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Copper, zinc and nickel occurrences in the Nuuk region, West Greenland

Peter W. Utterdijk Appel

December 1990

GRØNLANDS GEOLOGISKE UNDERSØGELSE
The Geological Survey of Greenland
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ABSTRACT

In the Nuuk region two ages of Archaean supracrustal rocks occur; Early and mid-Archaean. The Isua supracrustals are Early Archaean, and host an abundance of small copper showings. These are mainly disseminations, thin veins and stringers in banded amphibolites. Locally also sulphide facies iron-formation contains appreciable amounts of chalcopyrite.

The mid-Archaean Malene supracrustal rocks occur as enclaves over an area of more than 30,000 km^2. Malene supracrustal rocks is a term used here for convenience for supracrustals younger than the Isua supracrustals. The Nuuk region can be divided into terranes in which supracrustals occur. The relative age of these terranes are uncertain and it is not known whether the supracrustal rocks occurring in the different terranes are spatially related or whether they are of quite different ages. The Malene supracrustal rocks comprise mafic and ultramafic volcanics with minor metasediments and rare thin layers of banded iron-formation. Within the volcanic rocks anthophyllite-gedrite zones up to a few metres wide are found. These zones can be traced with intervals for kilometres. They often contain semi-massive sulphides: pyrrhotite, pyrite, chalcopyrite, sphalerite, molybdenite as well as small amounts of gahnite. The zones also contain trace amounts of tin and tungsten.

The Malene anthophyllite-gedrite zones closely resemble anthophyllite-gedrite zones elsewhere such as in Western Ontario where they underlie massive sulphide deposits e.g. the Geco deposit in Manitouwadge and the Winston lake massive sulphide ores. The anthophyllite-gedrite zones in Western Ontario are interpreted as metamorphosed hydrothermal alteration zones, an explanation which seems valid for the Malene occurrences.

In the southern part of the Nuuk region a large anorthosite complex occurs. In some anorthosite layers as well as in some of the mafic layers pyrrhotite, chalcopyrite and pentlandite have been observed, although as yet not in economic proportions.

INTRODUCTION

Nuuk, Capital of Greenland, formerly called Godthåb, is situated in the central part of West Greenland (Fig. 1). The Nuuk region is easily accessible and offers good logistic support. The sea is mostly ice free all year around, apart from the innermost part of the fiords where ice may hamper sailing with small vessels.

Nuuk has a population of about 12,000. It has an international airport with frequent flight connections to Denmark and weekly connections to North America. Helicopters as well as fixed wing aircraft can be chartered in Nuuk on an ad hoc basis. Nuuk has all year round ship connections with Denmark.

Only limited mineral exploration has been carried out in the Nuuk region. In the southern part, a large anorthosite complex has been prospected during the seventies for chromite, platinum and to some extent for copper and nickel. The northern part of the area is virtually virgin ground from an exploration point of view. Some exploration has been carried out on a major iron-formation (see below) in the Isukasia area 150 km north-east of Nuuk (Fig. 1). A few short campaigns were carried out for molybdenum near Nuuk, in the Ivisârtoq area of the inner Godthåbsfjord (Fig. 1) and one for scheelite in the area east of Nuuk.

The Geological Survey of Greenland (GGU) has carried out geologic mapping in the Nuuk region, and geologic maps in scale 1:100 000 have been published. In the northern part of the area GGU has carried out a regional geophysical survey. In addition GGU has carried out a regional stream sediment sampling programme mainly aimed at tungsten. The heavy mineral concentrates from the stream sediments have been investigated for scheelite and some of the samples have been analysed by Bondar-Clegg Laboratories, Canada for gold as well as Sc, Cr, Fe, Co, Ni, Zn, As, Se, Rb, Mo, Ag, Cd, Sb, Cs, Ba, La, Eu, Tb, Yb, Hf, Ta, W, Ir, Th and U (Appel, 1989).

GGU has carried out a stream sediment sampling programme where the fraction less than 0.1 mm was analysed for gold. The campaign covered the northern part of the Nuuk region (Steenfelt, 1987).

Parts of the data presented in this report are extracted from the GREENLAND MINERALIZATION DATA BANK. This data base contain information on prospecting activities carried out by mining companies, as well as mineral investigations carried out by GGU and other research groups. Data from the GREENLAND MINERALIZATION DATA BANK as well as data from other GGU data bases are published in a thematic map series. At the present time thematic maps are available from GGU covering the area between Nuuk and Maniitsoq, that is between 64^{o} North and 66° North. The thematic maps cover the following topics: geophysics, geochemistry of the fine fraction from stream sediments, geochemistry of heavy mineral concentrates from stream sediments, geology and mineral occurrences. Further sets of thematic maps covering other parts of Greenland are planned.

GENERAL GEOLOGY

The geology of the Nuuk region has been described by various authors, most recently by Kalsbeek & Garde (1989) and Friend et al. (1990). The reader is referred to the former for a detailed and up to date reference list. The following is a brief summary only of the regional geology.

The oldest rocks comprise the Isua supracrustal rocks, which occur as enclaves in the 3.760 Ga old Amîtsoq gneisses throughout large parts of the northern Nuuk region. The enclaves range from metre size up to the 30 km long and up to 4 km wide enclave at Isukasia (Fig. 1).

Malene supracrustals occurring as enclaves in the Nûk gneisses yield radiometric ages of 3.300 to 3.000 Ga. The Malene supracrustal enclaves are found over an area well over 30,000 km^2.

A major anorthosite complex was intruded into the Malene supracrustals. The largest outcrops occur in the Fiskenæsset area, south of Nuuk (Fig. 1). The anorthosite complex has been strongly deformed; it appears with a combined strike length of well over 200 km and an average width of less than 400 m. The complex hosts extensive chromite horizons as well as basic and ultrabasic rocks which locally carry appreciable amounts of sulphides.

The youngest major rock forming event in the Nuuk region was the emplacement of the Qôrqut granite some 2.500 Ga ago.

