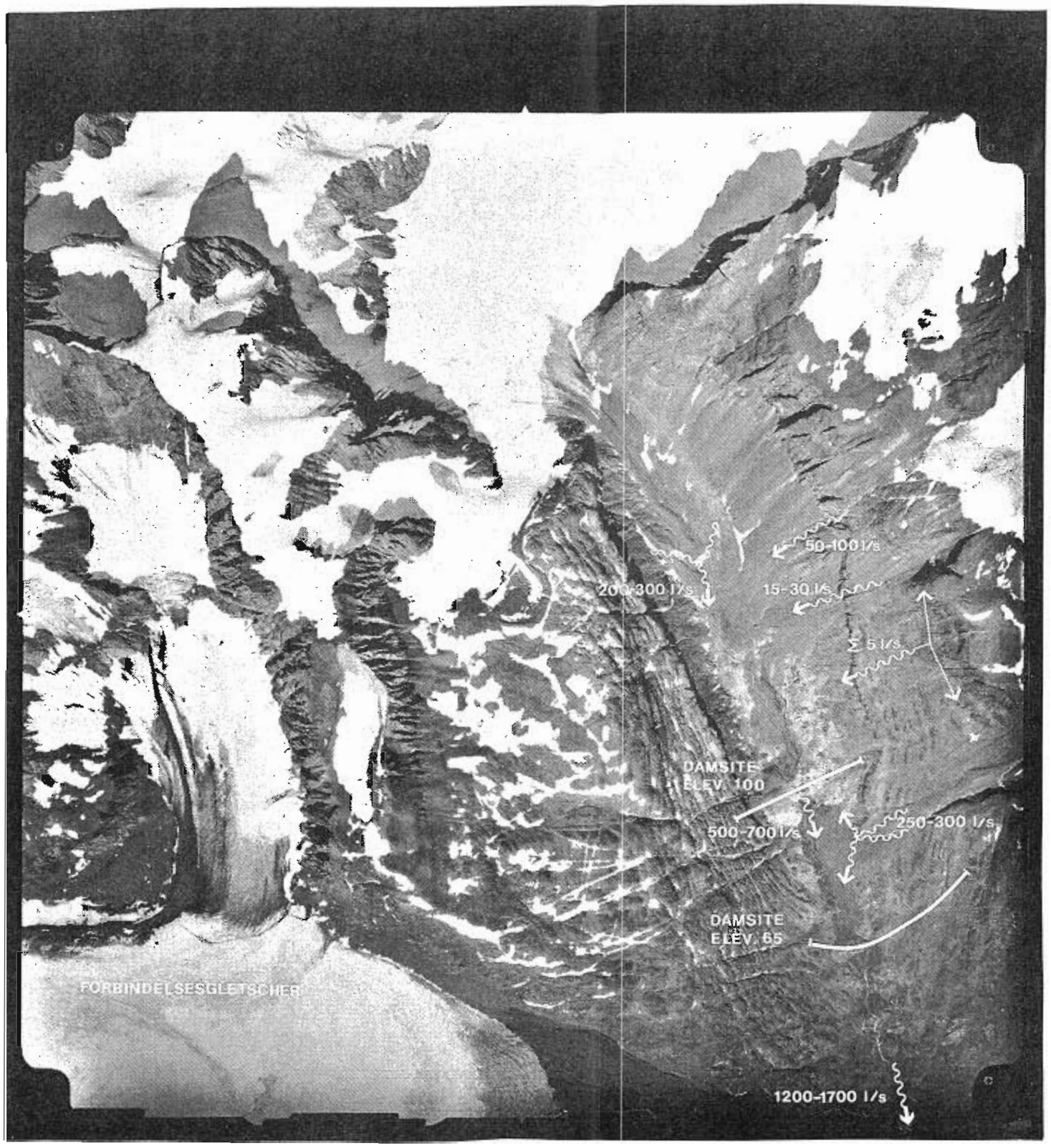
Sted: Place: SKÆRGÅRDEN		
Emne: Subject: SØDALEN		
Mål: Scale: 1:27.000	År: Year: 1990	Bilag nr. Supplement no. III
Grønlands Forundersøgelser · Misissueqqaarnerit · Greenland Field Investigations RRV/ Surveys and Resources		

