Geochemical investigation of heavy mineral concentrates from stream sediments in southern West Greenland, 62°30′N to 64°00′N - 1991 results

Peter Erfurt, Peter W. U. Appel
and Mogens Lind

Open File Series 92/1

January 1992

GGU

GRØNLANDS GEOLOGISKE UNDERSØGELSE
Kalaallit Nunaanni Ujarassiortut Misissuisoqarfiat
GEOLOGICAL SURVEY OF GREENLAND

GRØNLANDS GEOLOGISKE UNDERSØGELSE
Ujarassiortut Kalaallit Nunaanni Misissuisoqarfiat
GEOLOGICAL SURVEY OF GREENLAND

The Geological Survey of Greenland (GGU) is a research institute affiliated to the Mineral Resources Administration for Greenland (MRA) within the Danish Ministry of Energy. As with all other activities involving the non-living resources in Greenland, GGU's investigations are carried out within the framework of the policies decided jointly by the Greenland Home Rule Authority and the Danish State.

Open File Series

The Open File Series consists of unedited reports and maps that are made available quickly in limited numbers to the public. They are a non-permanent form of publication that may be cited as sources of information. Certain reports may be replaced later by edited versions.

Citation form

Open File Series Grønlands Geologiske Undersøgelse

conveniently abbreviated to:

Open File Ser. Grønlands geol. Unders.

GGU's Open File Series består af uredigerede rapporter og kort, som publiceres hurtigt og i et begrænset antal. Disse publikationer er midlertidige og kan anvendes som kildemateriale. Visse af rapporterne vil evt. senere blive erstattet af redigerede udgaver.

ISSN 0903-7322

GRØNLANDS GEOLOGISKE UNDERSØGELSE

Open File Series 92/1

Geochemical investigation of heavy mineral concentrates from stream sediments in southern West Greenland, 62°30'N to 64°00'N - 1991 results

Peter Erfurt, Peter W. U. Appel and Mogens Lind

January 1992

CONTENTS

ABSTRACT

In the southern part of the Nuuk area (62°30'N to 64°N) heavy mineral concentrates were collected from 106 streams, which mainly either drain supracrustal rocks or a stratiform chromite-bearing anorthosite complex. All samples were analyzed for gold + 34 other trace elements revealing scattered gold anomalies most of which can be ascribed to supracrustal rocks.

Furthermore 53 samples were analyzed for platinum and palladium. These results yielded a few anomalies in the anorthosite complex as well as some anomalies originating from ultrabasic lenses occurring in the supracrustal belts.

INTRODUCTION

In the eighties GGU carried out the first regional investigation of heavy mineral concentrates from stream sediments. The sample collections were carried out mainly by boat, thus only the coastal areas were covered. In 1991 a regional sampling programme was launched which aimed at covering the inland areas between Frederikshåb Isblink in the south and the Ameralik fjord in the north. The purpose of the programme is to provide reconnaissance geochemical data which can be integrated with geophysical and geological information to outline geochemical provinces or areas with a potential for mineral resources.

Sampling was conducted from the base camp Midgård situated some 16 km NNE of Fiskenæsset town and from camps in the Bjørnesund area (Fig. 1). A Bell 206 (Jet Ranger) helicopter was used for transportation.

The programme was jointly financed by GGU and by the Mineral Resources Administration for Greenland (MRA) of the Danish Ministry of Energy. Administratively, the surveyed area belongs to the southern part of the municipality of Nuuk, the capital of Greenland.

PREVIOUS WORK

The study region has been geologically mapped by GGU and is covered by published geological maps at the scale 1:100 000. During the eighties GGU carried out a stream sediment sampling programme in coastal areas mainly concerned with heavy mineral investigations, as a result of which extensive tungsten mineralizations were discovered in the Nuuk area, and scattered gold anomalies were found in heavy mineral concentrates in Bjørnesund (Appel 1989, 1990). Limited exploration has been carried out by private companies outside the Fiskenæsset area (Fig. 1).

In the Fiskenæsset area, considerable prospecting activities took place in the seventies. These were centred on chromite occurrences and possible platinum mineralisation as well as nickel copper in a regional gabbro-anorthosite complex. Appel (1989) presents a comprehensive list of released company reports, copies of which can be purchased from GGU.

Charter Consolidated Ltd. has undertaken diamond prospecting in large parts of West Greenland, mainly based on heavy mineral concentrates from stream sediment samples from selected areas. In 1972 the company participated in a joint programme in the Frederikshåb and Fiskenæsset areas with Renzy Mines Ltd. and Platinomino A/S. In 1977 sampling was performed under Charter's own concession in the Nuuk region, including parts of the area dealt with in this report. The heavy mineral concentrates were examined for diamonds and kimberlite indicator minerals, as well as analysed for base metals.

In 1985 Greenex A/S carried out reconnaissance geochemical prospecting in the Bjørnesund and Ravns Storø supracrustal rocks. The highest values recorded were 35 ppb Au and 2929 ppm Cu in stream sediment samples and 56 ppb Au in a chip sample.

GEOLOGY

Geologically, the Frederikshåb Isblink - Ameralik area covered lies within the central part of the Archaean gneiss complex of West Greenland. Except for local Proterozoic and Mesozoic dykes, the exposed rocks are Archaean, comprising c. 80% granitoid gneisses, 10% supracrustals and 10% anorthosites and related rocks.

A terrane model interpretation of the northern Nuuk region has been advocated by Friend et al. (1988, 1990) and Friend & Nutman (1991). These workers subdivide the region into three distinct crustal blocks (terranes) which were brought together in the late Archaean, the terrane boundaries being represented by mylonites or thrusts. Two of the terranes can be seen on Fig. 1. Two major late Archaean fold episodes accompanying the terrane accretion - north and west facing isoclinal nappes (F_1) and basin and dome structures (F_2) with NNE - striking axial surfaces - and produced a regional interference pattern overprinting early Archaean structures.

The adoption of such a terrane interpretation in general implies that the geological development of Archaean high-grade gneiss complexes is comparable to that of younger orogenic belts formed by plate tectonic processes. The present interpretation is that the rocks previously mapped as Nûk gneisses do not belong to one tectono-stratigraphic terrane formed during the middle Archaean. Confirmation is provided for the existence of a late Archaean unit - the 2800-2750 Ma granodioritic Ikkattoq gneisses - the dating of which shows that sialic accumulation in the Nuuk region occurred as a discrete episode in the late Archaean (Friend et al., 1988).

Two of the terranes recognised by Friend & Nutman (1991) are represented in the survey area, 97% of which consists of rocks of the Tasiusarsuaq terrane. Only six sites (~ 3% of the total) were sampled in gneisses of the Akulleq terrane, which occurs to the west and north of Buksefjord (Fig. 1). The oldest rocks of the Tasiusarsuaq terrane are the c. 3000 Ma supracrustal rocks occurring as enclaves in the gneisses throughout the block (Fig. 1). These, as well as the other supracrustal rocks of roughly similar age in the Nuuk region, are usually known under the collective term of Malene supracrustals (McGregor, 1969) and are treated as a single suite of rocks. In lieu of the present terrane model and the individuality of each terrane, it is possible that the supracrustals were originally unrelated and of different age (Friend et al., 1988). Chemical investigations of two sets of Malene supracrustal rocks now considered to represent different terranes, showed minor differences regarding depositional environment, but no definitive evidence of different formative tectonic regimes (Friend et al., 1981). The lithology varies considerably, but no formal division of the entire supracrustal sequence has been attempted anywhere, and for convenience, the term Malene supracrustal rocks is used in this report.

Within the Tasiusarsuaq terrane the intrusion of the layered gabbro-anorthosite Fiskenæsset complex into the supracrustal rocks took place at c. 2950 Ma. At about 2880 Ma grey dominantly calc-alkaline gneisses were emplaced, and the youngest rocks of this terrane are a suite of mixed granitic and tonalitic rocks, the Ilivertalik augen granite, emplaced in the gneisses at 2800 Ma (large granite mass in the central part of Fig. 1). After terrane accretion, late Archaean post-tectonic granites were emplaced.

Short descriptions of the major rock units of the Tasiusarsuaq terrane are given below, with emphasis on those most likely to have an economic potential, namely the anorthosites and the supracrustal rocks.

Ilivertalik augen granite

This consists of thick sheets of biotite- hornblende- and hypersthene-bearing granites which are sub-concordant with the regional layering in the surrounding gneisses. Thinner, discordant sheets extend up to 3 km away from the main bodies. The rocks are characterised by potash feldspar augen 1-2 cm long derived from primary tabular phenocrysts (Kalsbeek & Myers, 1973). Sheets of metadiorite and metatonalite up to 100 m thick are associated with the granites. They are compositionally layered with variable proportions of plagioclase, hornblende, diopside and hypersthene. Relict igneous textures are locally preserved. Some sheets contain an ultramafic olivine-hypersthene-magnetite cumulate near their centres grading upwards into a rusty weathering metadiorite with sulphides (Myers, 1974).

Grey gneisses

These are quartzo-feldspathic gneisses derived by deformation and metamorphism of tonalite, granodiorite and granite emplaced as sub-concordant sheets into the Fiskenæsset complex and the Malene supracrustal rocks.

The Fiskenæsset complex

This comprises a deformed and metamorphosed sheet-like basic body which was intruded into a supracrustal pillow lava sequence and is now found as thin layers and trains of inclusions within the supracrustals and gneisses. The layers have an average thickness of 380 m and a strike length of more than 200 km (Ghisler, 1976). The intrusion consists of seven major lithostratigraphic units (Myers, 1985). In ascending order these are: the Lower gabbro (50 m), Ultramafic (40 m), Lower leucogabbro (50 m), Middle gabbro (40 m), Upper leucogabbro (60 m), Anorthosite (250 m) and Upper gabbro (50 m).

Deformation was locally heterogenous, and all stages can be seen from undeformed to very strongly deformed rocks. Recrystallisation took place at both granulite and amphibolite facies, and most rocks have equigranular textures. Locally igneous structures and cumulate textures are preserved. Myers (1985) suggests that the major part of the Fiskenæsset complex formed by crystal fractionation and gravity settling of individual cumulus crystals (olivine, pyroxene, plagioclase and chromite), clusters of crystals (plagioclase) and giant poikilitic crystals (plagioclase enclosed by pyroxene). The influx of three successive pulses of tholeiitic magma seems involved in the formation of the complex (Myers, 1985) which has the average chemical composition of a calcic high-alumina leucogabbro with olivine- tholeiitic affinities (Ghisler, 1976).

Chromite and chromitite rocks are mainly confined to the Upper leucogabbro and Anorthosite units. By far the major part is concentrated in the latter unit where chrome-rich rocks occur as discontinuous layers and lenses usually between 0.5 and 3 m thick (Myers, 1985). A maximum thickness of 20 m is reached locally, mainly as a result of tectonic thickening. Two main types of chromitite rocks are distinguished by Ghisler (1976):

Augen chromitite is the most common type, spotted rocks consisting of white plagioclase in a black host of chromite and hornblende, the latter often altered to biotite. The plagioclase augen, usually 0.5 to 2 cm in size, consist mostly of a mosaic textured mass of grains 1-2 mm across, but single crystal augen occur. The cumulus plagioclase can dominate the rock, making up as much as 80%, reducing the chromite content to about 10%.

Hornblende chromitite usually forms layers 0.5 to a few cms thick. Horizons containing this rock are generally composed of several tens of hornblende chromitite layers with an equal number of anorthosite layers of similar thickness, but plagioclase-free seams of almost massive chromite and hornblende up to 1 m thick are found at several localities. The hornblende-chromitite is nearly always fine-grained and appears black, massive and homogenous, with hornblende often partly altered to biotite.

All gradations between the two types are found as well as structural types of chromitites. The end product of progressively increasing deformation is a schistose chromitite with distinct metamorphic banding (Ghisler, 1976). As a result of hydrothermal alteration secondary minerals such as fuchsite and chrome epidote were formed.

The chromites associated with anorthosite contain in rare cases sulphide amounts large enough to be seen with the naked eye; 0.8% sulphides which contained 0.35% Ni, 0.11% Cu, 4 ppm Au and 31 ppm Ag were found in one bulk sample (Ghisler, 1976). Sulphide showings are found throughout the complex, the largest amount in association with ultramafic rocks. The sulphides are commonly pyrrhotite, chalcopyrite and pentlandite, mineralised ultramafics on average contain 0.1-0.3% Cu and 0.1-0.2% Ni. In an overall view, the Fiskenæsset chromites have a striking similarity to the Sittampundi chromite deposits, with respect to geology, mineralogy and chemistry (Ghisler, 1976). However, there are also similarities between the Merensky reef chromites of the Bushveld complex and the chromites of Pt-anomalous ultramafic rocks in the Fiskenæsset complex, in particular with respect to Cr/Fe ratios. For this reason some analyses for platinum group elements (PGE) have been made on Fiskenæsset rocks. The highest PGE-values recorded are from a hornblende peridotite which over a few metres is mineralised with 1-5% disseminated sulphides. One grab sample with 0.54% Cu and 0.13% Ni contained 0.4 ppm Pt, 2.0 ppm Pd, 0.03 ppm Rh, 0.2 ppm Au and 2.7 ppm Ag (Ghisler, 1976). Page et al. (1980) undertook a geochemical investigation of the contents of some PGE in relation to primary stratigraphy, and concluded that the highest values 310 ppb Pt, 175 ppb Pd and 220 ppb Rh occurred in thin, lenticular ultramafic channel deposits in the upper part of the Lower leucogabbro unit and throughout the Middle gabbro unit. These channel deposits of ultramafic rocks were formed by magmatic currents serving as important carriers and concentrators of PGE. Chromites generally had low PGE-values, except were they appeared to be channel deposits within the Upper leucogabbro unit (Page et al., 1980). The chromites of the Fiskenæsset complex constitute a large low-grade resource in the order of a 100 million tonnes of "ore", on the average containing 14% Cr_2O_3.