GEOLOGY OF THE ISUA SUPRACRUSTAL ROCKS

Nutman (1986) has presented a detailed account of the geology of the Isua supracrustal rocks. The Isua iron-formation and associated sulphide occurrences have been described by Appel (1979, 1987). The following is a brief account only. The stratigraphy is schematically presented in Fig. 5 from Nutman (1986).

Isua supracrustal enclaves occur over a large area, but the major outcrop is situated at Isukasia north-east of Nuuk (Fig. 1). The Isua supracrustal rocks consist mainly of banded and massive amphibolites with interlayered metasediments. Some of the amphibolites display well preserved pillow structures but most only display a pronounced banding. The massive and banded amphibolites represent deformed pillow flows, mafic tuffaceous horizons and intrusive basic sills. The metasediments comprise acid rocks presumably of rhyolitic origin together with a single horizon of staurolite schists and a several metre wide conglomerate. Ultramafic lenses and pods occur frequently within the amphibolites. The origin of these is still debated.

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

Horizons of banded iron-formation are frequently found intercalated in the amphibolites. They range from a few centimetres in width up to a major iron-formation occurrence containing an estimated 2 billion tonnes of iron ore with 32 % Fe (Appel, 1987). The iron-formation occurs in different facies. Most common is oxide facies with magnetite-rich bands alternating with quartz bands (metachert). The bands range up to 10 cm in width. Carbonate facies iron-formation is found as up to 5 m thick and hundred metres long layers with thin magnetite bands alternating with thicker siderite-rich bands. Graphite as thin flakes is quite common in carbonate facies iron-formation. Silicate facies iron-formation consisting of alternating bands of grunerite and magnetite is frequently met in up to ten metre thick bands, which can be traced for hundreds of metres along strike. Gold contents just exceeding 1 ppm have been found in silicate facies iron-formation (Appel, 1987, 1990a).

COPPER OCCURRENCES IN THE ISUA SUPRACRUSTAL ROCKS

In the Isua area sulphides are found in a variety of rocks, mainly in iron-formation horizons and in banded amphibolites. The most prominent sulphides are iron-sulphides. Copper, as chalcopyrite and cubanite, is found in both iron-formation and banded amphibolites. Other sulphides are quite rare. Galena has been found in the western part of the supracrustal belt, as tiny scattered grains in an amphibolite and in a fuchsite-bearing shearzone. The galena appears not to be of economic significance.

No prospecting for copper has been carried out in the Isua supracrustal rocks. The only copper analyses stem from a research programme carried out by the author aimed at the geochemistry of the iron-formation (Appel, 1979).

In iron-formation copper is found as scattered disseminated grains in carbonate facies and in some silicate-sulphide facies layers. Grab sampling of the different facies yielded the following results. The grades in the carbonate facies are all below 0.07 % Cu, whereas silicate-sulphide facies they are up to 3.15 % Cu. The widths of the copper-bearing horizons are normally small, in the order of 10 cm. No attempts have been made to follow these horizons along strike.

In amphibolites copper sulphides frequently occur as fine grains arranged in thin layers parallel to banding. Occasionally the sulphides are evenly distributed. The sulphide-bearing amphibolites can be several tens of metres thick and are traceable for hundreds of metres. The amphibolites are interpreted to be tuffaceous in origin (Appel, 1979). No attempts have so far been made to carry out systematic mapping and sampling of the copper-bearing amphibolites.

During amphibolite facies metamorphism some of the copper and iron-sulphides were mobilized into discordant veins and veinlets. The largest vein found so far is about 10 cm wide, about one metre along strike and composed of massive chalcopyrite.

A representative selection of copper showings have been plotted on Fig. 2; analytical results are presented in Table 1.

Table 1. Assay results on grab samples from the Isua supracrustal belt (n.a. = not analysed).

Loc.	Rock type and major sulphide	Cu %	Remarks
14/1	Chalcopyrite in iron-formation	3.15	13 ppm Ag
14/2	Chalcopyrite in metachert	n.a.	ass. with galena
14/4	Chalcopyrite vein	26.8	
14/5	Chalcopyrite/Cubanite in amphibolite	0.21	
14/6	Chalcopyrite/Cubanite in amphibolite	0.30	
14/7	Chalcopyrite in amphibolite	20.8	

GEOLOGY OF THE MALENE SUPRACRUSTAL ROCKS

The Malene supracrustal rocks may not have formed contemporaneously throughout the Nuuk region neither may they have been spatially related. However, in this report all post 3.760 Ga old supracrustal enclaves in all three terranes defined by Friend et al. (1990) will be described under this heading.

The Malene supracrustal enclaves were recognized during GGU's regional mapping programme in the seventies, but were generally not mapped in any detail. In the Bjørnesund-Ikâtoq areas the so-called Ravns Storø belt was mapped in some detail, and the results are available as field maps, field diaries and a Ph. D. thesis (Friend, 1976). In the Buksefjorden area and on some of the islands north-west of Buksefjorden a considerable amount of detailed work has been carried out, mainly by a group from Exeter University, U.K. (Beech & Chadwick, 1980; Chadwick & Coe, 1983; Chadwick & Nutman, 1979; Appel, 1986, 1988a). The Malene mountain next to Nuuk was mapped in detail by Appel & Garde (1987). The major Malene supracrustal enclave in the Ivisârtoq area of the inner Godthåbsfjord area was mapped in detail by Chadwick (1986), and scheelite mineralization was described by Appel (1990b).

The most prominent lithology is mafic to ultramafic volcanic rocks. These occur as thick piles of pillow lavas with abundant mafic sills and gabbroic intrusions. Ultramafic lavas with pillow structures have been observed in the Ivisârtoq area (Fig. 1), and presumed spinifex textures have been observed on Bjørneøen in Godthåbsfjord (Fig. 1). Mafic pillows are frequently preserved in the Ivisârtoq area, at Bjørneøen and in the Ikâtoq area south of Bjørnesund (Fig. 1), whereas most pillows have been deformed beyond recognition in the central Nuuk region. In the volcanic piles several horizons of peridotites occur, some of which are of presumed extrusive origin, others are clearly intrusive.