N

0 1 2km

PHOTO NO. 3224
23. AUGUST 1973
- SEE REFERENCE (4)

Sted: Place: SKÆRGÅRDEN		
Emne: Subject: MIKIS FJORD		
Mål: Scale 1:27.000	År: Year: 1990	Bilag nr: Supplement no: IV
Grønlands Forundersøgelser • Misissueqqaarneril • Greenland Field Investigations		
RRV/ Surveys and Resources		



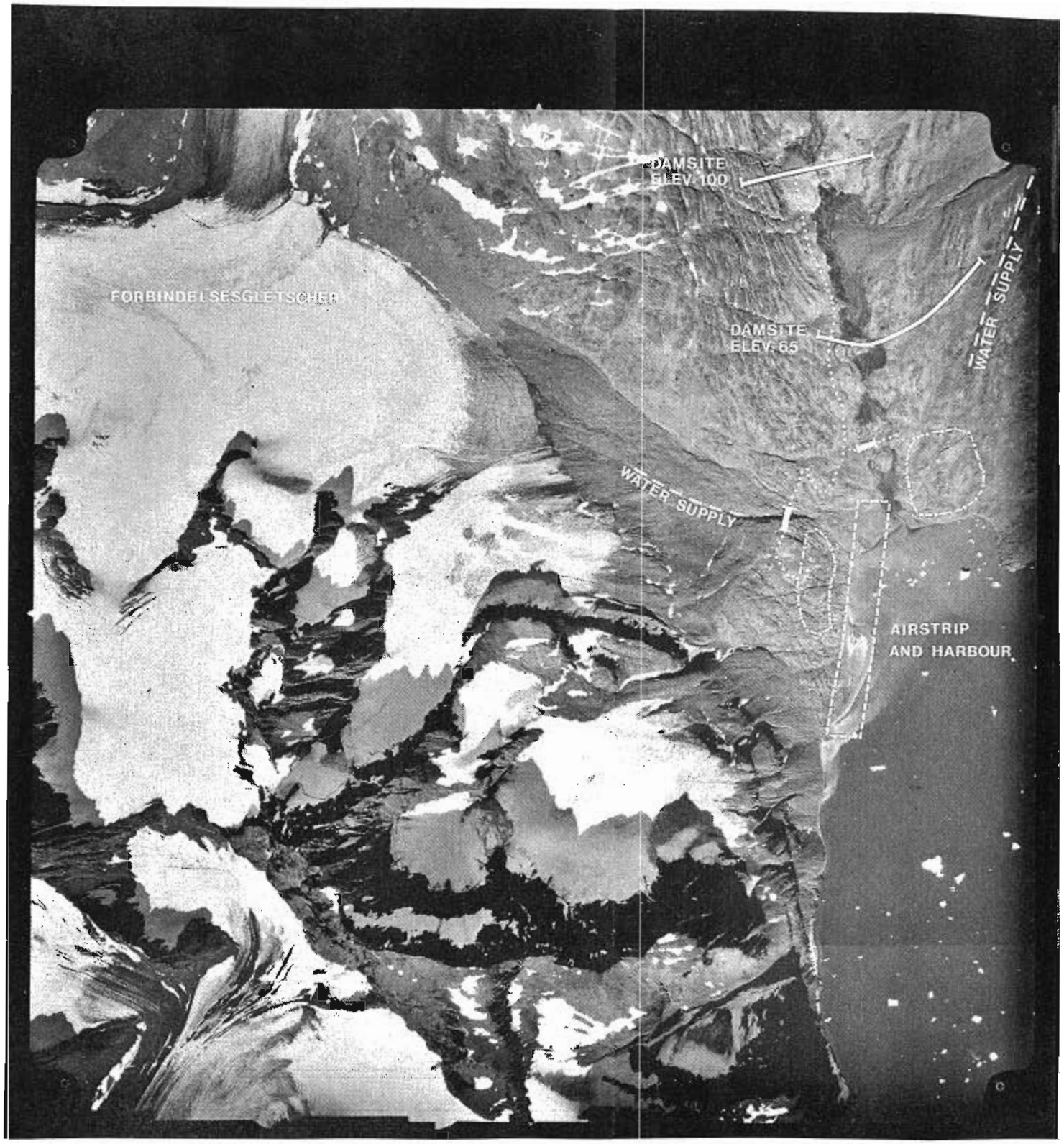
~N

0 1 2km

PHOTO NO. 3258
23. AUGUST 1973
- SEE REFERENCE (4)