The Malene supracrustal rocks

The lithology of the supracrustal rocks varies considerably from north to south in the survey region. The area between the eastern part of Buksefjorden and Sermilik (Fig. 1) described by Chadwick and Coe (1983), and the Ravns Storø supracrustal belt described by Friend (1975) serve to illustrate the lithological diversity.

Chadwick & Coe (1983) divide the supracrustal rocks in the Buksefjorden area into an eastern and a western part. The boundary between the two parts coincides with the terrane boundary of Friend & Nutman (1991). The western part of the supracrustals lies within the Akulleq terrane, the eastern part within the Tasiusarsuaq terrane. Lithological range is greater in the western part and only a few of the metasedimentary rocks known from here occur in the eastern part. It is possible that sedimentary rocks were not a significant part of the eastern succession which is dominated by homogenous as well as banded amphibolites, whereas ultramafic rocks and paragneisses are rare, occurring only as small enclaves (Chadwick & Coe, 1983). From Buksefjorden south to Sermilik the amphibolites are mainly metagabbros and metabasites. Diopside-hornblende-plagioclase ± quartz ± garnet is a common assemblage. Boudinè lenses of calc-silicate rocks are also present. On the north coast of Sermilik a granulite facies metamorphosed supracrustal sequence shows more variable lithology. It includes garnet-clinopyroxene-hornblende banded rock in layers up to 100 m thick resembling deformed pillow rocks (Friend et al., 1981), garnet-sillimanite-plagioclase-biotite metasediments interlayered with metabasite and clinopyroxenite, and grey marble with thin layers of quartzite presumed to represent original bedding. Megacrystic metagabbro with abundant plagioclase-rich aggregates are also present.

Further south in the investigated area (Fig. 1) is the up to 4.5 km thick Ravns Storø supracrustal belt which is dominated by different types of amphibolites, with subordinate metasediments and leucocratic rocks. Deformation and metamorphism have almost obliterated original stratigraphy, and the supracrustal association may include sheets of rocks of widely different ages and tectonic setting brought together by major Archaean tectonic displacements (B. Chadwick, pers. comm. 1991). Relatively undeformed primary structures such as pillows and agglomerates can be recognised at places, with a transitional deformation sequence to completely metamorphic textured rocks also occurring (Friend, 1975). Even in the best preserved pillow structures, the state of strain is such that unambiguous way-up criteria are not evident (B. Chadwick, pers. comm. 1991). Friend (1975) divided the main part of the Ravns Storø belt into two mappable parts, the Ikatoq and Ikatup units. Since way-up criteria and top and bottom of the supracrustal belt cannot be firmly recognised, the formal term Ravns Storø Group should not be used.

The Ikatoq unit consists of hornblende porphyroblastic amphibolites concordantly interlayered with up to 30 cm thick irregular, boudinaged horizons of metasediments, and with two types of pale grey leucocratic schists. The latter comprise staurolite-cordierite rocks with anthophyllite, plagioclase and quartz constituting the other main phases, and anthophyllite-cummingtonite schists with plagioclase plus minor quartz and garnet. The hornblende porphyroblastic amphibolites may be regarded as sills. The leucocratic schists and metasediments intruded by these are seen as a suite displaying a primary depositional composition variation constituting a layering which is from a few centimetres to 2 metres thick (B. Chadwick, pers. comm., 1991). These horizons grade into hornblende porphyroblastic amphibolites containing reddish brown weathering tremolite-rich ultramafic bodies, ranging in size from a few metres to lengths of about 500 metres.

The Ikatup unit consists of a layered amphibolite series, partly intrusive in origin, and a series of rocks dominated by pillow lavas. The layered amphibolites are c. 220 m thick and, apart from minor pillow lavas and leucocratic schists, consist of seven cycles of ultramafic to mafic rocks. Each cycle grades from pale green tremolite schist to a more "typical" amphibolite, with the introduction of plagioclase and hornblende at the expense of tremolite. The pillow lava series is 300-500 m thick and formed of several sub-units. The relatively less-deformed pillows are uniform grey and commonly measure 30 x 15 cm. They consist of a plagioclase-rich core with specks of black hornblende and a mafic hornblende-rich margin. The interpillow material is a dark grey hornblende amphibolite. With increasing metamorphism the pillows become yellow-green as plagioclase is converted to epidote, and with increasing deformation the pillows are destroyed, resulting in the formation of grey and grey/yellow-green banded amphibolites.

Agglomerates are associated with the pillow lavas. They consist of variously shaped blocks, usually 10-15 cm in size, set in a grey amphibolite matrix. The fragments consist partly of broken-up pillows similar in mineralogy to the pillow cores and partly of wholly felsic material. The felsic agglomerate fragments are of unknown origin; there are no major similar stratigraphic horizons in the area (Friend, 1975).

Friend (1975) and Friend et al. (1981) relate the Ravns Storø supracrustal rocks to an oceanic environment, the amphibolites erupted as submarine volcanic rocks, intruded by gabbros. The rocks have, allowing for the high MgO content of early Archaean crust, typical low-K tholeiitic compositions, as found in modern mid-oceanic basalts. This affinity, however, is also found in basalts of modern marginal basins. Seen in conjunction with the occurrence of metasediments and felsic agglomerate clasts of unknown provenance, some sort of island-arc environment may be suggested for the Ravns Storø belt. This is highly speculative, and in contrast to Friend (1975), it links the supracrustal belt to the model favoured by Windley (1984) for Archaean greenstone belts.

The leucocratic schists are compositionally very different from the other supracrustal rocks. They have SiO_2-contents ranging from c. 50-75%, and for a specific SiO_2-value chosen, they have too low K_2O-contents and too high Na_2O contents to clearly represent either metasediments, rhyolites or other volcanic rocks. A possible explanation is that the leucocratic schists are the metamorphosed equivalents of hydrothermally altered volcanic rocks or exhalites (Beeson, 1988).

The Bjørnesund supracrustal rocks have not been investigated in any detail, neither in this campaign nor in the previous mapping carried out by GGU in the seventies. They consist of strongly deformed sequences of pillow lavas, pillow breccias, and massive amphibolites intercalated with tens of metres wide zones consisting of quartz, sillimanite and anthophyllite rocks, locally with sulphides and in rare cases with thin tourmalinites. Furthermore are found lenses up to several hundred metres long and tens of metres wide of ultrabasics.

The Bjørnesund supracrustal rocks have been subject to carbonate alteration. This alteration occurs as local veining as well as more regional carbonate replacement. The regional replacement is found in shear zones which cut the supracrustals as well as the gneisses. The carbonate alteration appears as a fine network of brownish carbonate veinlets penetrating the rocks. Some cases have been observed where more than 50 percent of the rock has been replaced.

MINERAL INDICATIONS IN THE SUPRACRUSTAL ROCKS

In the supracrustal rocks of the Frederikshåb Isblink - Ameralik region several mineralizations have been discovered. In the northern part of the survey area in the Akulleq terrane at L. Narssaq (Fig. 1) is a the supracrustal sequence with a tens of metres wide horizon of calc-silicates with scattered molybdenite mineralizations. In the same area semimassive pyrrhotite-chalcopyrite mineralized amphibolites have been found in metre wide zones.

In the coastal area near Buksefjorden hydrothermal alteration zones consisting of anthophyllite-gedrite mineralized with chalcopyrite, molybdenite and gahnite have been found with strike lengths of some hundred metres and widths up to a couple of metres.

In the granulite facies metamorphosed supracrustals of the Sermilik area, scheelite mineralizations have been found as thin layers, stringers and specks in banded amphibolites.

The heavy mineral concentrates collected by GGU in the eighties revealed various anomalies which presumably originate from supracrustal enclaves.

Gold anomalies were found in the Sermilik and Grædefjord areas as well as in Bjørnesund. The latter presumably originate from the Bjørnesund supracrustal rocks.

Tungsten was found as scattered anomalies in the Sermilik and Grædefjorden areas, again presumably derived from supracrustal rocks.

Boron anomalies have been found in streams draining supracrustal rocks of Sermilik and Bjørnesund. These anomalies presumably stem from tourmalinites, a rock type which has been found in the supracrustals of the Nuuk region (Appel, 1988, 1992).

PHYSIOGRAPHY AND CLIMATE

The relief of the surveyed region varies considerably. A western coastal belt comprising about one-fifth of the region has elevations from 0 to 300 m. The northern part of this is dominated by almost flat terrain, while further south the topography consists of low ridges striking roughly NE-SW and reflecting geological structure. Drainage is poorly developed. This is particularly true in the outcrop area of the Ravns Storø supracrustals, which outcrop mainly on a number of very flat islands which are dominated by swampy areas and a topography which varies between sea level and 50 m altitude. This particular area is thus not suited for sampling coarse grained stream sediments; thus only a few heavy mineral concentrates were collected, but to compensate the stream sediment sampling programme was expanded (Erfurt et al., 1991).

In the inland and remaining four-fifths of the region, drainage is well developed due to the mountainous alpine-like terrain with deep relief and an elevation ranging from 0 to 1800 m, average about 600 m. Erosion rate is high due to the seemingly perennial nature of most streams (except for the winter freeze), of which many drain ice/snow fields.

In the area as a whole, temperatures below freezing prevail from October to April and temperatures above freezing from May to September. The annual mean temperature (-1.0^{o}C in the central coastal part of the area) is too high for permafrost to occur at sea level. Average temperatures will decrease with elevation by about 6 to 10^{o}C/km, but in summer temperatures may also increase inland from the coast due to "continentality" (Braithwaite, 1991). Discontinuous permafrost may occur at higher elevations. The mean annual precipitation in the area is high, c. 765 mm water, fairly evenly divided between winter and summer. Most precipitation from October to April is snow, and the main snowmelt occurs in May.

The 1990/91 season was fairly normal in the surveyed area with regard to temperatures and precipitation, and consequently runoff and stream sediment transport probably occurred on an average level.

The meltwater from the Inland Ice drains through narrow canyons and/or large lakes into fjords dissecting the landscape. Glaciers protruding from the main ice cap at places drain directly into fjords, e.g. the Sermeq glacier (Fig. 1). Valleys and gentle slopes are covered with till and talus, and marine deposits occur inland at the mouths of some larger rivers. Older and recent moraines, as well as glaciofluvial deposits, cover large parts of areas close to the Inland Ice.

The vegetation cover (herbs, low scrub, grass) is moderate in the coastal low relief area and the bedrock exposure is about 25-30%, best where ridges dominate the landscape. Inland, the exposure is generally 50-60%, except in larger broad valleys which tend to support vegetation.

SAMPLING

In the inland area between Ameralik fjord 64^{o}N and Bjørnesund, 44 stream sediment samples were collected by Peter Erfurt and Karen Bollingberg in 1991. In the Bjørnesund - Frederikshåb Isblink area Mogens Lind and Peter Erfurt, assisted by Jette Halskov and Jan Sangstad, collected 42 stream sediment samples. This latter sampling programme was of a semiregional character, locally with a high sampling density in areas where the previous sampling programme revealed gold anomalies (Appel, 1989).

On the islands where the Ravns Storø supracrustals outcrop limited sampling for coarse stream sediments was conducted during the 1991 field season. The low topography islands do not have suitable streams, and the easternmost island with higher topography was sampled in 1985 but the samples had not been analyzed for gold (Appel, 1989). The 1985 samples have now been analysed for gold and 34 other elements together with the samples collected in 1991, and the results are included in this report.

The sample sites for the regional programme were selected prior to the field season and marked on arial photographs. The sites were selected according to the present knowledge of the geology. The main targets were streams draining supracrustal enclaves as well as streams draining the Fiskenæsset anorthosite complex. These streams were rather densely sampled, whereas areas dominated by gneisses and the Ilivertalik granite were spot sampled only.

At each sample site 5 to 10 litres of detrital material was collected, sized less than 5 cm, preferably from coarse gravels in high energy environments. Each sample was composed of 2 to 5 subsamples from different locations in the stream bed. A few samples collected on foot traverses were sieved and panned at the sampling site, while all samples from the helicopter programme were brought back to camp for further treating. The volume of the samples was measured prior to wet sieving into two grain size fractions using a sieve aperture of 0.5 mm. The coarse fraction was discarded after visual inspection for economic minerals. From the fine fraction heavy mineral concentrates were produced on a rotary automatic panning device - known as "goldhound" (Toverud, 1984); this device is manufactured by Gold Screw Inc., California. The sampling procedure for the 1985 campaign has been described in Appel (1989).