Intercalated in the volcanics are sedimentary sequences consisting of mica quartzites, which are often pyritiferous, and frequent horizons of cordierite-sillimanite schists with relic staurolite. Locally these schists carry varying amounts of anthophylite-gedrite. Of particular importance is the presence of anthophyllite-gedrite-rich layers and bands up to a few metres wide and traceable at intervals for hundreds of metres along strike. Several of these layers contain appreciable amounts of pyrite, chalcopyrite, sphalerite and gahnite, see below. The anthophyllite-gedrite layers resemble the anthophyllite-rich zones underlying massive sulphide ores in Western Ontario, that are interpreted as hydrothermal alteration zones.

The metasediments also include tourmalinites that are of restricted volumetric significance but have great metallogenetic significance. Tourmalinites are best exposed at Malene mountain, next to Nuuk, where they occur in up to one metre wide layers consisting of tourmaline up to 60 % and plagioclase +/- quartz. They locally contain up to 10 % scheelite (Appel, 1988b). Tourmalinites are also found in quartz-sillimanite schists, where tourmaline occurs as disseminated grains composing as much as 75 % of the rock. The tourmaline is interpreted as a sea-floor precipitate and the boron is suggested to be of submarine exhalative origin (Appel, 1988b).

Marble horizons are quite rare in the Malene supracrustals. In the Sermilik area (Fig. 1), however, granulite facies supracrustals contain up to one metre thick marble bands, consisting of calcite with small amounts of olivine and hercynite. In the area south of Bjørnesund a several kilometre long layer of marble and calc-silicates occur in gneisses. Normally carbonate-rich layers have been metamorphosed and preserved as calc-silicate horizons, which are quite abundant especially in the L. Narssaq area south of Nuuk, and in the Ivisârtoq area of inner Godthåbsfjord (Fig. 1).

In the Ivisârtoq area calc-silicate zones can be traced with intervals for more than 3.5 km with a maximum recorded width of about 8 m. Channel sampling revealed grades up to 0.35 % tungsten over a width of 2.5 metres. The calc-silicate zones also contain high amounts of chromium and nickel (see Fig. 2). Additionally one of the zones contain elevated amounts of bromine up to 400 ppm. The zones are interpreted as peridotites which have been hydrothermally altered by calcium-rich solutions. The solutions carried high amounts of tungsten in solution that was precipitated in the altered peridotites. If gold had been carried in solution in the hot brines, it must have been precipitated elsewhere, possibly where the brines encountered iron-rich environments.

The Malene supracrustal rocks have been repeatedly deformed and metamorphosed several times. Most areas have been metamorphosed under amphibolite facies conditions, whereas some areas e.g. Sermilik and parts of the Fiskenæsset area, were affected by granulite facies metamorphism.

COPPER, ZINC OCCURRENCES IN THE MALENE SUPRACRUSTAL ROCKS

The mineralizations in the Malene supracrustal enclaves will be described geographically starting from the north. Selected representative occurrences have been plotted on Fig. 2 and 3, and a list of occurrences together with analytical results is presented in Table 2.

Ivisârtoq area

Only few copper showings have been noted in this area. Scattered malachite staining is found in a peridotite horizon which marks the interlude between two cycles of basic and ultrabasic pillow lava eruptions. The horizon can be traced for well over 7 kilometres along strike.

An extensive pyrite-rich horizon intercalated in mafic pillow lavas can be traced with intervals for more than 5 km over a width of several tens of metres. The zone consists of massive to semi-massive pyrite together with fuchsite stained metachert and amphibolites. Chalcopyrite and molybdenite are found locally, although never in large amounts. Grab samples and drill core samples yield copper contents up to 0.13 % and nickel contents of 0.12 %. Molybdenum is always in trace amounts. The pyrite-rich zone locally carries more than 1 % barium, presumably as baryte.

Extensive peridotite sheets occur in the mafic and ultramafic volcanic pile. Some of these have been hydrothermally altered to calc-silicates now hosting scheelite. These zones contain high amounts of nickel (Table 2) in epidote, not in sulphides.

Sulugssugutaussaussaq area

In this area, in short named Sulug, a thin banded iron-formation occurs. It consists of alternating bands of magnetite and grunerite. Interlayered with the iron-formation is a horizon consisting of anthophyllite and pyrite. Grab samples from these zones contain up to 0.4 % zinc and up to 330 ppm selenium.

Malene mountain

On Malene mountain next to Nuuk anthophyllite is found as a major constituent of quartz-cordierite-sillimanite schists which locally contain tourmalinites. The anthophyllite rocks are not associated with sulphides but with stratabound scheelite occurring in tourmalinites and banded amphibolites.

L. Narssaq area

A sulphide-bearing zone up to 15 m wide hosted in amphibolites and consisting of diopside, scapolite and epidote with semimassive to disseminated pyrrhotite and chalcopyrite is found (Loc. 147/18 on Fig. 3). Decades ago the zone was trenched by a resident of Nuuk. No records of this work have been left. No recent detailed sampling has been carried out.

Two other mineralizations are:

1. Anthophyllite-gedrite zones with up to 10 % sulphides, mainly pyrrhotite with lesser amounts of chalcopyrite (Loc. 147/19 on Fig. 3).
2. A sequence of banded to massive calc-silicates up to 50 m thick, which contain abundant porphyroblasts of molybdenite. Maximum contents of molybdenum found so far is 650 ppm.

Islands off the coast

Many of the hundreds of small and large islands off the coast host Malene supracrustal rocks. Anthophyllite-gedrite bands with iron- and copper sulphides locally magnetite rich, occur on several islands. Since relatively few islands have been investigated it can be assumed that anthophyllite-gedrite rocks are widespread and of regional distribution.

Pularqavît

On this island pyrrhotite-chalcopyrite bearing anthophyllite-gedrite bands are intercalated in the metasediments and amphibolites (Fig. 1). No samples have been analysed.

