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Gold content of regional stream sediment samples from South Greenland

Agnete Steenfelt

April 1990

GRØNLANDS GEOLOGISKE UNDERSØGELSE
The Geological Survey of Greenland
ØSTER VOLDGADE 10, 1350 KØBENHAVN K, DANMARK

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A newly conducted analysis of 2192 stream sediment samples shows that anomalous gold values (25-850 ppb) are distributed over much of South Greenland. The results of the analysis for Au and As are presented and briefly commented.

Sampling and analysis

The stream sediment samples were collected during a regional reconnaissance geochemical uranium exploration programme (Syduran) covering South Greenland (Armour-Brown et al., 1982). About 2300 samples were collected at an average density of 1 sample per 6 km^2. The samples were dry-sieved in the laboratory and the <0.1 mm grain size fraction was analysed at Risø National Laboratory, Denmark, for uranium by delayed neutron counting, and for 17 major and trace elements by radio-isotope energy dispersive X-ray fluorescence (Kunzendorf, 1979). The results have been presented as geochemical element distribution maps at a scale of 1:1,000,000 (Armour-Brown et al., 1982; Olesen, 1984). The evaluation of the results, mainly with respect to uranium, is found in Armour-Brown et al. (1983), Armour-Brown & Olesen (1984) and Steenfelt & Armour-Brown (1988).

The remains of the fine fraction of the samples have been used for instrumental neutron activation analysis at Actlabs, Canada, where gold plus 33 other trace elements were determined. The analyses were conducted on 7 gram or even on 1 gram aliquots (instead of the now recommended 30 grammes) due to very limited amount of material available. With such small amounts of material the nugget effect may seriously influence the gold determinations and the results must be considered as a rough guide only. In the evaluation of the results the emphasis should be placed on the geographical distribution of gold concentration rather than on the magnitude of individual values.

Of the 2192 samples analysed, 475 (=22.7%) yielded gold values above the detection limit of 5 ppb, and 1336 (=55.2%) yielded arsenic values above 2 ppm. The frequency distributions of the detected values are given in the table:

Au ppb	number	As ppm	number
5-25	441	2-30	1209
26-50	14	31-60	82
51-75	5	61-90	16
76-100	3	91-120	10
>100	12	>120	18

Summary of the geology

The geological map at 1:500,000 scale by the Geological Survey of Greenland (Allaart, 1975) enclosed with this report serves to summarize the geology of South Greenland. A description of this map is in preparation (Kalsbeek et al., in prep.). Parts of the region are covered by geological maps at 1:100,000 scale published by GGU.

The northernmost part of South Greenland is underlain by Archaean basement whereas the entire southern part belongs to the early Proterozoic Ketilidian mobile belt. The Ketilidian is thought to represent juvenile Proterozoic crust accreted to the Archaean continent (Patchett & Bridgwater, 1984; Kalsbeek & Taylor, 1985). A mid-Proterozoic alkaline igneous province (Gardar province) pierces the northern part of the Ketilidian belt and the southernmost part of the Archaean basement.

Allaart (1976) divided the Ketilidian mobile belt into 4 structural units. From north to south these are: 'border zone', 'granite zone', 'folded migmatite zone', and 'flat-lying migmatite complex'. The boundaries between these units are shown on the gold and arsenic distribution maps of this report.

The 'border zone', forming the southernmost part of the Archaean basement, consists of tonalitic to granodioritic gneisses and basic supracrustal sequences. The most important Archaean supracurstal occurrence, known as the Tartoq group, contains horizons of quartz banded iron-formation (Appel, 1984). To the east and southeast the Archaean basement is overlain by Proterozoic metasedimentary and basic metavolcanic rocks (Midternæs and Grænseland) which are progressively deformed and metamorphosed towards the south. The Proterozoic supracrustals also contain banded iron-formation (Appel, 1974).

The 'granite zone' is dominated by numerous intrusions of granitic (*s.l.*) batholiths with scattered inclusions of supracrustal rocks. Minor plutons of basic rocks are associated with the granites. According to isotopic age dating (summarised in Kalsbeek & Taylor, 1985) the granite intrusions were emplaced over the period c. 1850 to 1740 Ma.

The 'folded migmatite zone' comprises large occurrences of pelitic to semipelitic sediments and basic volcanic sequences which are metamorphosed up to granulite facies and are often strongly migmatised. They are intruded by granites of the same general age as those in the 'granite zone'.

The 'flat-lying migmatite complex' consists of flat-lying, high-grade migmatites intruded by large sheets and bodies of granites, including major Rapakivi complexes.