A special sampling programme was conducted in a large delta in the Qôrorssuaq valley in order to test the possibility of a placer deposit. This is reported in Appendix 1.

SAMPLE PREPARATION AND ANALYSIS

The heavy mineral concentrates were shipped to Denmark, where they were dried and split. One of the splits were sent to Activation Laboratories, Canada, where they were analysed by instrumental neutron activation (INAA) and some samples for further analyses by fire assay combined with inductively coupled plasma emission spectrometry (ICP-ES). Table 1 lists the elements analysed for, and the analytical detection limits of the elements considered relevant for presentation in this report.

DATA PRESENTATION

The results considered significant are presented in Geochemical Maps (Figs. 2 to 11). However, not all the results could spatially fit into the standard 1:1 000 000 scale maps. In such cases the most anomalous samples were chosen for presentation in the geochemical maps. Also given on the geochemical maps is a summary of statistical parameters and histograms of the frequency distribution for each element. All analyses presented are INAA, except Pt and Pd which were analysed by ICP-ES. Samples collected south of 63°N were analysed for gold by ICP-ES. The size of the dots is related to the element concentration of the samples as indicated below the histogram. In cases where the frequency distribution approximates log-normal the maximum dot size corresponds to the 98th percentile of the distribution, otherwise the scaling has been chosen so as to reflect variations in the geochemical background as clearly as possible. Maximum values are included with the statistical parameters in the figures. The complete set of assay results is obtainable from the GGU data base upon request.

DISCUSSION AND PRELIMINARY INTERPRETATION OF THE RESULTS

The gold contents in the stream sediments are plotted in Fig. 2. Most of the anomalies can be ascribed the proximity to supracrustal rocks, such as the anomalies in the Bjørnesund area, where especially the supracrustal belt on the north shore of Bjørnesund stands out. The Ravns Storø supracrustals only contribute rather small amounts of gold in the heavy mineral fraction of the stream sediments. It should, be borne in mind that most of the streams draining the Ravns Storø supracrustal rocks carry very little coarse material. The most significant gold anomalies are found in two streams on the north side of Bjørnesund, where they drain a supracrustal enclave with prominent ultrabasic bodies. In this supracrustal enclave anthophyllite zones and thin tourmalinites together with a prominent rustzone are found. Analyses revealed a few scattered gold anomalies from grab samples of amphibolites (Appel, 1992).

The supracrustal rocks along the south side of Bjørnesund yield small gold anomalies in the stream sediments, confirming the pattern found in a previous investigation (Appel, 1989). Preliminary analyses have been made of chip and grab samples of carbonate-altered Bjørnesund supracrustals, of which the most significant result is a fire assay ICP analysis which returned 5.2 ppm gold.

Most of the other gold anomalies shown on Fig. 2 can be ascribed to supracrustal rocks, such as the anomalies on the south side of Grædefjorden, which obviously stem from an extensive supracrustal enclave.

In two streams draining the Fiskenæsset anorthosite complex small gold anomalies were found (Fig. 2). The gold is probably derived from ultramafic layers in the complex. Such gold bearing ultramafics were recorded from the Fiskenæsset complex by Platinomino A/S (Appel, 1992).

The remaining gold anomalies shown on Fig. 2 appear to be in gneisses, but probably originate from minor supracrustal enclaves not indicated on the geologic map.

Platinum distribution is shown in Fig. 3. There are only few and rather small anomalies of which most can be ascribed to the Fiskenæsset anorthosite complex. The anomalies in the outer Bjørnesund area and the southernmost anomaly probably stem from ultrabasics in the supracrustal rocks. Of the samples from streams draining the Fiskenæsset complex as well as the Bjørnesund and Ravns Storø supracrustals 53 were analysed for Pt and Pd.

The palladium distribution pattern shown in Fig. 4 is diffuse, and most values are quite low. The two maximum values occur in the Bjørnesund area where they can be ascribed to ultrabasic lenses in the supracrustals.

The zinc contents in the heavy mineral concentrates is plotted in Fig. 5. The Bjørnesund and Ravns Storø supracrustal rocks do not appear to produce significant zinc anomalies, whereas the Fiskenæsset anorthosite complex surprisingly appears to yield prominent zinc anomalies. One explanation could be that small amounts of sphalerite could be associated with some of the pyrrhotite-chalcopyrite mineralizations found in the Fiskenæsset complex. Another possible explanation is that the zinc could be derived from the particular supracrustals into which the anorthosite complex intruded. Ghisler (1976) reports scattered grains of sphalerite in the amphibolites occurring adjacent to the Fiskenæsset complex. A peculiarity is that the fine grained stream sediments from the Bjørnesund supracrustal rocks have high zinc contents, in contrast to the samples from the Ravns Storø supracrustals (Erfurt et al., 1991).

The chromium anomalies shown in Fig. 6 are clearly related to the Fiskenæsset anorthosite complex.

The nickel distribution pattern is depicted in Fig. 7, and it is obvious that most of the nickel anomalies can be ascribed to the Fiskenæsset anorthosite complex. A few minor nickel anomalies occur in the gneisses, but these are likelyu to be derived from the major Proterozoic dykes occurring in West Greenland. It is also apparent that the ultrabasic lenses occurring in some of the supracrustal sequences also shed nickel into the heavy mineral concentrates.

The cobalt distribution pattern (Fig. 8) reveals again an interesting difference between the main supracrustal belts. The Ravns Storø supracrustal rocks appear enriched in cobalt compared to the Bjørnesund supracrustals.

The lanthanum, cerium and neodymium distribution patterns as shown in Figs. 9-11 are quite remarkable. The Fiskenæsset anorthosite complex, and especially the part of the complex outcropping in Qeqertarssuatsiaq, stands out. This is quite unexpected in so far as anorthosite complexes are not known for high contents of light rare earth elements (LRRE). The following explanation is offered. LREE occur frequently in sphene where they can constitute several percent; sphene is not common in the Fiskenæsset anorthosite complex, but Ghisler (1976) reported altered chromitite horizons with up to 13% sphene.

It should be emphasized in conclusion, that the results reported here show good correlation with the investigations carried out on the fine grained stream sediments (Erfurt et al., 1991). One exception, however, is gold, which does appear more sparse in the heavy mineral concentrates than in the silt samples. An explanation could be that the gold is so fine grained that it often "floats" away in the panning process of the heavy mineral concentrates.

ACKNOWLEDGEMENTS

The authors thank Agnete Steenfelt for producing the geochemical maps, Peter Dawes for making helpful suggestions improving the manuscript and Tony Higgins for improving the English.

REFERENCES

Appel, P.W.U. 1988: Stratiform tourmalinites in the Archaean tungsten province of West Greenland. Mineral. Petrol., 39, 79-91.

Appel, P.W.U. 1989: Investigations of heavy mineral concentrates from stream sediment samples collected during the period 1982 to 1986 in the Nuuk area, West Greenland. Open File Ser. Grønlands geol. Unders. 89/1, 17 pp.

Appel, P.W.U. 1990: Tungsten mineralization in the Nuuk region, West Greenland. Open File Ser. Grønlands geol. Unders. 90/4, 51 pp.

Appel, P.W.U. 1992: Bjørnesund project - 1991, southern West Greenland. Rapp. Grønlands. geol. Unders., in press.

Beeson, R. 1988: Identification of cordierite-anthophyllite rock types associated with sulphide deposits of copper, lead and zinc. Trans. Instn. Min. Metall. (Sect. B: Appl. Earth Sci.) 97, B108-B115.

Braithwaite, R.J. 1991: Temperature and precipitation climate between Paamiut and Nuuk, West Greenland. Internal Note, Grønlands geol. Unders.

Chadwick, B. & Coe, K. 1983: Descriptive text to Geological map of Greenland 1:100 000 Buksefjorden 63 V.1 Nord. The regional geology of a segment of the Archaean block of southern West Greenland. Grønlands geol. Unders., 70 pp.

Erfurt, P., Steenfelt, A. & Dam, E. 1991: Reconnaissance geochemical mapping of southern West Greenland from 62°30'N to 64°00'N - 1991 results. Grønl. geol. Unders. Open File Ser. 91/9, 18 pp.

Friend, C.R.L. 1975: The geology and geochemistry of the pre-Ketilidian basement complex in the Ravns Storø area, Fiskenæsset region, Southern West Greenland. Unpublished Ph.D thesis, Univ. London, 245 pp.

Friend, C.R.L., Hall, R.P. & Hughes, D.J. 1981: The geochemistry of the Malene (Mid-Archaean) ultramafic-mafic amphibolite suite, southern West Greenland. Spec. Publs geol. Soc. Aust. 7, 301-312.

Friend, C.R.L., Nutman, A.P. & McGregor, V.R. 1988: Late Archaean terrane accretion in the Godthåb region, southern West Greenland. Nature 335, 535-538.

Friend, C.R.L., McGregor, V.R. & Nutman, A.P. 1990: Late Archaean crustal evolution in the Nuuk region of southern West Greenland. In Glover, J.E. and Ho, S.E. (ed.): Third International Archaean symposium, Perth 1990, Extended abstr. vol., 253-255.

Friend, C.R.L. & Nutman, A.P. 1991: Refolded nappes formed during late Archaean terrane assembly, Godthåbsfjord, southern West Greenland. J. Geol. Soc. Lond. 148, 507-519.

Ghisler, M. 1976: The Geology, Mineralogy and Geochemistry of the Pre-Orogenic Archaean Stratiform Chromite Deposits at Fiskenæsset, West Greenland. Monogr. Series Miner. Deposits 14, 156 pp.

Kalsbeek, F. & Myers, J.S. 1973: The geology of the Fiskenæsset region. Rapp. Grønlands geol. Unders. 51, 5-18.

McGregor, V.R. 1969: Early Precambrian geology of the Godthåb area. Rapp. Grønlands geol. Unders. 19, 28-30.

Myers, J.S. 1974: Acid and intermediate intrusions, deformation and gneiss formation, north-east of Fiskenæsset. Rapp. Grønlands geol. Unders. 73, 7-15.

Myers, J.S. 1985: Stratigraphy and structure of the Fiskenæsset complex, southern West Greenland. Bull. Grønlands geol. Unders. 150, 72 pp.

Page, N.J., Myers, J.S., Haffty, J., Simon, F.O. & Aruscavage, P.J. 1980: Platinum, palladium and rhodium in the Fiskenæsset complex, southwestern Greenland. Econ. Geol. 75, 907-915.

Toverud, Ö. 1984: The Goldhound: A new device used in geochemical prospecting for tin and tungsten in Sweden. In Armands, G. & Schager, S. (ed.) 16^{e} Nordiske Vintermötet Stockholm 9-13 januari 1984. Abstracts. Medd. Stockholms Univ. Geol. Inst., nr. 255, p. 229.

Windley, B.F. 1984: The evolving continents, 2nd Edition. New York: John Wiley & Sons, 399 pp.

<u>Company reports available for inspection at GGU:</u>

Brunet, J.E. 1978: Report on the investigation of Western Greenland 1977. Internal report, Charter Consolidated Limited, 12 pp, 3 appendices, 16 maps.

Christensen, K. 1985: Greenex' Prospecting 1985. Rapport nr. 4-85. Internal report, Greenex A/S, 21 pp.

APPENDIX
QÔRORSSUAQ VALLEY BULK SAMPLING

PREVIOUS INVESTIGATIONS

Geochemical sampling by GGU in 1985 from the coastal parts of the Bjørnesund area revealed anomalous gold contents in a heavy mineral concentrate from fairly fine grained stream sediments at the outlet of the Qôrorssuaq valley river (Appel, 1989). As the valley hosts a large inland delta, it was decided to conduct a preliminary test of the placer potential.

PHYSIOGRAPHICAL AND GEOLOGICAL SETTING

The Qôrorssuaq valley stretches approximately east-west from the inner south side of Bjørnesund to the Inland Ice, with a total length of 14 km (Fig. 1). The upper narrow part of the valley has a V-shaped profile and a steep gradient with the river running in a gorge. About 7 km from the fjord the valley becomes wider and attains a U-shaped profile. The gradient decreases rapidly and the valley floor is sediment covered. The central part is occupied by a 5 km long and 500 to 700 m wide alluvial plain with deltaic deposits (Fig. 12). On both sides this plain is bordered by a combination of alluvial terraces, glacial deposits, and towards the valley sides tallus cones. A low bedrock threshold at the valley outlet impedes migration of the delta into the fjord. The river obtain its main input from a meltwater lake adjacent to the Inland Ice. Further contributions come from rivers draining local glaciers and lakes on the highland plateaus. On entering the alluvial plain the main flow of the river is divided into two branches flanking the plain. The proximal part is characterized by a braided pattern of active and abandoned channels separated by gravel bars, while the lower reaches are cut by only a few abandoned channels.

Geologically the valley is situated within quartzo-feldspathic gneisses. The Bjørnesund supracrustal belt runs nearly parallel to the valley on the highland plateau to the south. It caps the southern valley side for the easternmost 7 km.