Mitsimaviqsuaq

Amphibolites on the island of Mitsimaviqsuaq host an up to two metre wide anthophyllite-gedrite horizon. The horizon can be traced at intervals for several hundred metres. It is slightly rusty and carries small amounts of pyrrhotite, chalcopyrite and molybdenite.

Qilangarssuit

This island situated south of Nuuk hosts a fairly large enclave of Malene supracrustal rocks. Field work by the author in 1982 revealed an abundance of amphibolites with 1-5% chalcopyrite, together with pyrrhotite and pyrite. Some of the chalcopyrite-bearing zones are calc-silicates consisting of diopside and epidote with varying amounts of pyrrhotite and chalcopyrite (Loc. 147/20 on Fig. 3 and Table 2). No chemical analyses are available.

Sagdlerssua

On the small island, immediately south of Qilangarssuit, there is a zone of anthophyllite-gedrite rocks up to 2 metre wide, with cordierite, sillimanite, chalcopyrite and pyrrhotite (Loc. 147/17 on Fig. 3 and Table 2). Sagdlerssua also hosts one of the few horizons of magnetite banded iron-formation found in the Malene supracrustals.

Table 2. Assay results of grab samples from the Malene supracrustal belt (n.a. = not analysed).

Loc.	Rock type	Cu %	Zn %	Ni %	Remarks
Cu147/1	Pyrite schist	0.13	n.a.	n.a.	1.69 % Ba
Cu147/2	Pyrite-Pyrrhotite schist	0.09	n.a.	n.a.	
Ni147/2	Pyrite-Pyrrhotite schist	n.a.	n.a.	0.13	13 ppb Au
Ni143/21	Calc-silicate	n.a.	n.a.	0.10	0.67 % W
Ni143/22	Calc-silicate	n.a.	n.a.	0.09	0.82 % W
Ni143/27	Calc-silicate	n.a.	n.a.	0.15	0.90 % W
Ni143/28	Calc-silicate	n.a.	n.a.	0.18	1.59 % W
Zn147/3	Iron-formation	n.a.	0.08	n.a.	330 ppm Se
Zn147/4	Iron-formation	n.a.	0.41	n.a.	160 ppm Se
Zn,Cu147/15	Anthophyllite-gedrite	0.09	1.11	n.a.	20 ppm Ag
Cu147/17	Anthophyllite-gedrite	0.51	0.01	0.01	
Cu147/18	Calc-silicate	5.03	0.03	0.04	
Cu147/19	Anthophyllite-gedrite	0.51	0.01	0.04	
Cu147/20	Calc-silicate	2.46	0.01	0.07	

Simiútat

South of Nuuk the two small islands Simiútat are composed exclusively of Malene supracrustal rocks. Amphibolites host an anthophyllite-gedrite horizon several hundred metres long and up to several metre wide (Loc. 147/15 on Fig. 3 and Table 2). The horizon is frequently monomineralic with anthophyllite-gedrite crystals up to 10 cm long locally arranged in garbenschiefer texture. The horizon contains large amounts of pyrrhotite, magnetite, chalcopyrite, sphalerite, molybdenite, pyrite and gahnite named in order of decreasing abundance. The highest assay results obtained are 0.19 % Cu and 1.1 % Zn. Associated with this horizon is a thin iron-formation, consisting of grunerite and magnetite, and showing a week banding. In the iron-formation disseminated flakes of molybdenite are found. The highest grade obtained from grab samples assay 0.18 % Mo, 0.12 % Sn and 170 ppm W.

COPPER, NICKEL OCCURRENCES IN THE INNER GODTHÅBSFJORD AREA

The inner Godthåbsfjord area has been prospected on a reconnaissance basis by the Kryolitselskabet Øresund A/S. The company inspected the area by helicopter and landed on rust-zones large enough to be spotted from the air. Seven rust-zones were grab sampled. The company did not investigate the local geology in any detail, and much doubt surrounds the regional setting of the rocks sampled. The analytical results are presented in Fig. 2 and listed in Table 3.

Table 3. Assay results of grab samples from the inner Godthåbsfjord area. (n.a.= not analysed).

Loc. Nr.	Rock type	Cu %	Ni %	Mo %
147/8	Amphibolite	0.09	0.14	3.12
147/9	Amphibolite	0.10	0.20	n.a.
147/10	Quartz vein	0.11	0.23	1.8
147/11	Pyroxene amphibolite	0.05	0.12	n.a.
147/12	Amphibolite	0.10	0.22	n.a.
147/13	Amphibolite	0.06	0.28	n.a.
147/14	Mylonite	0.02	0.17	n.a.

GEOLOGY OF THE FISKENÆSSET ANORTHOSITE COMPLEX

The Fiskenæsset anorthosite complex has been described in detail by various authors, for example Ghisler (1976) and Myers (1985). Only a brief description is given here and for further details the reader is referred to the two papers quoted.

The Fiskenæsset complex is a large stratiform anorthosite body with a strike length of more than 200 km with an average thickness of slightly less than 400 m. It is a layered intrusion consisting of 87 % anorthosite (anorthite plagioclase) and leucogabbro together with minor gabbroic and ultramafic components such as dunites, peridotites and pyroxenites. Chromite is concentrated in stratigraphically controlled horizons in the anorthosites. Minor chromite horizons have been found in ultramafic layers. The main chromite horizons occurring in anorthosites are between 0.5 and 3 m wide, but due to tectonic thickening locally occur in up to 20 metre thick horizons. The chromite occurs in augen chromitite where the chromite is associated with hornblende and plagioclase. The latter forms the augens. Massive and banded chromitite are also frequent.

The tonnage of a 1 to 7 m wide chromite horizon is estimated at 2.5 million tons of ore with about 30 % chromite by volume (Ghisler, 1976). This zone can be traced intermittantly for 1400 m along strike on the east coast of Qeqertarssuatsiaq dipping 20^{o} to 40^{o} parallel to the slope of the topography down to 50 m below surface.