ALL DISCHARGE ESTIMATES WERE ON 17. AUG. 1990

Sted Place: SKÆRGÅRDEN		
Emne Subject: VANDFALDSDALEN		
Mål Scale 1:27.000	År: Year: 1990	Bilag nr: Supplement no V
Grønlands Forundersøgelser · Misissueqqaarnerit · Greenland Field Investigations RRV/ Surveys and Resources		



~N

0 1 2km

PHOTO NO. 3256
23. AUGUST 1973
- SEE REFERENCE (4)

AREA FOR CAMP, PLANT ETC.

ROAD

BRIDGE

Sted: Place: SKÆRGÅRDEN		
Emne: Subject: MIKIS HUS		
Mål: Scale: 1:27.000	År: Year: 1990	Bilag nr.: Supplement no: VI
Grønlands Forundersøgelser · Misissueqqaarneril · Greenland Field Investigations		
RRV/ Surveys and Resources		

N

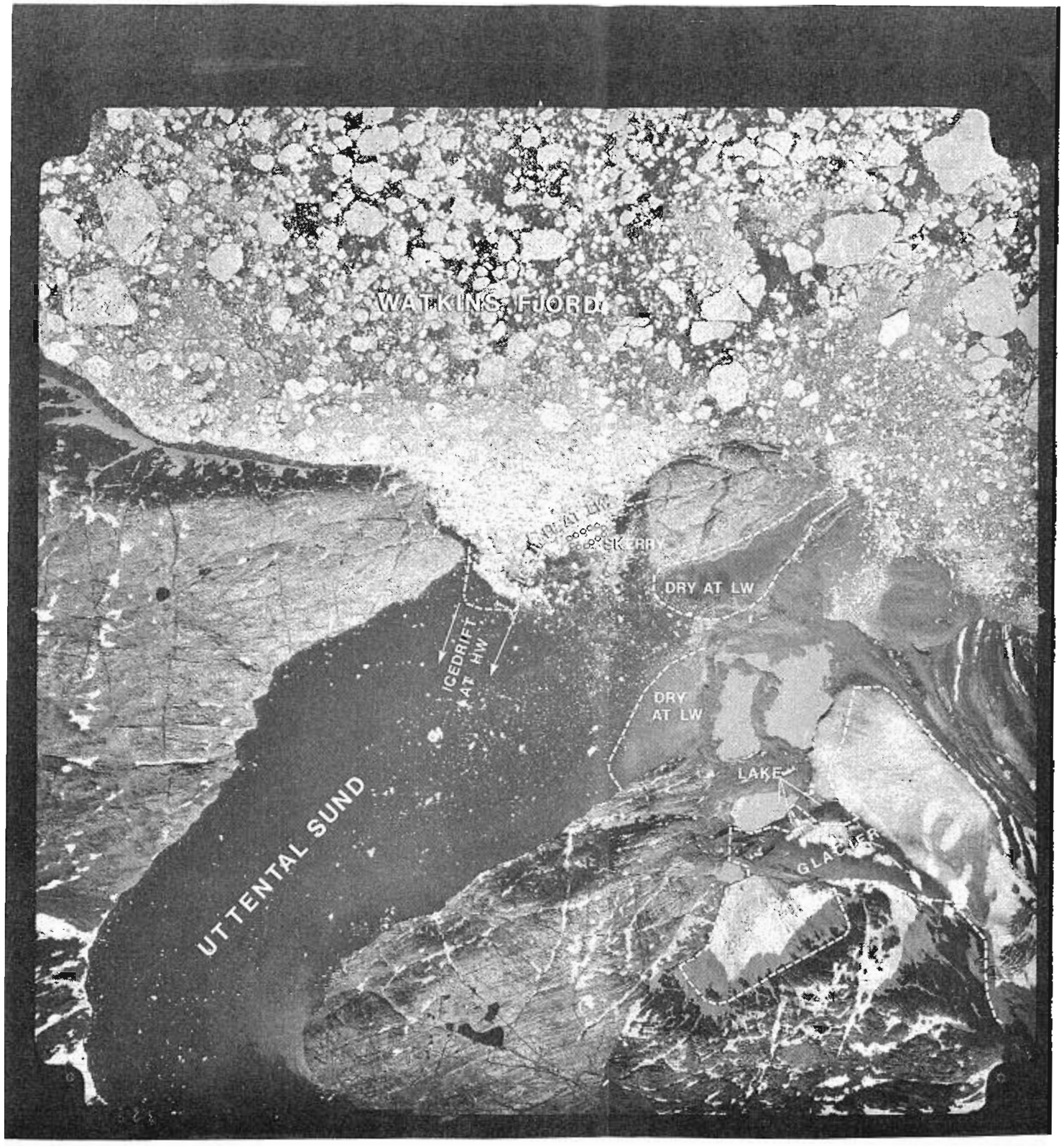
0 1 2km

PHOTO NO. 3287
23. AUGUST 1973
- SEE REFERENCE (4)

AREA FOR CAMP, PLANT ETC.

ROAD

Sted: Place: SKÆRGÅRDEN		
Emne Subject: SKÆRGÅRDEN		
Mål: Scale: 1:27.000	År: Year: 1990	Bilag nr: Supplement no: VII
Grønlands Forundersøgelser · Misissueqqaarnerit · Greenland Field Investigations		
RRV/ Surveys and Resources		