SAMPLING

The sampling programme comprised 3 bulk samples with volumes of 90 to 130 litres, and 7 smaller samples with volumes of 27 to 43 litres. Sample locations are shown in Fig. 12. Sample sites were selected to represent high energy environments, preferably coarse gravels in front of the upstream end of point bars in abandoned channels. After removing boulders from the surface a pit was dug and the minus 10 cm material sampled. Fine grained material attached to the plus 10 cm boulders was washed off and combined with the minus 10 cm fraction. Wet volumes of the minus 10 cm and the plus 10 cm fractions were measured. The 3 bulk samples consisted of one main and one subsample. The latter consisted of 15 litres of minus 10 cm material collected as a channel sample in the pit wall. Boulders more than 10 cm obtained during this step were treated as described for the main sample. The subsamples were wet sieved through a set of sieves with apertures of 10, 5, 1 and 0.5 mm and their volumes were measured. The main samples were wet sieved through the 0.5 mm sieve. The minus 0.5 and 0.5 to 1 mm fractions were processed in the "Goldhound" as described for the regional samples. Depth of pit and volume of the various fractions are presented in Table 2. Furthermore maximum size of boulders within 10 metres of the pit is recorded. Due to defect equipment sieving data were obtained for two of the subsamples only. The histograms in Fig. 13 illustrate the grain size distribution in these subsamples.

ANALYTICAL PROGRAMME

The following analytical programme is in progress for the heavy mineral concentrates: 1. Splits of all samples are analysed as described for the regional samples. 2. Splits of the main sample from the three bulk samples are reserved for mineralogical investigations. 3. Determination of total gold will be made in the remaining concentrates.

PRELIMINARY RESULTS

At the time of writing analytical results are available for the splits only. Table 3 presents the analytical results for gold obtained by INNA and ICP-ES and for palladium by ICP-ES. Platinum was below detection limit in all samples. The reported values, all occurring within the 10 ppb range, are very low, especially considering that they represent heavy mineral concentrates. Although the full analytical data set is not available, the immediate impression is that the Qôrorssuaq valley alluvial plain holds no potential for placer gold.

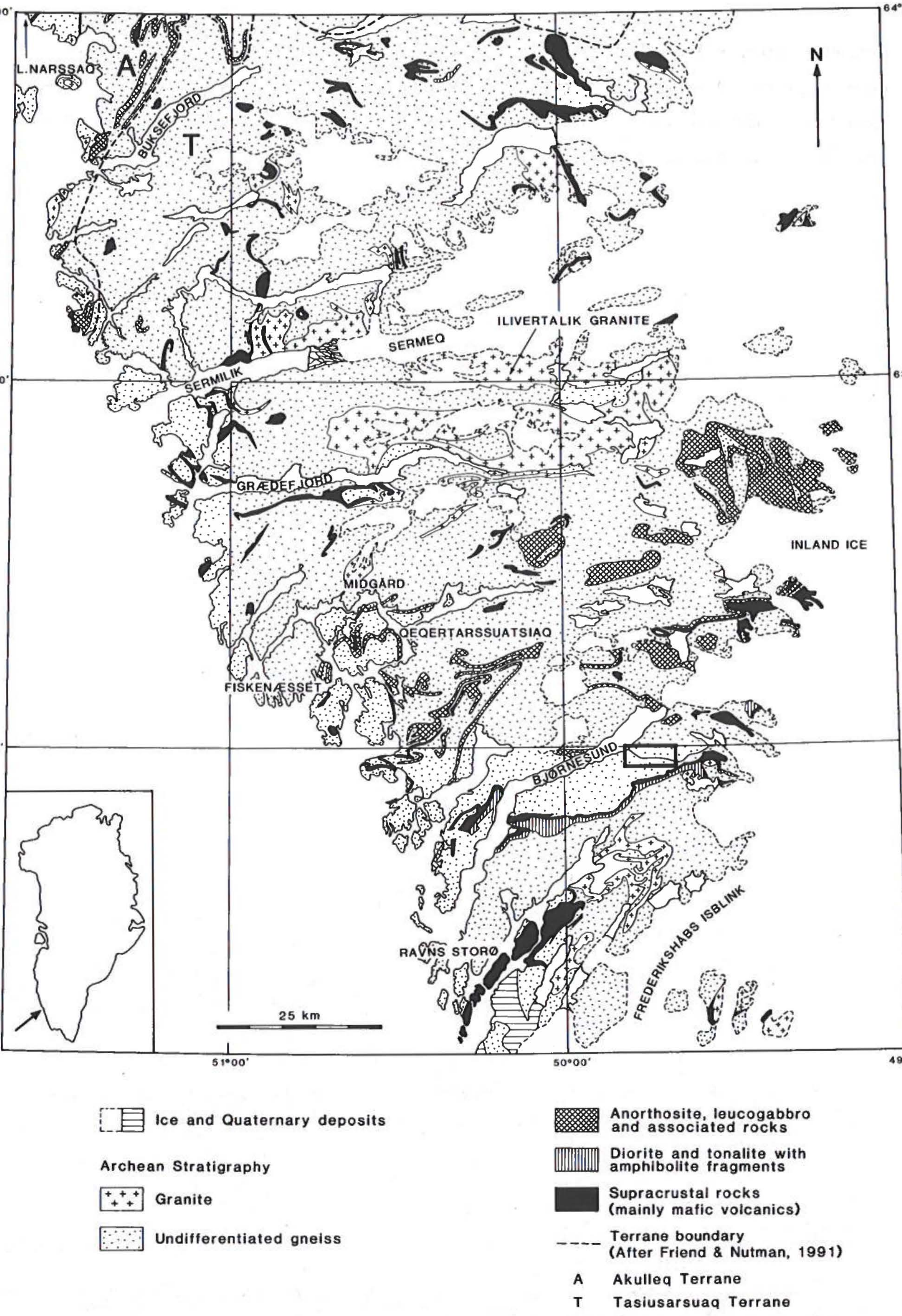
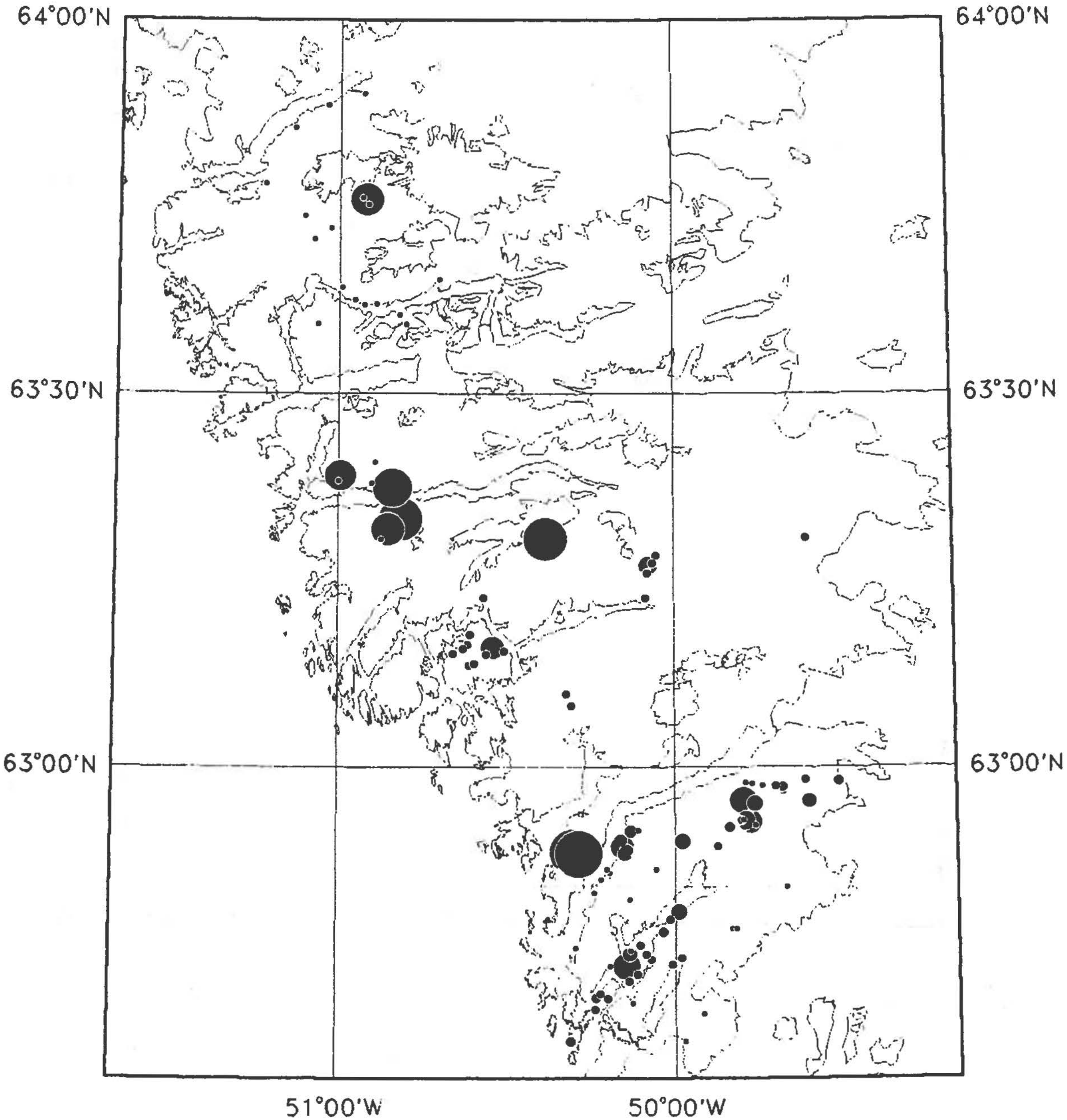
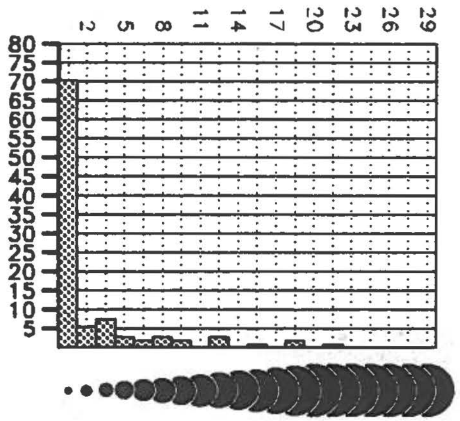


Fig. 1. Simplified geological map of the area from Frederikshåbs isblink to latitude 64°N
Area with detail map of the Qôrorssuaq placer prospect is framed
Based on the GGU 1:500 000 geological map of Greenland, Sheet 2, Frederikshåbs Isblink – Søndre Strømfjord.

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Au in panned concentrate of stream sediment