The anorthosite complex has been repeatedly metamorphosed under amphibolite to granulite facies conditions and has been deformed several times. The deformation has caused extensive boudinage as a result of which chromitite horizons can be followed rarely more than a few hundred metres along strike.

COPPER, NICKEL OCCURRENCES IN THE FISKENÆSSET AREA

A. SULPHIDES IN THE ANORTHOSITE COMPLEX

Large concentrations of sulphides do not occur in the anorthosite complex. A few percent sulphides are found associated with anorthosite hosted chromite horizons. One grab sample contained 0.8 % sulphides assaying 0.35 % Ni, 0.11 % Cu, 4 ppm Au and 31 ppm Ag.

Sulphides are much more common in rocks of ultramafic composition, and hundreds of sulphide showings have been recorded and analysed by Platinomino A/S. A selection of these showings have been plotted on Fig. 3 and the results listed in Table 4. The sulphides are mainly pyrrhotite, chalcopyrite with small amounts of pentlandite.

The Fiskenæsset anorthosite complex shows strong similarities with other major anorthosite complexes and thus a prospecting programme aimed at platinum was carried out during the early seventies by Platinomino A/S. The company records are available for inspection at GGU. The company did not discover widespread high values, but small hornblende peridotites were found which contained up to 4 ppm PGE.

Table 4. Assay results on grab samples from the anorthosite complex. (Samples 83/9, 83/12 and 83/19 are from amphibolites of unknown origin) n.d. = not detected.

Loc. Nr.	Rock Type	Cu %	Ni %	Au ppm	Ag ppm
83/4	Peridotite	0.54	0.13	n.d.	n.d.
83/6	Peridotite	0.04	0.10	n.d.	
83/7	Anorthosite	0.29	n.d.	n.d.	n.d.
83/9	Amphibolite	0.15	0.01	n.d.	n.d.
83/10	Peridotite	0.47	0.18	n.d.	n.d.
83/11	Peridotite	0.95	0.11	n.d.	n.d.
83/12	Amphibolite	0.42	n.d.	n.d.	n.d.
83/13	Hornblendite	0.43	0.06	3.1	124
83/14	Anorthosite	0.34	0.09	n.d.	n.d.
83/15	Anorthosite	0.24	0.13	n.d.	n.d.
83/16	Peridotite	0.33	0.33	n.d.	n.d.
83/19	Amphibolite	0.13	0.03	n.d.	n.d.
83/23	Hornblendite	0.29	0.06	n.d.	n.d.

B. SULPHIDES OUTSIDE THE ANORTHOSITE COMPLEX

In the Fiskenæsset area rusty amphibolites are quite common, and during the Platinomino A/S prospecting some were grab sampled. A little north of

Fiskenæsset a peculiar rock type was found. It consist of rounded pebbles of gneiss and amphibolite up to 10 cm long in a sulphide-rich matrix, the sulphides mainly being pyrrhotite with small amounts of pyrite and molybdenite (Appel, 1971). The zone which is hosted in amphibolites can be traced at intervals for several kilometres with a width of up to 5 metres. It has been interpreted as a pebble dyke or a conglomerate. The zone was trenched and some of the samples analysed. Two of the sampled localities are shown on Fig. 3 and results are listed in Table 5.

Table 5. Assay results on grab samples from a conglomerate ? zone
n.d. = not detected.

Loc. Nr.	Rock type	Cu %	Ni %	Ag ppm	Au ppm
83/24	Conglomerate ?	0.07	0.07	3.7	0.09
83/25	Conglomerate ?	0.13	n.d.	n.d.	n.d.

CONCLUSIONS

The Isua supracrustal rocks clearly hold a potential for copper +/- gold mineralizations, and a detailed prospecting programme is warranted. This programme should first of all comprise investigations of the different facies of iron-formation, especially silicate facies. It might also be worth while to investigate the fuchsite stained barium-bearing metasediments recently discovered in the Isukasia area.

The Malene supracrustal rocks display marked similarities with the supracrustal belts of Western Ontario and elsewhere. The Wawa belt of Western Ontario consists of a sequence of tholeiitic to komatiitic extrusive and intrusive rocks interlayered with various metasediments. Iron-formations also occur, but mostly in volumetrically insignificant amounts, comprising magnetite-quartz bands, silicate facies as well as sulphide facies consisting of quartz and pyrite. The metasediments comprise quartz-cordierite-sillimanite schists locally with thin tourmalinites such as in the Hemlo area, Ontario. In Western Ontario anthophyllite-gedrite rich zones occur in metasedimentary horizons as well as in metavolcanics. These zones underlie several major copper-zinc ore deposits in the Wawa belt such as the Geco mine in the Manitouwadge area and the Winston Lake massive sulphides. The massive sulphide deposits of Western Ontario contain abundant gahnite. Gahnite is regarded as a good indicator for massive sulphide deposits, such as the Broken Hill, Australia. Interestingly enough the semi-massive sulphides in the Malene anthophyllite-gedrite rocks also carry gahnite.

The anthophyllite-gedrite horizons of Western Ontario are interpreted as hydrothermal alteration zones, an explanation which also seems plausible for the anthophyllite-gedrite zones in the Malene supracrustals rocks.

Anthophyllite-gedrite zones appear to be fairly abundant in the Malene supracrustals. Most of the zones have not been investigated geochemically. The few that have contain high amounts of trace elements such as zinc, copper, molybdenum, tin and tungsten.

Summarising, the Malene supracrustals are thus regarded as potential hosts for massive copper-zinc sulphide deposits. Only a fraction of the known supracrustal enclaves have been prospected in any detail. It is thus recommended that the remaining supracrustal enclaves are investigated, especially the supracrustal enclaves in the Bjørnesund-Ikátoq area, south of Fiskenæsset.

It is also suggested that more work should be carried out on the islands south of Nuuk, in order to delinate the anthophyllite-gedrite bands. If the area looks promising, geophysics should be carried out to determine massive sulphide bodies below sea-level.