The Gardar Province comprises mid-Proterozoic sediments and lavas deposited in a continental rift zone as well as 10 major alkaline intrusive complexes and numerous dykes emplaced between c. 1300 and 1120 Ma. The latest review of the province is given by Upton & Emeleus (1987). Extensive hydrothermal activity accompanying the emplacement of the magmas (Berrangé, 1966) caused mineralisation in the margins of two intrusive complexes (Nb, Ta, U, Th, Pb, Mo) (Sørensen et al., 1974; Tukiainen, 1988) as well as in fracture zones in the surrounding granite-gneiss (U) (Armour-Brown et al., 1982; Nyegaard et al., 1986; Nyegaard & Armour-Brown, 1986).

Previous gold exploration

During reconnaissance exploration in the Archaean Tartoq group of the 'border zone' gold bearing sulphide mineralisation in greenstone sequences was encountered (Appel & Secher, 1984). Three types were distinguished: 1) Siliceous strata-bound arsenopyrite-pyrite layers, 2) tennantite-bearing quartz veins associated with these layers, and 3) scattered chalcopyrite-bearing quartz veins and lenses. Analyses of 5 mineralised grab samples yielded from 2 to 17 ppm Au.

At the abandoned copper mine (Josva mine) on the south coast of Kobberminebugten Harry & Oen (1964) found grains of gold in bornite veins hosted by Proterozoic supracrustal rocks. Later investigations (Ghisler, 1968; Secher & Kalvig, 1987; Secher, unpublished data) confirmed the presence of small amounts of gold (2-3ppm) associated with the bornite mineralisation. A soil survey with samples collected in a 100 by 100 m grid over the supracrustals of the south coast of Kobberminebugten did not indicate any important gold mineralisation (gold values up to 16 ppb) other than the one at Josva mine associated with bornite (A. Steenfelt, unpublished data).

Reconnaissance by Kryolitselskabet Øresund A/S (Nielsen, 1976) and the Geological Survey of Greenland (Secher & Kalvig, 1987 and unpublished data) over the Proterozoic supracrustal sequences of the 'border zone' resulted in the discovery of gold bearing sulphide mineralisations (2-5 ppm in grab samples) at other sites in the area surrounding Kobberminebugten.

In the 'folded migmatite zone' gold has been detected in both stream sediments (fine fraction) and panned concentrates. In 1987 a batch of 238 stream sediment samples of the Geological Survey of Greenland's Syduran collection was analysed for gold by instrumental neutron activation analysis (Steenfelt, 1987). The result showed that gold anomalies are frequent in the metavolcanic as well as in the metasedimentary sequences. Gold has been reported to occur in small sulphide mineralised ultramafic bodies which have intruded the volcano-sedimentary sequences (Berrangé, 1970). However, the frequency and size of the mafic intrusions are not adequate to explain the number of stream sediment gold anomalies, and the source of gold is more likely associated with the supracrustal rocks. There has been limited field work in the area, and so far mineralisations have not been reported.

Following the discovery of gold in panned concentrates in the Nanortalik district a joint-venture of Nanortalik Minerals A/S and Greenex A/S evaluated the potential for placer type gold in Quaternary alluvial deposits in two large valleys north of Nanortalik (Christensen, 1989). A large number of 0.6 m^3 samples were collected along lines across the valleys from the uppermost 1 to 4 metres of the alluvial sediment, preconcentrated in a Denver Goldsaver, and two fractions (2-10 mm and <2 mm) were analysed. The gold contents varied typically between 0.001 g/m^3 and 0.02 g/m^3, and this was regarded unfavourable and the testing was discontinued.

Samples of panned concentrate were collected in the drainage systems above the gold-bearing alluvium (Christensen, 1989). Gold (100 ppb) and arsenic (up to 4600 ppb) were obtained in samples draining mafic metavolcanic rocks, and it is therefore assumed that the source of gold is associated with these rocks. However, gold mineralisation has not yet been found *in situ* and the c. 100 rock analyses made were all below 88 ppb gold.

Distribution of gold values in the present study

In the evaluation of exploration data the 98th percentile is commonly used as a threshold above which values are defined as anomalous. In the present case the use of this principle would result in a threshold of 25 ppb Au and 34 anomalies. However, taking into consideration that the samples used in this survey were not collected specifically for gold exploration and that the amounts analysed are very small, the actual numbers may not be very significant. Consequently, low values (but above the detection limit) should not be disregarded and higher values should not be used to rank the importance of anomalous sites. The most significant aspect of these regional data are the abundance and spatial distribution of the gold-bearing samples in relation to the geological setting.

When the enclosed gold distribution map is compared with the geological map, the first impression is that the gold containing samples are scattered randomly over the whole of the investigated area. They appear not to be controlled by any lithological or structural features. However, the distribution of arsenic is a great help in interpreting the distribution pattern of gold. This pattern is best described using the structural zones of Allaart (1976).