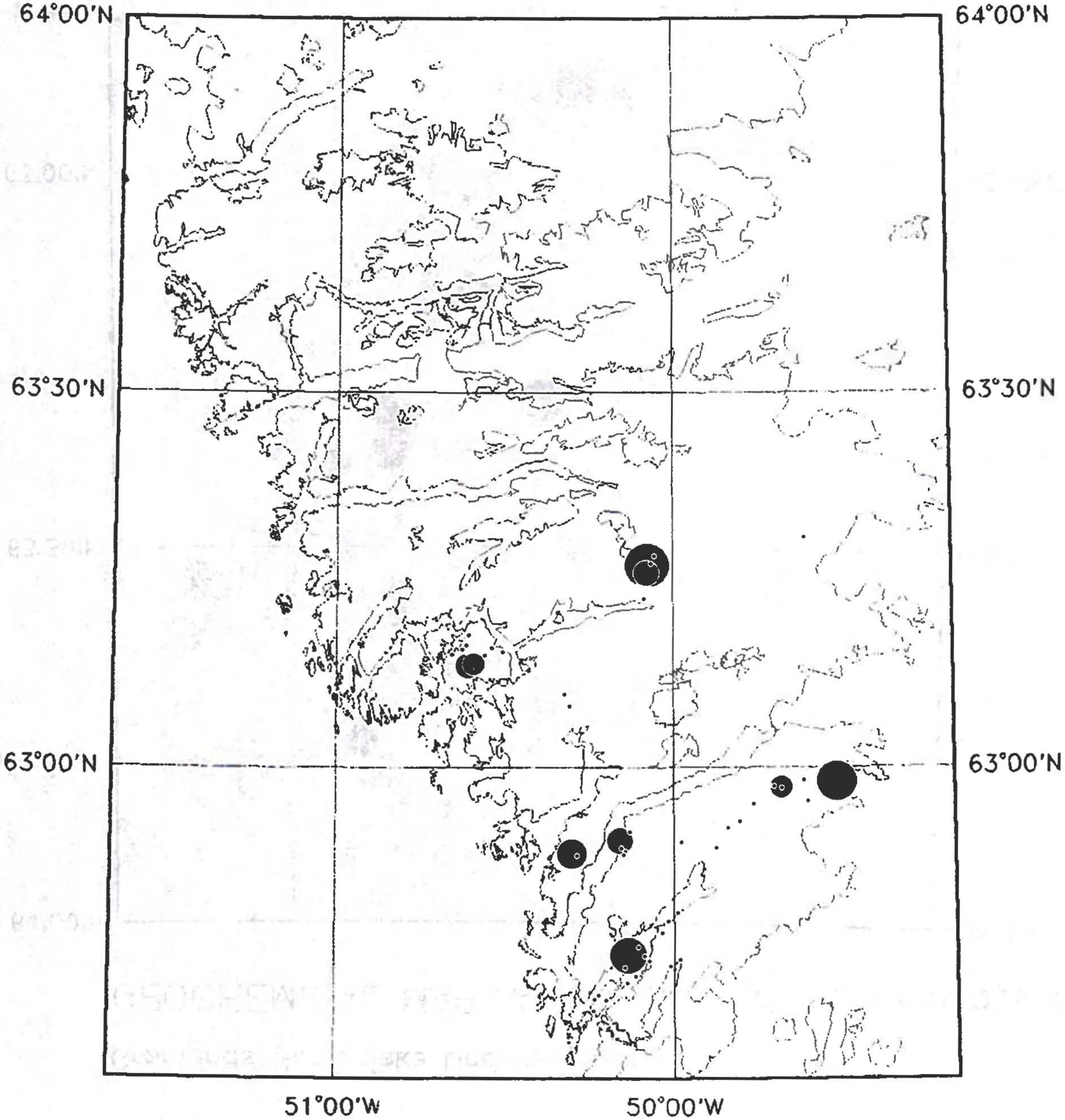


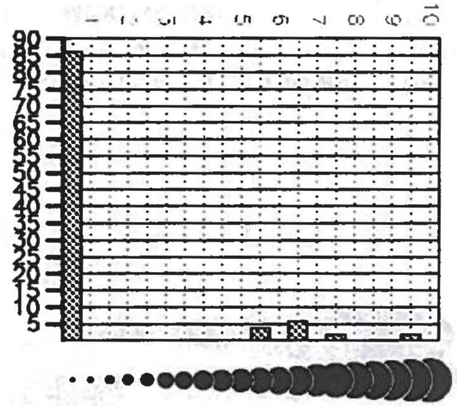
Number of samples: 106
Min. value: 0
Max. value: 52
Mean: 3
Median: 1
Variance: 42
Std. Dev.: 6

Fig. 2

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Pt in panned concentrate of stream sediment





Pt ppb

Number of samples:	53
Min. value:	0
Max. value:	11
Mean:	1
Median:	0
Variance:	8
Std. Dev.:	3

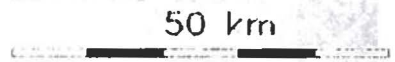
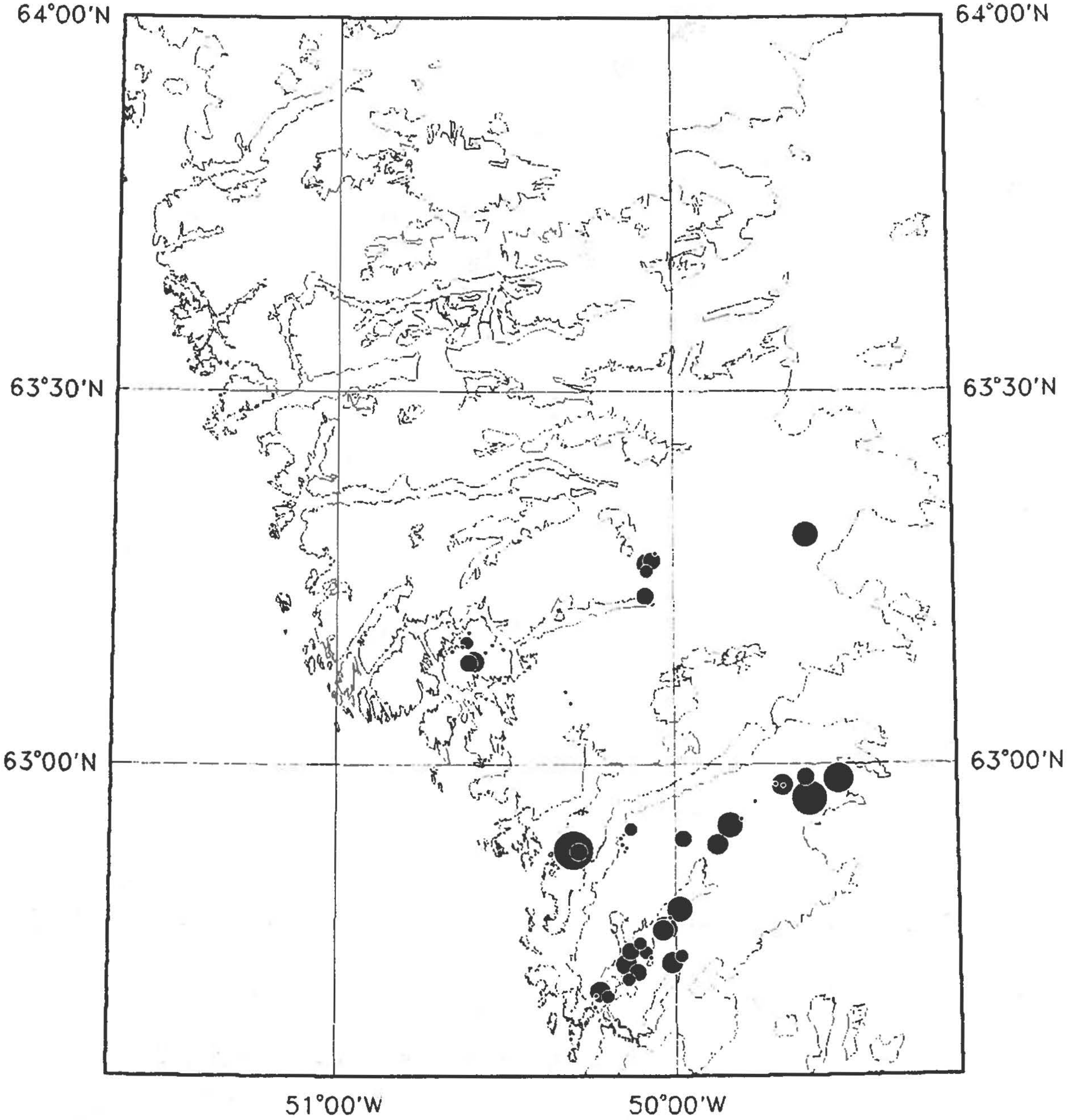
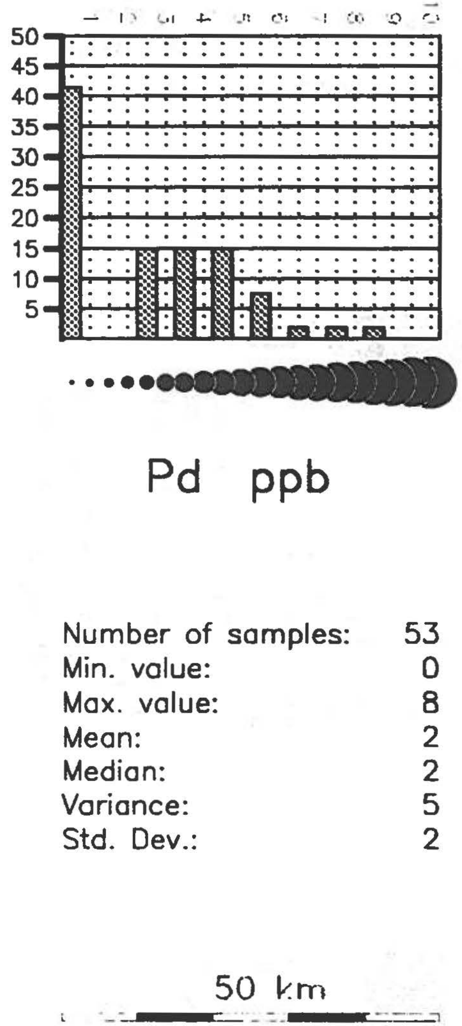


Fig. 3

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Pd in panned concentrate of stream sediment





Number of samples:	53
Min. value:	0
Max. value:	8
Mean:	2
Median:	2
Variance:	5
Std. Dev.:	2

Fig. 4

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Zn in panned concentrate of stream sediment

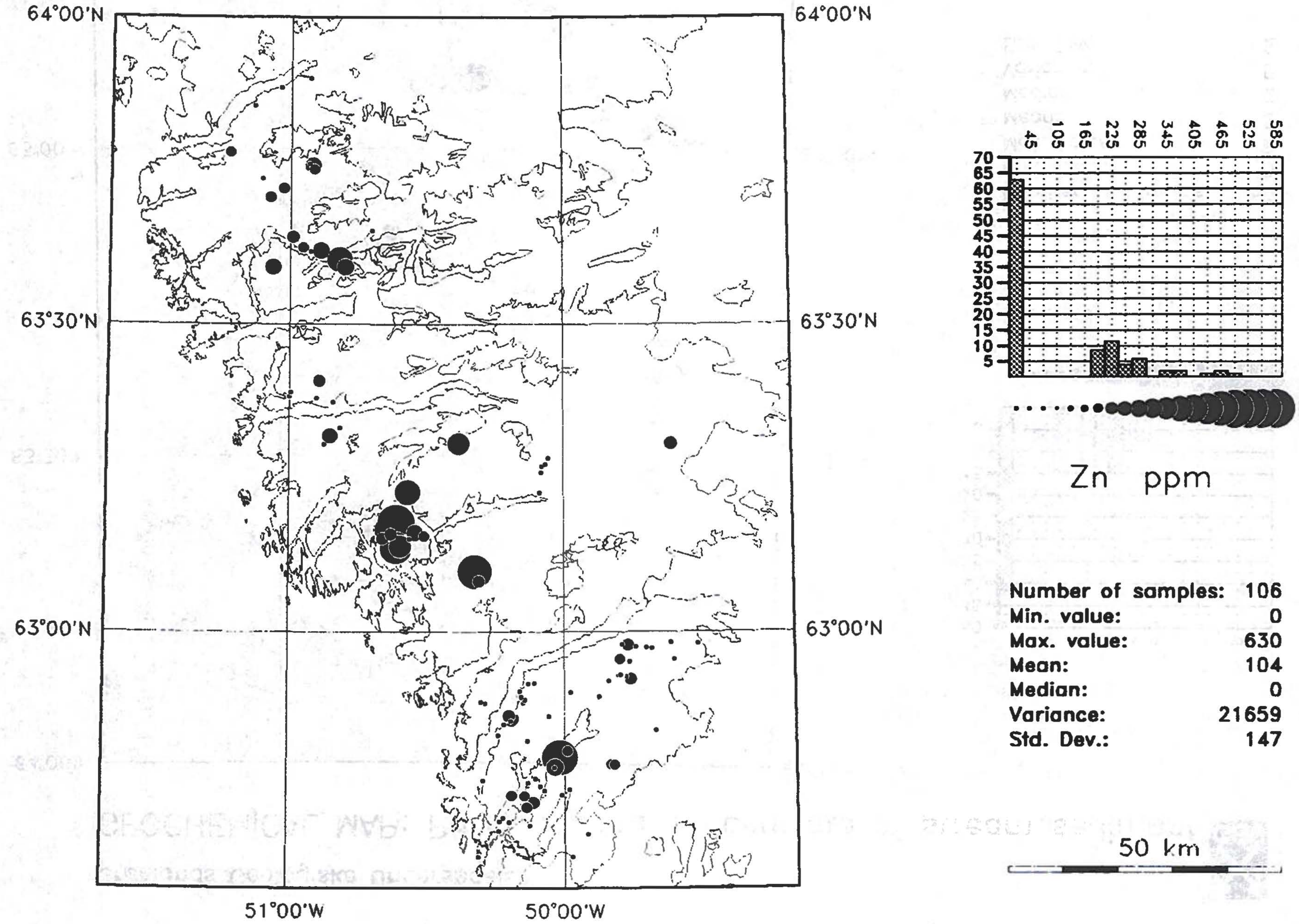
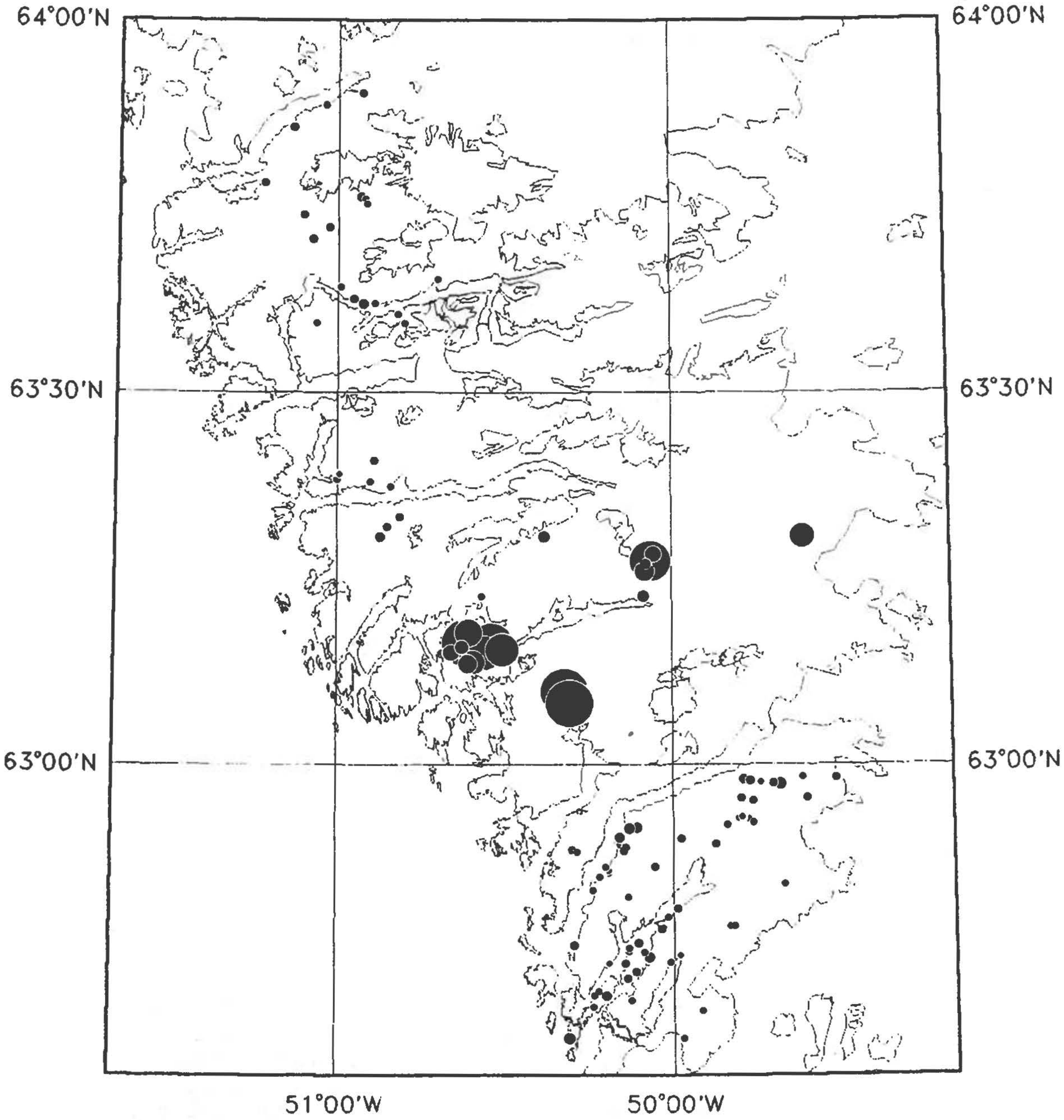
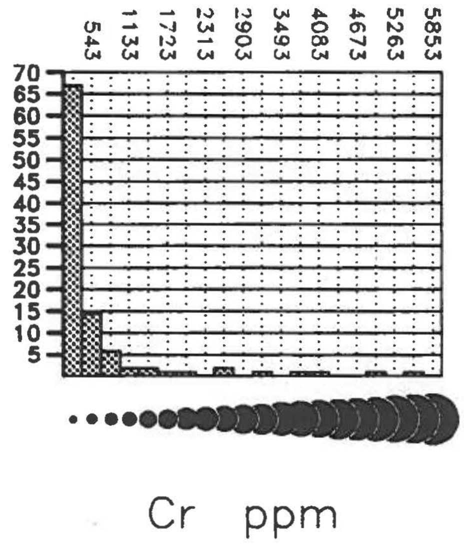