The Fiskenæsset anorthosite complex obviously holds a potential for copper, nickel PGE deposits. Much more work should however be carried out in tracing the chromite and sulphide-bearing ultramafic rocks along strike.

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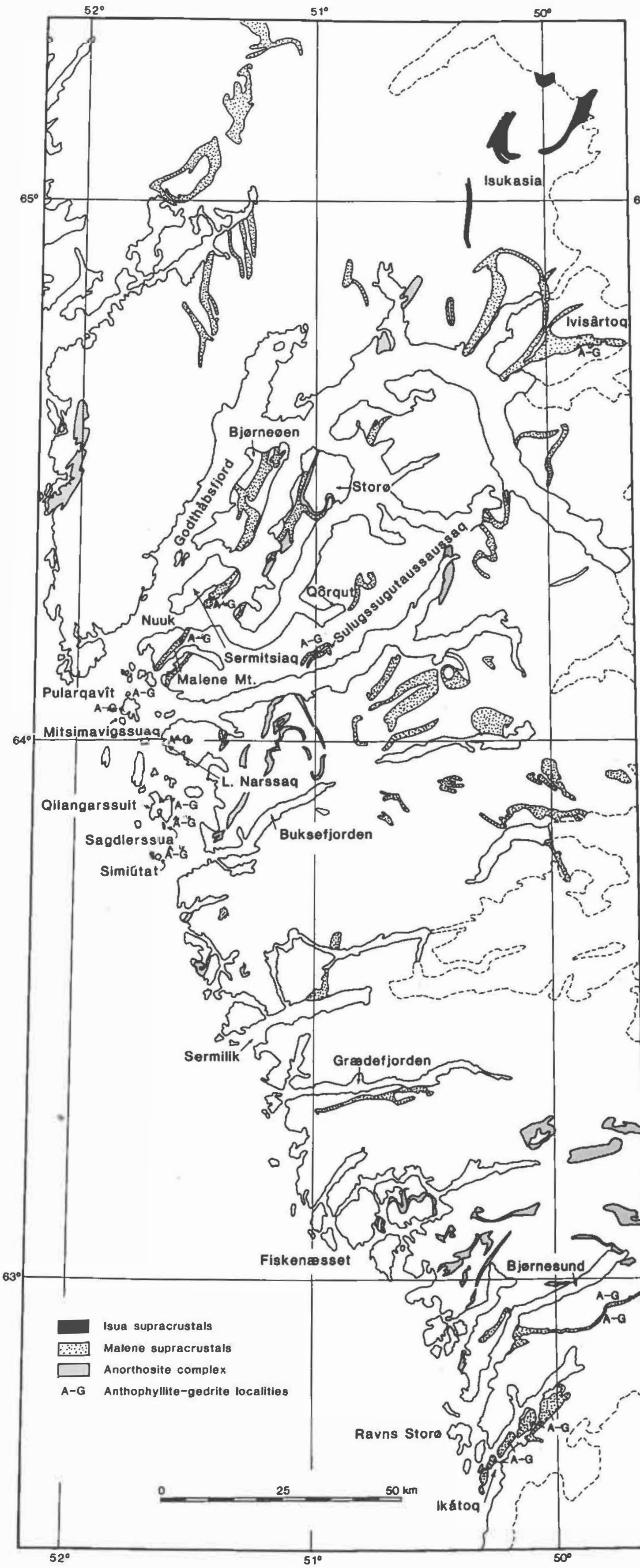

Fig. 1: Index map of the Nuuk region showing supracrustal enclaves and the anorthosite complex

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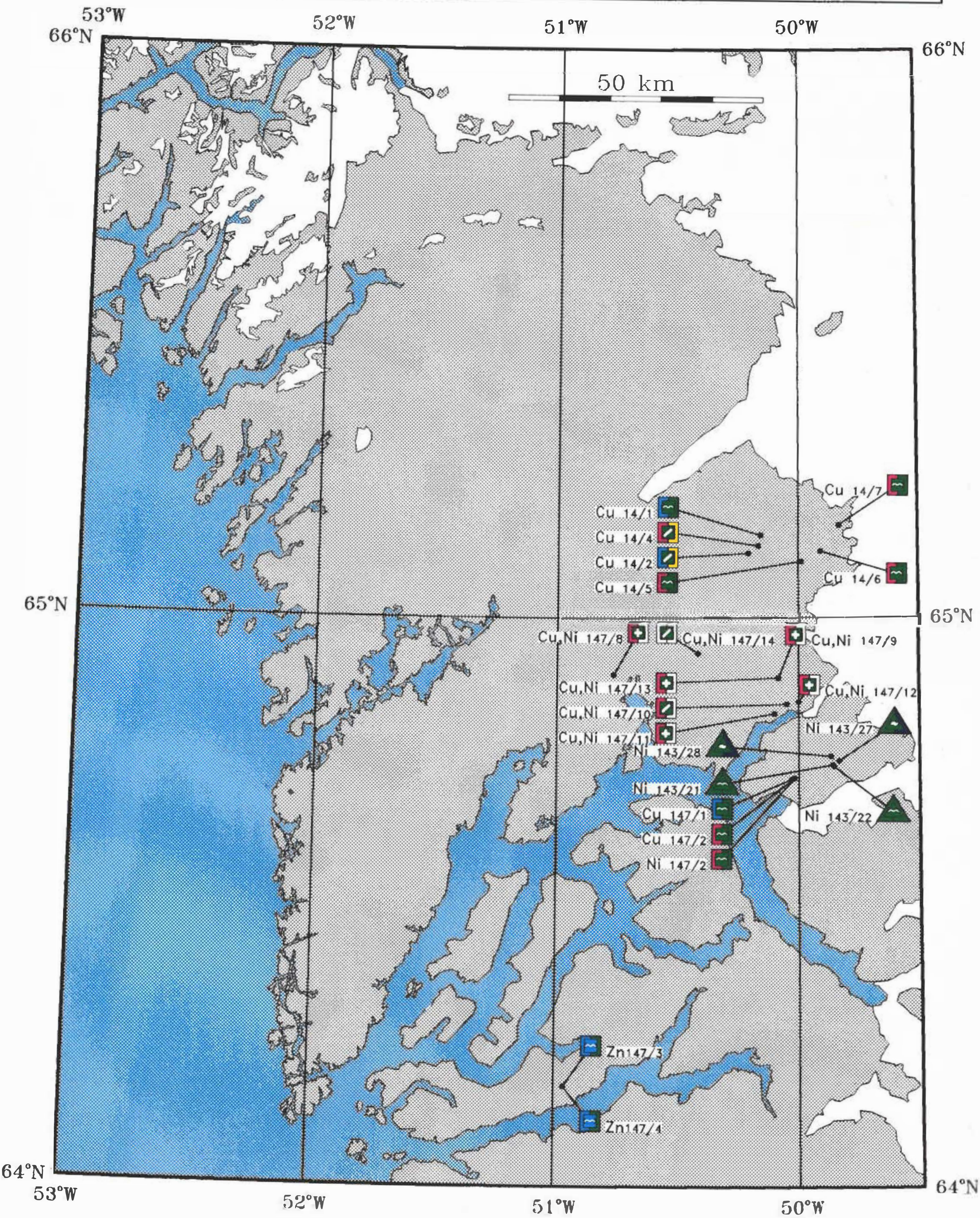