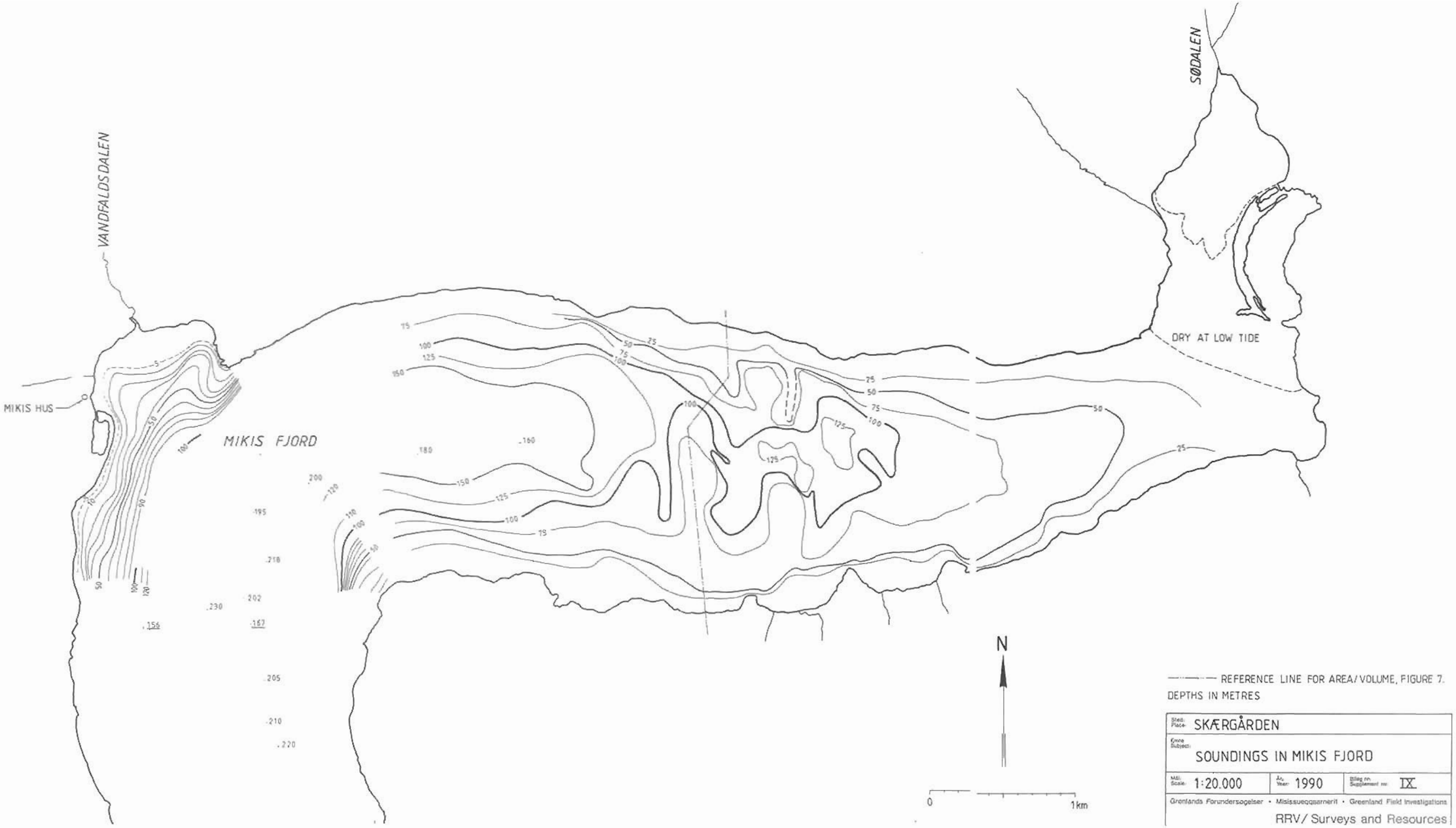
N

0 1 2km

PHOTO NO. 3291
23. AUGUST 1973
- SEE REFERENCE (4)

Sted. Place: SKÆRGÅRDEN		
Emne Subject: UTTENTAL SUND - NORTH		
Målf. Scale: 1:27.000	År. Year: 1990	Bilag nr. Supplement no: VIII