FIG. 5

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Cr in panned concentrate of stream sediment





Number of samples:	106
Min. value:	110
Max. value:	27000
Mean:	1227
Median:	310
Variance:	14314229
Std. Dev.:	3783

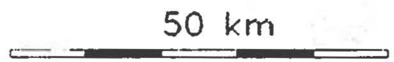


Fig. 6

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Ni in panned concentrate of stream sediment

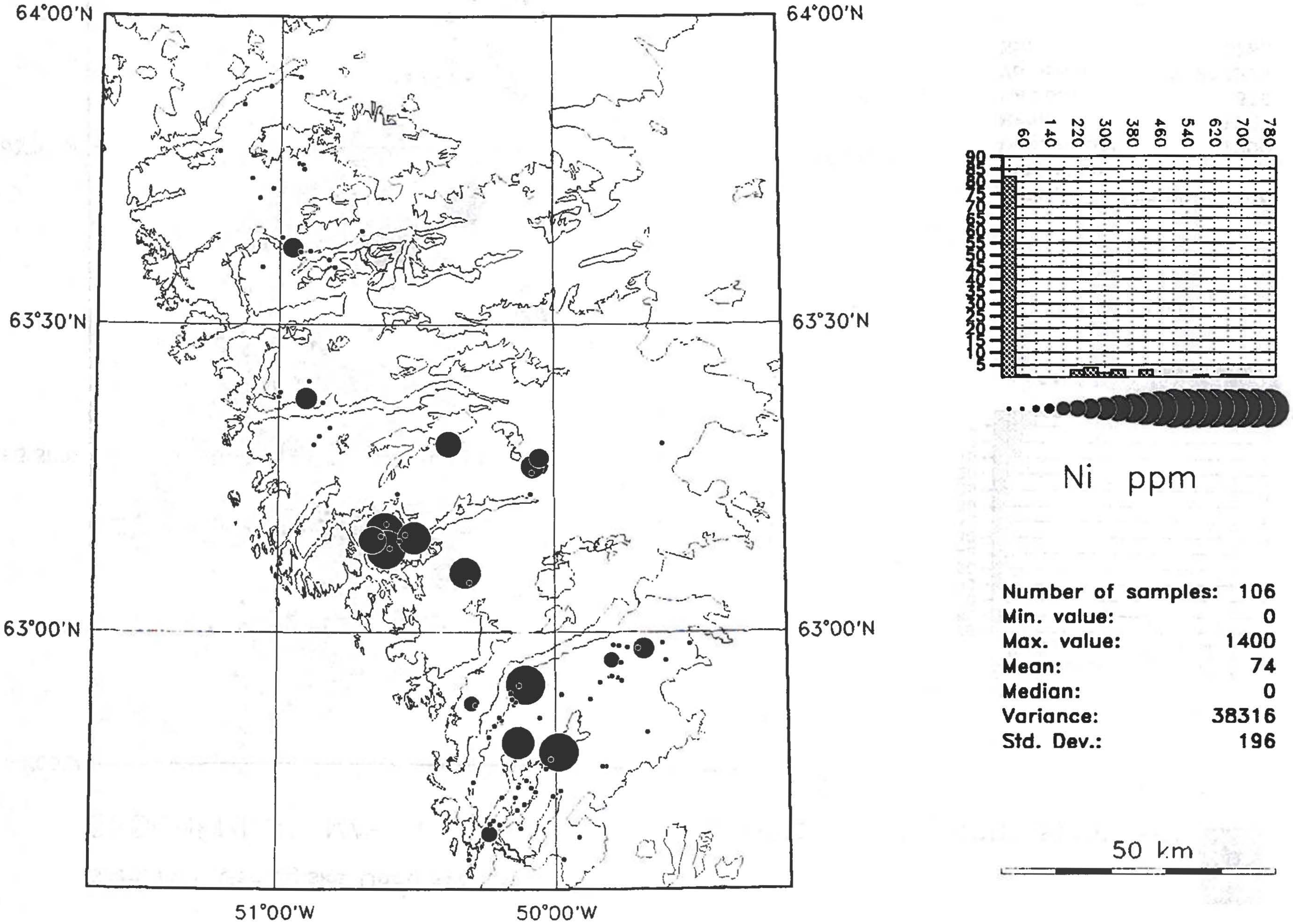
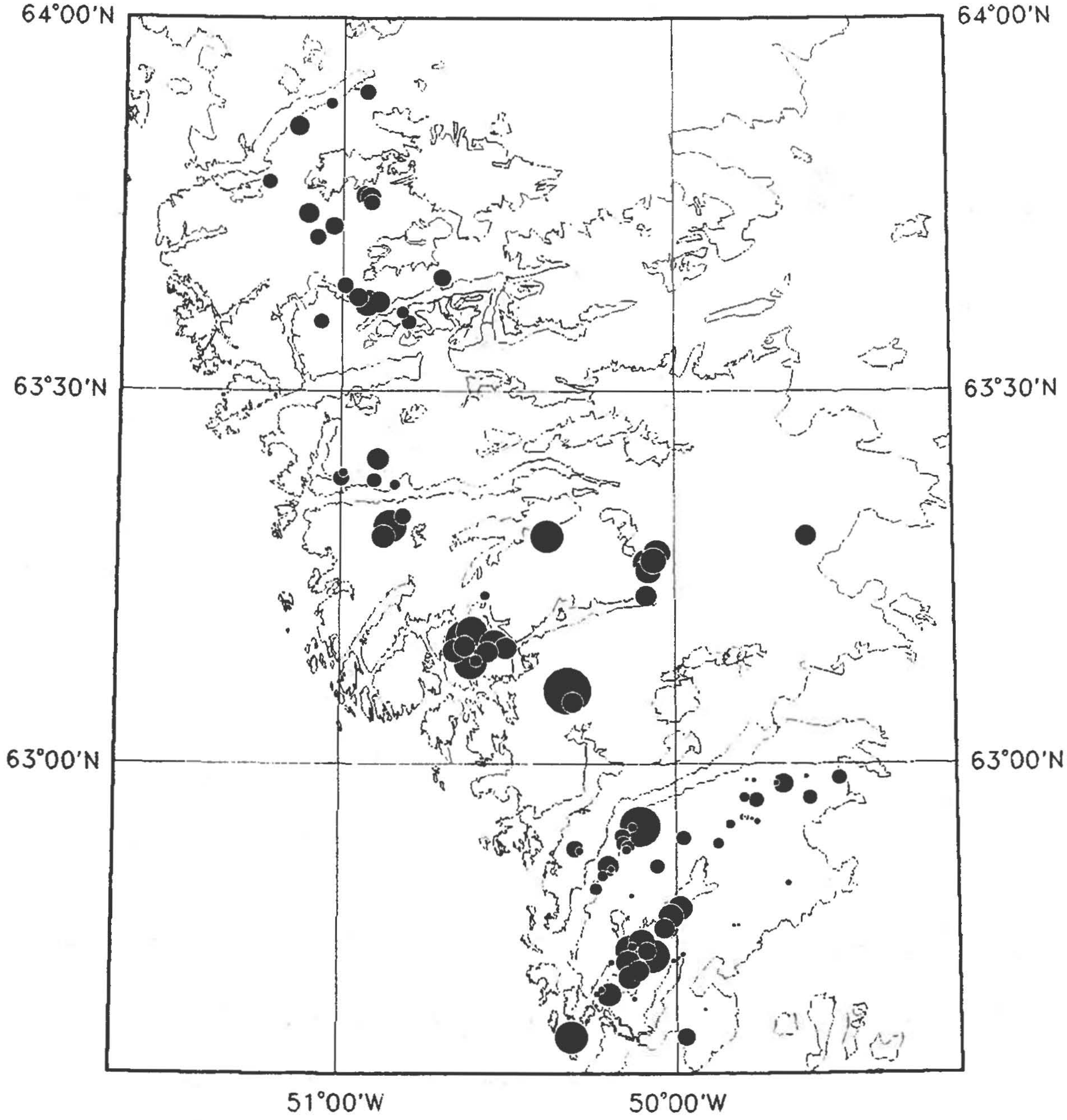
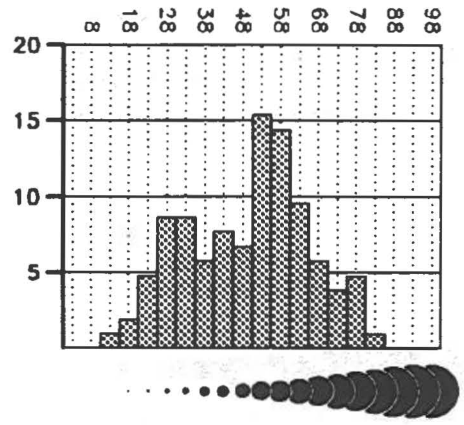


Fig. 7

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Co in panned concentrate of stream sediment





Number of samples:	106
Min. value:	13
Max. value:	130
Mean:	50
Median:	51
Variance:	375
Std. Dev.:	19