Fig. 2

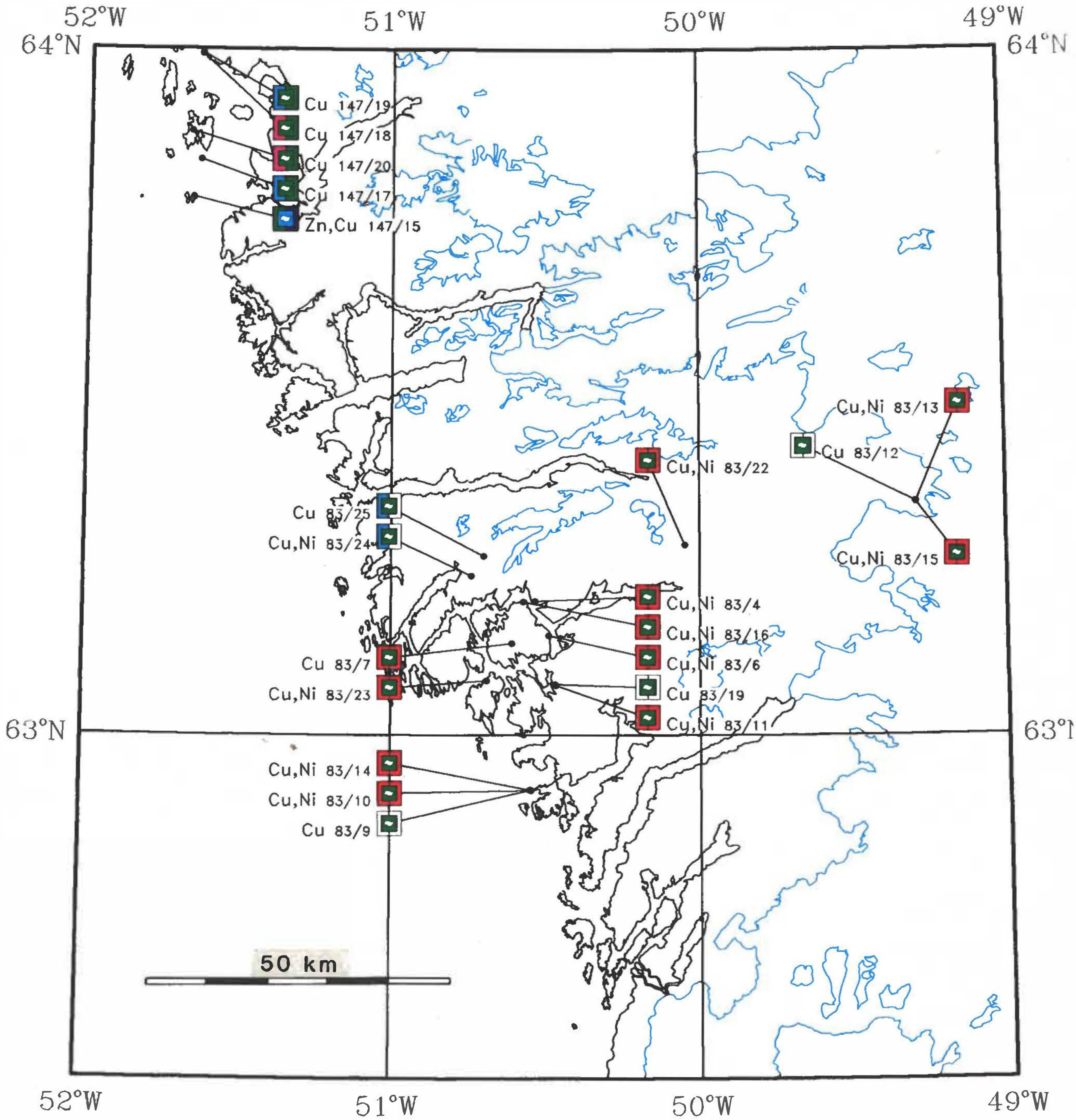
52°W
51°W
50°W
49°W
64°N
64°N
Cu 147/19
Cu 147/18
Cu 147/20
Cu 147/17
Zn,Cu 147/15
Cu,Ni 83/13
Cu 83/12
Cu,Ni 83/22
Cu 83/25
Cu,Ni 83/24
Cu,Ni 83/15
Cu,Ni 83/4
Cu,Ni 83/16
Cu,Ni 83/6
Cu 83/7
Cu 83/19
Cu,Ni 83/23
Cu,Ni 83/11
63°N
Cu,Ni 83/14
Cu,Ni 83/10
Cu 83/9
50 km
52°W
51°W
50°W
49°W

Fig. 3

Open File Series 90/9 Copper, zinc and nickel occurrences in the Nuuk region, West Greenland Peter Uitterdijk Appel