Grønlands Forundersøgelser • Misissueqqaarnerit • Greenland Field Investigations
RRV/ Surveys and Resources



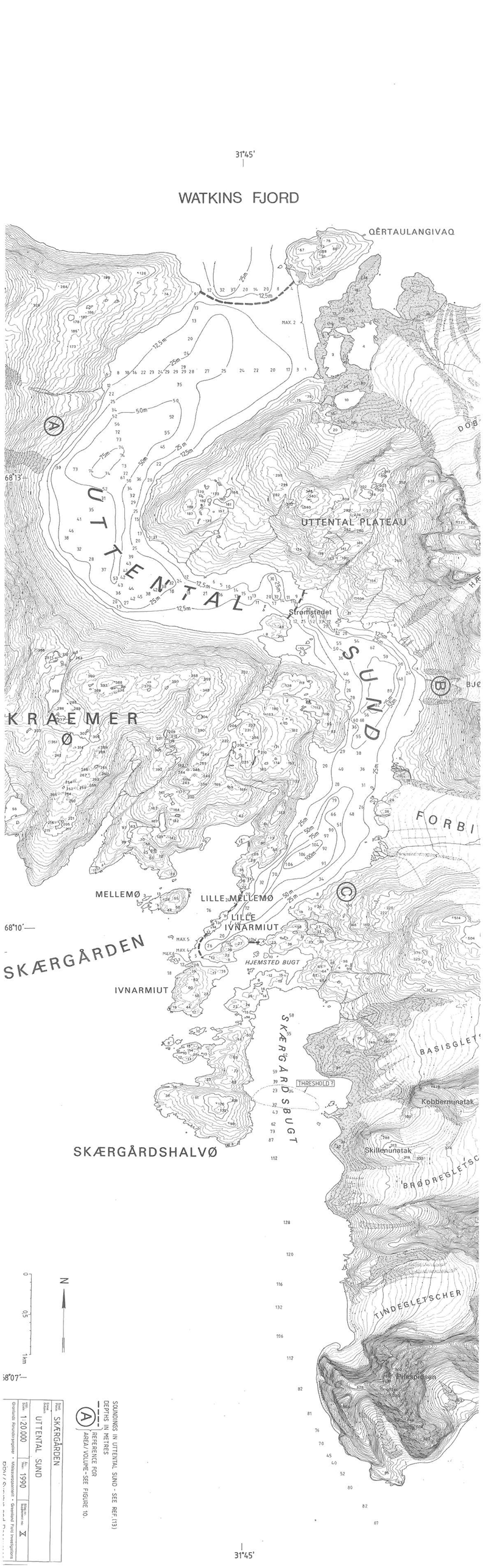
—·—·— REFERENCE LINE FOR AREA/VOLUME, FIGURE 7.