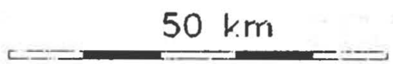
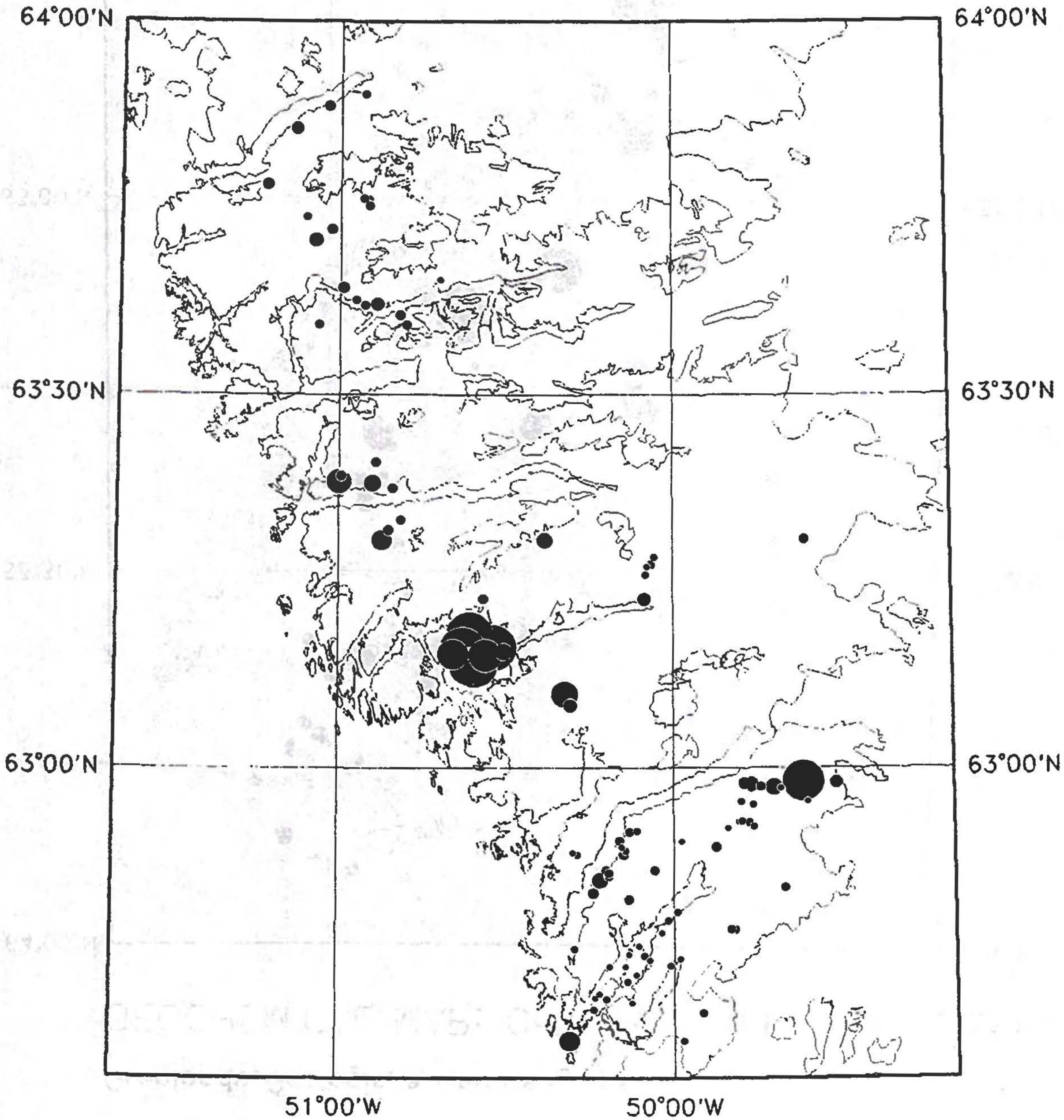
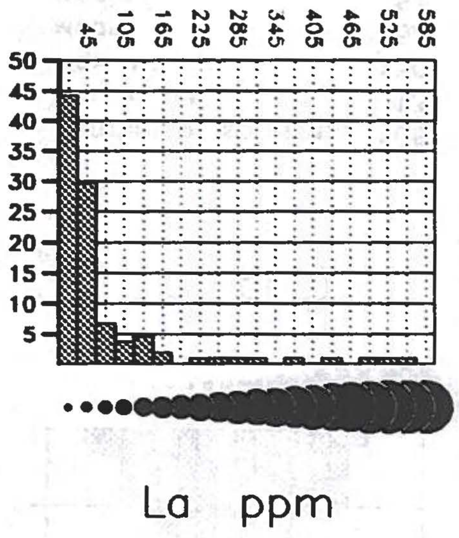


Fig. 8

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: La in panned concentrate of stream sediment





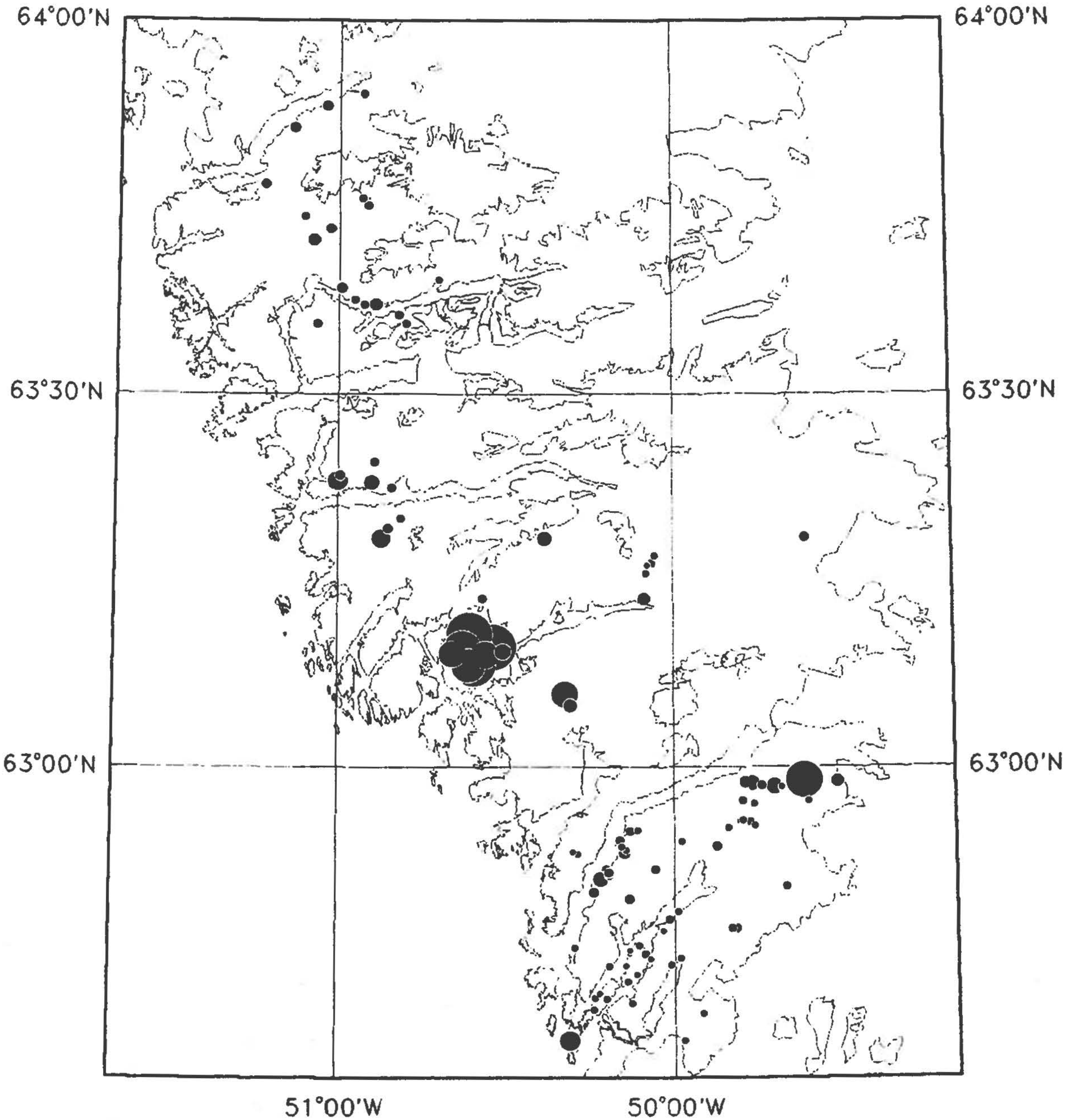
Number of samples:	106
Min. value:	4
Max. value:	740
Mean:	82
Median:	35
Variance:	19571
Std. Dev.:	140

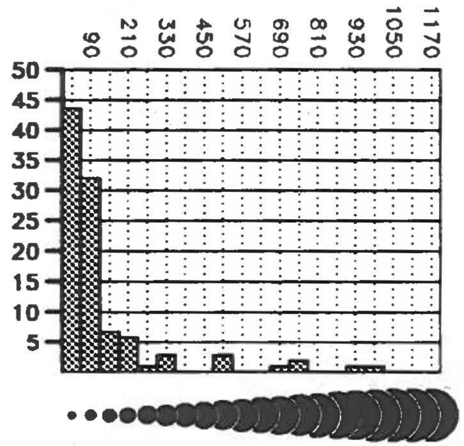
50 km

Fig. 9

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Ce in panned concentrate of stream sediment





Ce ppm

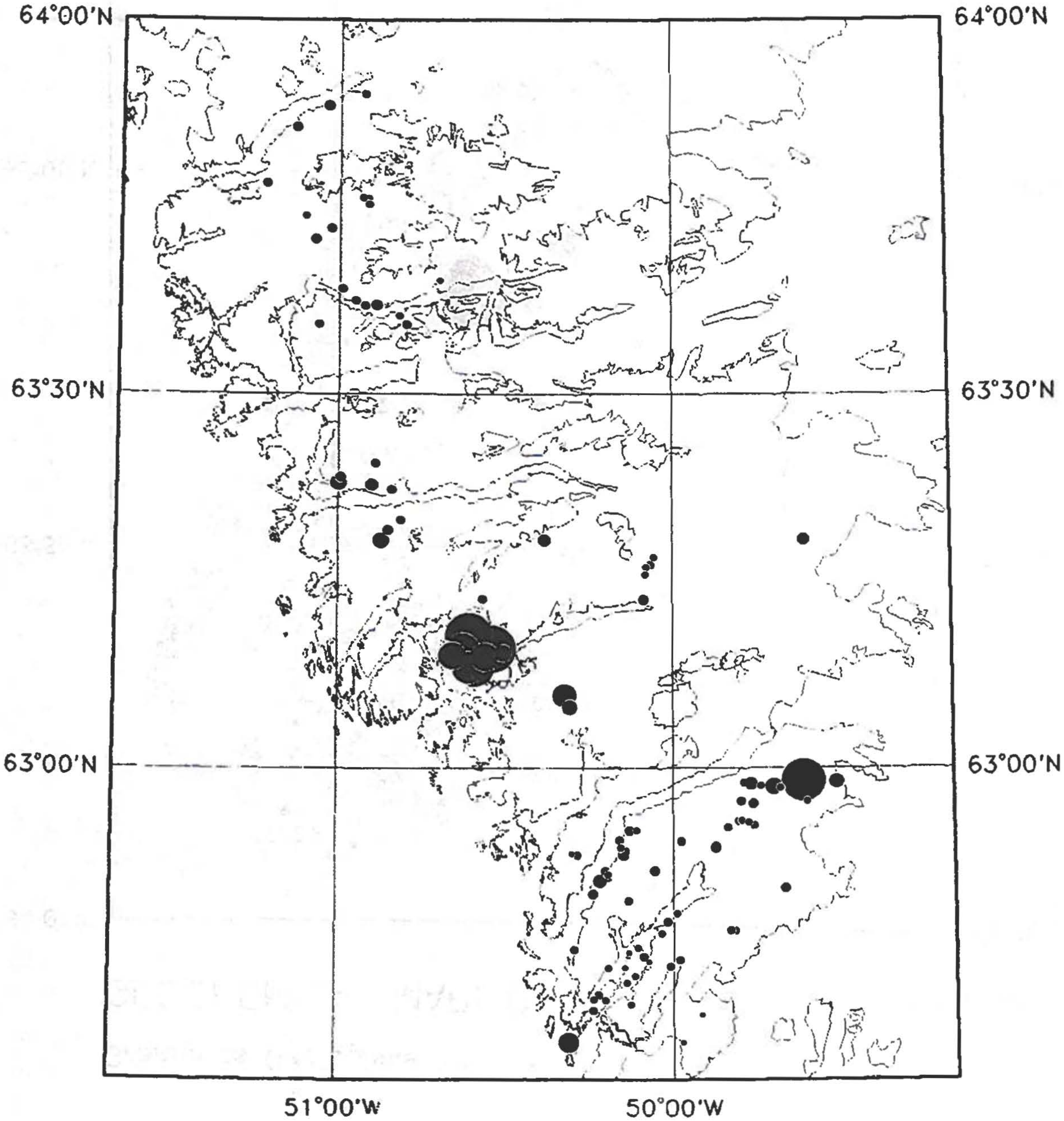
Number of samples:	**106**
Min. value:	**−1**
Max. value:	**1260**
Mean:	**150**
Median:	**67**
Variance:	**56384**
Std. Dev.:	**237**