LEGEND

HOST ROCK

- Metamorphic
- Volcanic
- Igneous
- Sedimentary
- Unknown

GENETIC ENVIRONMENT

- Magmatic
- Volcanogenic
- Igneous
- Sedimentary
- Syngenetic
- Epigenetic
- Hydrothermal
- Unknown

MORPHOLOGY

- Stratiform
- Stratabound
- Lenticular
- Massive
- Disseminated
- Vein
- Pipe
- Stockwork
- Other

RESOURCE

- Fe, V, Ti, Mn, Cr
- PGE, Au
- Mo, W, Sn, Hg, Sb ,Bi
- Pb, Zn, Ag
- Gemstone, indust. mineral
- Cu, Ni, Co
- U, Th, Zr, Nb, REE

MINERALOGY

- Sulphide
- Native element
- Gemstone
- Silicate
- Other
- Oxide
- Sulphate
- Phosphate Carbonate Indust. min.

DATA SOURCE

The Greenland mineral occurrence database.

The data have been compiled from Survey reports, industry mineral assessment reports and published and unpublished research data.

All localities represent mineral occurrences observed on surface, in drill holes or mine workings.

SYMBOL SIZE / ECONOMIC IMPORTANCE

- Mine
- Prospect
- Showing

EXAMPLE

Disseminated lead sulphide(s) of hydrothermal origin hosted by volcanic rock(s). More detailed information available from the Greenland mineral occurrence database, occurrence ID: 24/13. Underlining indicates the presence of several occurrence IDs on the same site.

Pb 24/13

Projection: Lambert conformal conic
Standard parallel: 66° 30' N
Scale factor: 0.99700
Ellipsoid: Hayford
Datum: Qornoq
Scale: 1:1 000 000

Ice margins and coast lines digitized from 1:250 000 topographic maps. Permission No: KMS A.200/87

Released: 01–DEC–90

GRØNLANDS GEOLOGISKE UNDERSØGELSE
Geological Survey of Greenland
Øster Voldgade 10 DK–1350 København K Danmark

Fig. 4

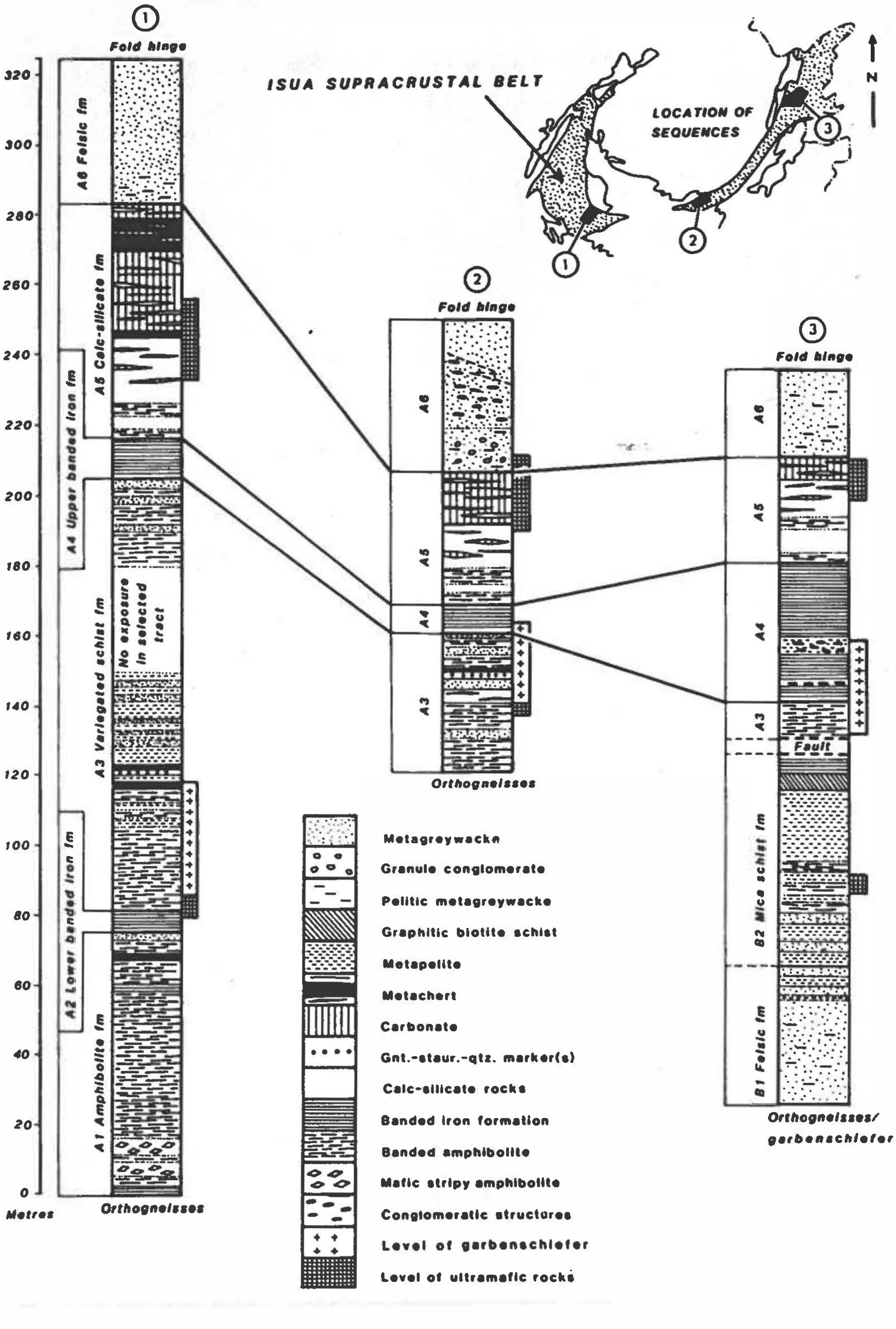

Fig. 5 Schematic stratigraphic sequence in the Isua supracrustal belt. (Nutman, 1986).

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