DEPTHS IN METRES

Sted: Place:	SKÆRGÅRDEN
Emne: Subject:	SOUNDINGS IN MIKIS FJORD
Mål: Scale: 1:20.000	År: Year: 1990 — Bilag nr. Supplement no: IX

Grønlands Forundersøgelser • Misissueqqaarnerit • Greenland Field Investigations

RRV/ Surveys and Resources


31°45'
WATKINS FJORD
QÊRTAULANGIVAQ
UTTENTAL SUND
UTTENTAL PLATEAU
Strømstedet
KRÆMER Ø
MELLEMØ
LILLE MELLEMØ
LILLE IVNARMIUT
68°10'
SKÆRGÅRDEN
IVNARMIUT
HJEMSTED BUGT
SKÆRGÅRD SBUGT
THRESHOLD ?
SKÆRGÅRDSHALVØ
Kobbermunatak
Skillenunatak
BRØDREGLETSCHER
TINDEGLETSCHER
Frilspidsen
68°07'
31°45'
N
0
0.5
1km
SOUNDINGS IN UTTENTAL SUND - SEE REF.(13)
DEPTHS IN METRES
REFERENCE FOR AREA/VOLUME - SEE FIGURE 10.
SKÆRGÅRDEN
UTTENTAL SUND
1:20 000
1990

Tidligere rapporter udgivet af GFU/RRV om fysiske miljøforhold:

Geotekniske rapporter nr. 1-13, December 1980 - December 1988. DGI-rapporter (Geoteknisk Institut)

Litteraturstudium over meteorologiske, ismæssige og hydrografiske undersøgelser, Østgrønland, DHI (Dansk Hydraulisk Institut). Juli 1980.

Environmental Studies Offshore East Greenland, 1980 meteorological, hydrographic and ice investigations. April 1981, DHI (Dansk Hydraulisk Institut)

Environmental Studies Offshore East Greenland, 1981 - ice, meteorological, hydrographic conditions. Januar 1982, DHI (Dansk Hydraulisk Institut)

Ambient noise in the sea off Scoresbysund, East Greenland. Januar 1982 Ødegaard & Danneskjold-Samsøe

Vurdering af besejlingsmulighederne til og fra Jameson Land. Februar 1982, DHI (Dansk Hydraulisk Institut)

Fysisk miljø i Carlsberg Fjord og Flemming Fjord, tillæg til "Vurdering af besejlingsmulighederne til og fra Jameson Land". Februar 1982 - Marts 1982, DHI (Dansk Hydraulisk Institut)

Forundersøgelser, Jameson Land, station 133, 1982. GTO/FRA, Januar 1983

Landtransport/overland transportation, Jameson Land, Flemming Fjord. GTO/FRA, dansk og engelsk version, September 1983

An Analysis of Ice-Conditions in Flemming Fjord, East Greenland. November 1983, DHI

Forsyningsbase, Supply Base, Jameson Land, Flemming Fjord. GTO/FRA, Oktober 1983 dansk og engelsk version

Baggrundsundersøgelser, Jameson Land 1983. GTO/FRA, Oktober 1983

Sne som slidlag for kørsel, Jameson Land. GTO/FRA, April 1984 dansk og engelsk version

Sneforholdene i Jameson Land. April 1984 - Københavns Universitets Geografiske Institut