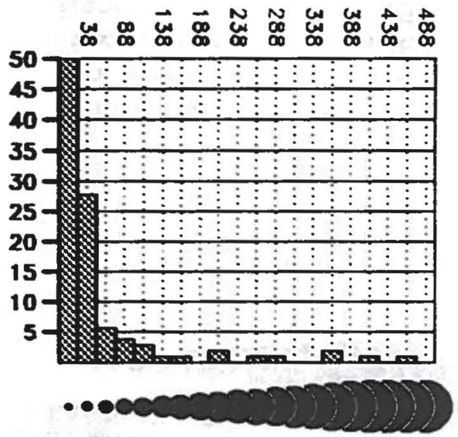
50 km

Fig. 10

Grønlands Geologiske Undersøgelse

GEOCHEMICAL MAP: Nd in panned concentrate of stream sediment





Nd ppm

Number of samples:	**106**
Min. value:	**−1**
Max. value:	**530**
Mean:	**59**
Median:	**24**
Variance:	**9345**
Std. Dev.:	**97**

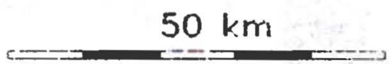


Fig. 11

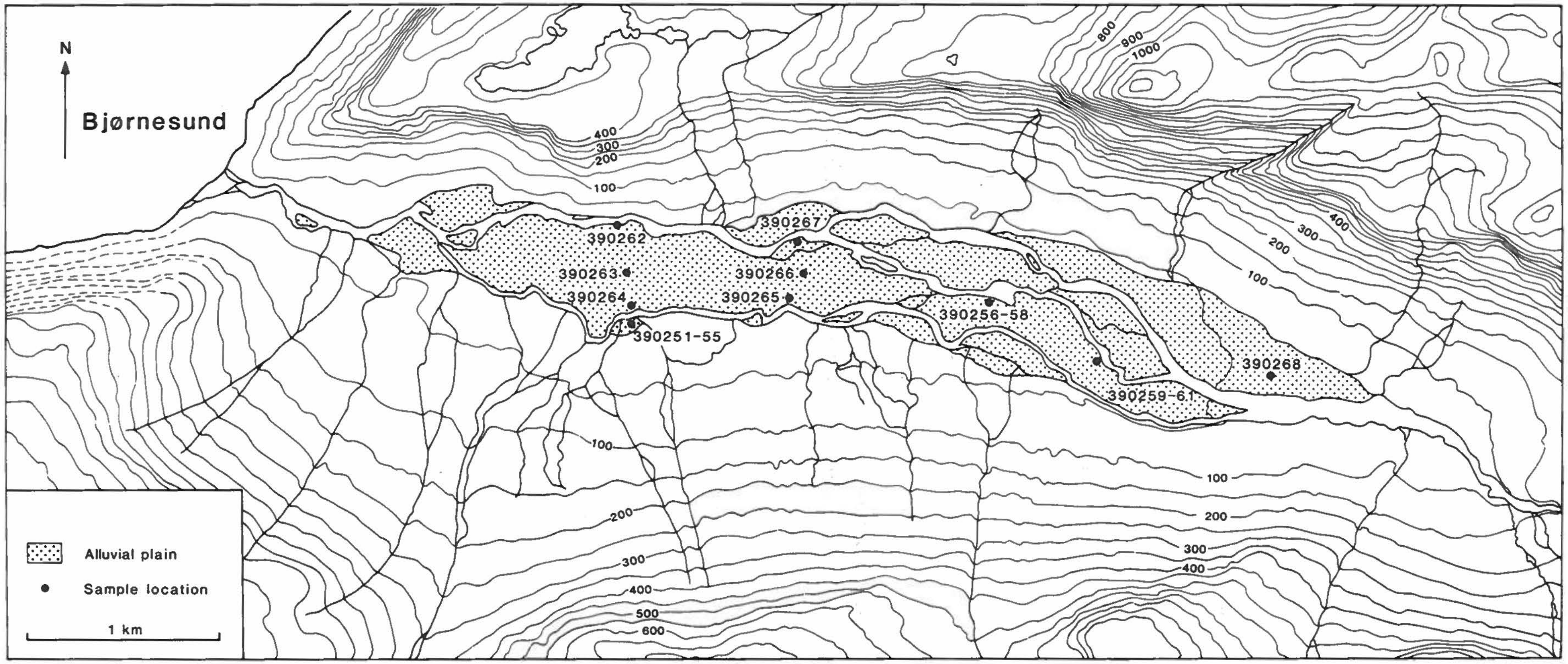


Fig. 12 Qôrorssuaq Valley sample sites. (Reproduced with permission (A.200/87) from KMS).

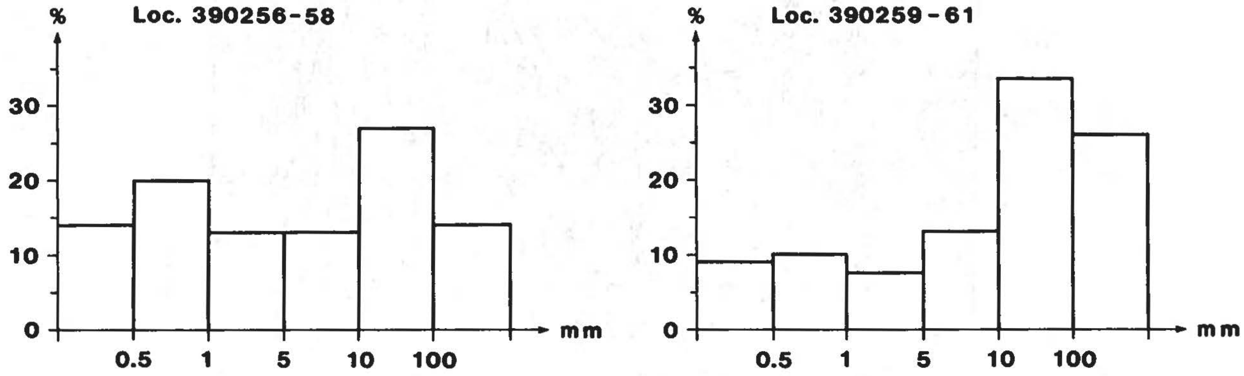


Fig. 13 Qôrorssuaq Valley.
Grain size distribution in the two sieved subsamples.

Table 1. Analyses and detection limits. All analyses by Activation Laboratories Ltd.

All samples were analysed for the following elements: Au Ag As Ba Br Ca Co Cr Cs Fe Hf Hg Ir Mo Na Ni Rb Sb Sc Se Sn Sr Ta Th U W Zn La Ce Nd Sm Eu Tb Yb Lu.

56 samples from streams draining the Fiskenæsset complex and supracrustal rocks were separately analysed for Au, Pt and Pd. The following elements had analyses below detection limits, or were not considered relevant to this report: Ag As Ba Br Ca Cs Fe Hf Hg Ir Mo Na Sc Se Sn Sr Sb W Ta Th U Sm Eu Tb Yb Lu.

These are not considered further, the analyses are available at GGU.

Detection limits:

INAA

Au 1 ppb	Co 5 ppm	Cr 10 ppm	Ni 50 ppm
Zn 50 ppm	La 1 ppm	Ce 3 ppm	Nd 5 ppm

ICP-ES

Au 1 ppb Pt 5 ppb Pd 2 ppb

Table 2. Qôrorssuaq valley bulk sample data. See explanation in text.

Sample no.	Type	Depth of pit (cm)	Max. boulder (dm)	Sampled volume (l)		Sieved subsample, fractions in mm, vol. in l					Total vol. (l)
				+100 mm	-100 mm	100-10	10-5	5-1	1-0.5	-0.5	
390255	main	60	3	0	75						
390253-54	sub	60		0	15				3.75	2.25	
	total				90						90
390258	main	70	10	18	90						
390256-57	sub	70		2.5	15	4.5	2.3	2.2	3.5	2.5	
	total			20.5	105						125.5
390259	main	50	20	34	75						
390260-61	sub	50		5	15	6.5	2.5	1.3	2.0	1.8	
	total			39	90						129
390262	main	30	3	12	31						43
390263	main	40	5	2	28						30
390264	main	35	3	0	27						27
390265	main	35	2	0	29						29
390266	main	35	5	3	31						34
390267	main	30	5	10	29						39
390268	main	20	50	8	24						32

Table 3. Qôrorssuaq valley. Analytical results on splits of heavy mineral concentrates. < : Below detection limit.

Sample no.	Type	Fraction (mm)	Au (ppb) INAA	Au (ppb) ICP-ES	Pd (ppb) ICP-ES
390253	sub	1.0-0.5	<	6	<
390254	sub	-0.5	<	4	<
390255	main	-0.5	<	4	6
390256	sub	1.0-0.5	<	1	7
390257	sub	-0.5	<	3	4
390258	main	-0.5	<	1	1
390261	sub	1.0-0.5	<	1	<
390260	sub	-0.5	<	2	5
390259	main	-0.5	<	7	4
390262	main	-0.5	<	1	6
390263	main	-0.5	<	1	4
390264	main	-0.5	<	1	4
390265	main	-0.5	<	2	6
390266	main	-0.5	9	1	<
390267	main	-0.5	<	1	<
390268	main	-0.5	10	1	3

OPEN FILE SERIES

Unedited reports available in limited numbers.
Prices are in Danish kroner exclusive of local taxes, postage and handling.

89/5	The geology of Sarqaqdalen, West Greenland, with special reference to the Cretaceous boundary fault system. By T. C. R. Pulvertaft. 1989. 36 pp., 3 plates.	95.00
89/6	Geometrical and geological analysis of photogrammetrically measured deformed sediments of the fjord zone, central East Greenland. By H.-J. Bengaard. 1989. 101 pp., 7 plates.	920.00
89/7	Gold mineralisation in the Skaergaard intrusion. By T. F. D. Nielsen. 1989. 14 pp. incl. app.	30.00
90/1	A preliminary seismic stratigraphic study of the Paleocene-Eocene section offshore southern West Greenland between 66° and 68°N. By T. G. Ottesen. 1990. 46 pp., 25 figs.	1045.00
90/2	Prospecting for base and noble metals in the Íngia area, West Greenland: analytical results. By B. Thomassen. 1990. 61 pp. incl. 5 tables, 15 maps.	60.00
90/3	Seasonal runoff forecast for Kangerluarsunnguaq near Nuuk/Godthåb, West Greenland. By R. J. Braithwaite. 1990. 17 pp.	32.00
90/4	Tungsten mineralization in the Nuuk region, West Greenland. By P. W. U. Appel. 1990. 51 pp.	45.00
90/5	Gold content of regional stream sediment samples from South Greenland. By A. Steenfelt. 1990. 12 pp., 3 maps.	180.00
90/6	Structural and economic aspects of the Proterozoic marble on Nûgssuaq, West Greenland. By A. A. Garde & B. Thomassen. 1990. 14 pp.	90.00
90/7	Reconnaissance for noble and base metals in the Ivigtut-Kobberminebugt area, South Greenland: analytical results. By P. Erfurt & M. Lind. 1990. 14 pp., 1 table, 13 maps.	300.00
90/8	Gold occurrences in supracrustal rocks of the Nuuk region, West Greenland. By P. W. U. Appel. 1990. 21 pp.	85.00
90/9	Copper, zinc and nickel occurrences in the Nuuk region, West Greenland. By P. W. U. Appel. 1990. 28 pp.	65.00
90/10	Reconnaissance and exploration for gold and base metals in the area between Arsuk and Neria Fjords, South-West Greenland. Work performed 1971 to 1985: results and discussion. By P. Erfurt. 1990. 30 pp., app. 60 pp., 1 map.	115.00
91/1	Magmatic platinum-nickel occurrences in the Tertiary West Greenland Basalt Province: prospecting by Greenex A/S in 1985-1988. By F. Ulff-Møller. 1991. 37 pp.	65.00
91/2	Occurrences of kimberlite, lamproite and ultramafic lamprophyre in Greenland. By L. M. Larsen. 1991. 36 pp., app. 9 pp., 5 maps.	65.00
91/3	The Isua iron ore deposit at Isukasia, West Greenland. By P. W .U. Appel. 1991. 31 pp.	55.00
91/4	The Ivigtut cryolite deposit in South Greenland. Short note on recent geoscientific developments. By J. Bondam. 1991. 29 pp., 1 map.	65.00
91/5	Gold and base metal potential of the Íngia area, central West Greenland. By B. Thomassen. 1991. 115 pp. incl. 12 tables.	110.00
91/6	A preliminary seismic study of part of the pre-Paleocene section offshore southern West Greenland between 66°N and 68°N. By T. G. Ottesen. 1991. 28 pp., 8 figs, 7 maps.	in press
91/7	Oil seep in basement, Germania Land, North-East Greenland. By F. G. Christiansen, J. Bojesen-Koefoed, Sven M. Jensen & L. Stemmerik. 1991. 18 pp., 9 figs, 6 tables.	45.00
91/8	Reconnaissance geochemical exploration of map sheet 67 V 2 (67° to 68°N, 49°30' to 52°W), West Greenland. By A. Steenfelt & E. Dam. 13 pp., 42 figs.	70.00
91/9	Reconnaissance geochemical mapping of southern West Greenland from 62°30'N to 64°00'N – 1991 results. By P. Erfurt, A. Steenfelt & E. Dam. 21 pp., 30 figs.	in press
92/1	Geochemical investigation of heavy mineral concentrates from stream sediments in southern West Greenland, 62°30'N to 64°00'N – 1991 results. By P. Erfurt, P. W. U. Appel & M. Lind.	in press

January 1992

ISSN 0903-7322