Korridorer mellem Constable Pynt og det centrale Jameson Land, GTO/FRA og GFM, dansk, grønlandsk, engelsk version, December 1984

Sneundersøgelser, Jameson Land,oktober 1984 GTO/FRA og GFM med bistand fra Københavns Universitet's Geografiske Institut, Januar 1985

Sneforholdene i Jameson Land, april/maj 1985 - GTO/FRA, April 1986

Automatiske målestationer, Jameson Land GTO/FRA, April 1986

Transportkorridorer i det centrale Jameson Land GTO/FRA, December 1986

Blykoncentratspild, ved Nyhavn, Mestersvig GTO/FRA, Marts 1987. RRV 87-1

Tilstandsvurdering af bygninger og anlæg i Nyhavn, Mestervig. GTO/FRA April 1987 + fotoregistrering. RRV 87-2

Geomorfologi, Jameson Land. Delrapport 1, Hovedregioner. GTO/FRA, Juni 1987. RRV 87-3

Geomorfologi, Jameson Land. Delrapport 2, Region 5. GTO/FRA, December 1987. RRV 87-4

Automatiske målestationer, Jameson Land, sommeren 86 og 87. GTO/FRA, Januar 1988. RRV 88-1

Sarfartoq transportkorridorer, forslag og konsekvenser. KNK, GM og GTO, Februar 1988. RRV 88-2

Transportkorridorer Sarfartoq-området, teknisk rekognoscering 1987. GTO, Februar 1988. RRV 88-3

Indledende beskrivelse af: Klima, hydrologi og besejlingsforhold ved Narsaq, Sydgrønland. NTF/RRV, Maj 1988. RRV 88-4

Geomorfologi, Jameson Land. Delrapport 3, Region 3. NTF/RRV, Oktober 1988. RRV 88-5

Baggrundsundersøgelser 1988. Highwoodgruppens koncessionsområde øst for Narsaq, Sydgrønland. NTF/RRV, December 1988. RRV 88-6

Background Studies 1988. Highwood Group Concession Area east of Narsaq, South Greenland. NTF/RRV, December RRV 88-7

Geomorfologi, Jameson Land. Delrapport 4, Region 8 og 11. NTF/RRV, April 1989. RRV 89-1

Geomorfologi, Jameson Land. Delrapport 5, Region 9. NTF/RRV, Juni 1989. RRV 89-2

Klima, Jameson Land. NTF, Juli 1989.

Topographical Mapping, Platinova Resources Ltd. Concession Area, Ivittuut, Southwest Greenland. NTF/RRV, December 1989. RRV 89-3

Background Studies 1989. Platinova Resources Ltd. Concession Area. Ivittuut, South-West Greenland. NTF/RRV, January 1990. RRV 90-1

Geomorfologi, Jameson Land. Delrapport 6, Region 7 og 13. GFU/RRV, Januar 1990. RRV 90-2

Background Studies 1989. The Kangerluarsuk Concession Area. South-East of Narsaq, South Greenland. NTF/RRV, January 1990. RRV 90-3

Klimaundersøgelser 1987-89. Klimastation 503, Sarfartoq. Syd for Kangerlussuaq/Sdr. Strømfjord, Vestgrønland. GFU/RRV, Marts 1990. RRV 90-4.

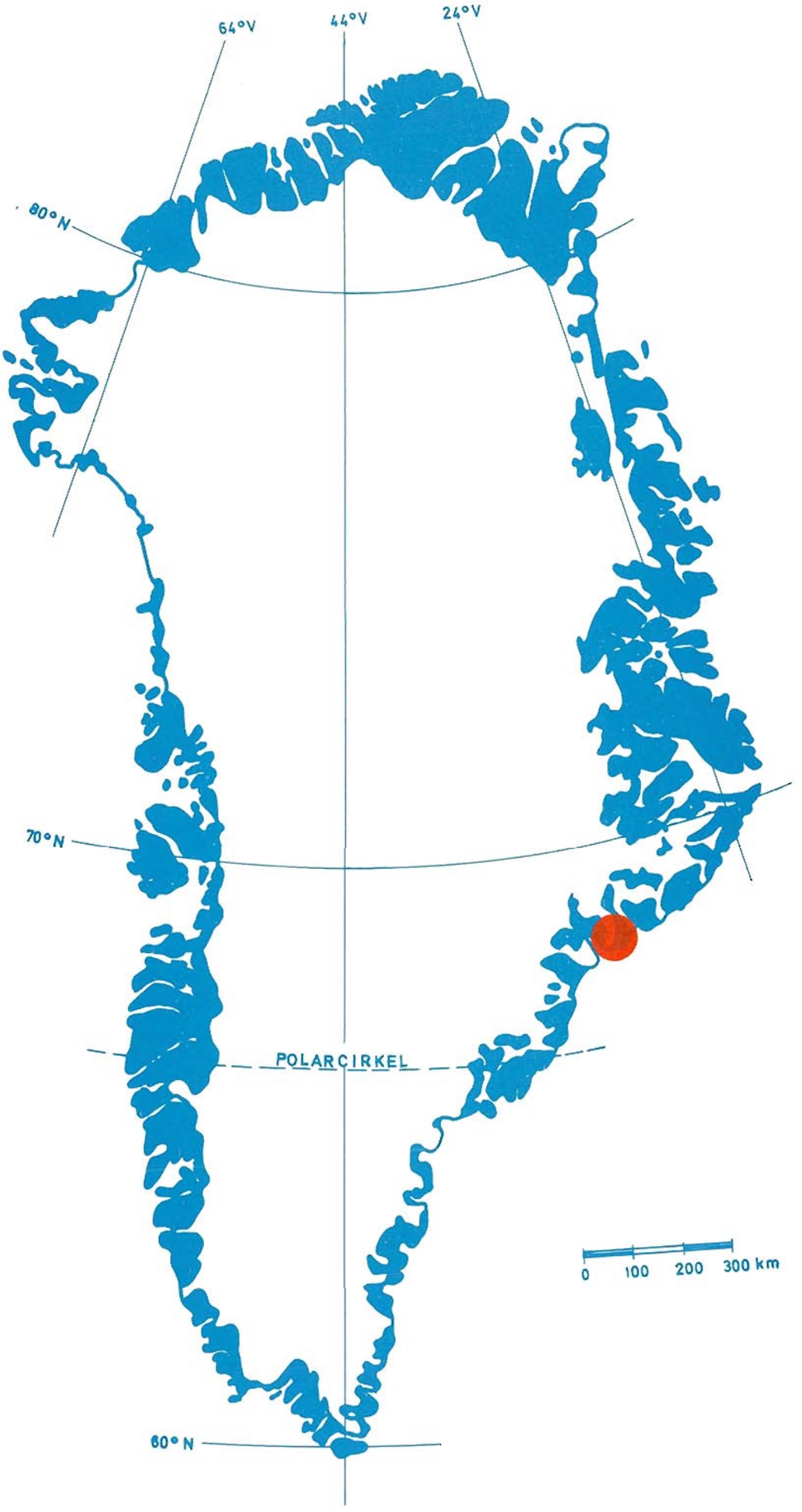
Climate 1987-1989. Weatherstation No. 503, Sarfartoq. South of Kangerlussuaq/Sdr. Strømfjord, West Greenland. GFU/RRV, March 1990. RRV 90-5.

Geomorfologi, Jameson Land. Delrapport 7. Pingel Dal, Ørsted Dal og Coloradodal. GFU/RRV, Marts 1990. RRV 90-6.

Automatiske temperaturmålestationer, Jameson Land, 1988 og 1989. GFU/RRV, April 1990. RRV 90-7.

Rekognoscering Karstryggen, Schuchert Dal, Østgrønland, 1987. GFU/RRV, August 1990. RRV 90-8.

Vand i fjeld med permafrost. Etablering af målesystem i Sorte Engel minen, 1990. GFU/RRV, Oktober 1990. RRV 90-9.


64°V
44°V
24°V
80°N
70°N
POLARCIRKEL
60°N
0
100
200
300 km