In the 'border zone' all the elevated arsenic values as well as almost all the gold values above the detection limit may be related to occurrences of basic supracrustal rocks. The few gold values situated in areas of gneiss do not coincide with elevated arsenic and cannot be explained with our present knowledge. The gold-arsenic data confirm the existence of sulphide associated gold mineralisation both in the Archaean (Tartoq group), and the Proterozoic supracrustals (Midternæs, Grænseland and the island of Arsuk) which is in agreement with the results of most of the previous geological reconnaissance mentioned above.

Over the 'granite zone', gold anomalies are scattered with some tendency to clustering around Igaliko Fjord. These anomalies are located in gneiss or granite and do not coincide with areas of elevated arsenic. In fact, the absence of arsenic in the 'granite zone' is remarkable. The few arsenic values above 2 ppm are located in the Gardar alkaline intrusion Ilímaussaq, east of Narssaq. There is a scarcity of supracrustal rocks within the 'granite zone' and it is unlikely that the anomalies are related to unmapped basic volcanics. At present a documented explanation of the anomalies in this zone cannot be offered. One can only guess at a possible relation to shear and fracture zones which are known to occur quite frequently in the 'granite zone' and in the Igaliko Fjord area in particular (Nyegaard & Armour-Brown, 1986; Conradsen et al., 1985). The wallrock of many of the faults and fractures is affected by extensive secondary alteration (hematitisation, chloritisation, silicification) accompanied by small amounts of fluorite, calcite, iron and copper sulphides (Berrangé, 1966). One sample of altered rock contained 0.2 ppm gold. Nyegaard & Armour-Brown (1986) provided further evidence for hydrothermal alteration in fracture zones in the form of albitisation, carbonatisation, and fluoritisation associated with uranium mineralisation.

In the 'folded migmatite zone' there is a concentration of high arsenic values. The boundary between the 'granite zone' and the 'folded migmatite zone' nearly coincides with the northern boundary of this arsenic province. The high arsenic values appear to be related to the Proterozoic metasediments and basic metavolcanics. Compared with the 'border zone' the supracrustals of the 'folded migmatite zone' are considerably higher in arsenic.

The 'folded migmatite zone' also contains the greatest density of elevated gold values. It should be noted that 238 of the Syduran samples from this zone have been analysed for gold once before, as mentioned above, and little material (80 samples) was left to be included in the present analysis. Therefore, there are more anomalies in the Nanortalik region (see Steenfelt, 1987) than shown in the present gold distribution map.

The result of the present analyses strongly supports previous indications (anomalies in stream sediments and gold plus arsenic in panned concentrates) of the existence of gold mineralisation associated with the Proterozoic supracrustal sequences in the 'folded migmatite zone'. As mentioned before, this area has not been satisfactorily explored for mineral occurrences, and primary gold mineralisation has not been so far reported.

In the 'flat-lying migmatite complex' the level of arsenic is low. The few high gold values are scattered and cannot be related to any particular geological setting.

Conclusion

The new analytical data provide the first regional information on the abundance and distribution of gold in South Greenland, and they show that anomalies occur over large areas.

While previous gold exploration has mainly been concerned with greenstones in the 'border zone', the present data strongly suggest that the 'folded migmatite zone' and the 'granite zone' should also be considered as target areas for intensified gold exploration.

In the 'folded migmatite zone' the gold anomalies occur in arsenic rich supracrustals which suggests that the gold is associated with sulphide mineralised rocks. By contrast, the gold anomalies in the 'granite zone' occur in granitic rocks devoid of arsenic. This indicates a completely different type of mineralisation which is tentatively related to hydrothermal activity associated with Gardar magmatism.

The frequency and magnitude of gold concentrations encountered in South Greenland is surprisingly high considering the fact that the samples and fractions used for analysis were not ideal from a gold exploration point of view. Moreover when the gold results are compared with that of other regional surveys the values obtained in South Greenland seem high. For example, in the northern part of Fennoscandia the 95th percentile for gold content in the fine fraction of till was 9.5 ppb and maximum 436 ppb (Bølviken et al.,1986).

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Enclosures

Geological map of Greenland 1:500 000 sheet 1, South Greenland (Allaart, 1975).

Semi-transparent map 1:500 000 of gold in the <0.1 mm grain size fraction of stream sediments. The radius of the circles is linear proportional to the gold concentration of the sample (see scaling factor on the map). Maximum radius (0.5 cm) equals 100 ppb. Gold concentrations above 100 ppb are written in the circles.

Semi-transparent map 1:500 000 of arsenic in the same samples and presented in the same way as gold. Maximum radius equals 100 ppm. Higher concentrations are not quantified on the map.

REFERENCES

Allaart, J. H. 1975: Geological map of Greenland. 1:500 000 sheet 1, Sydgrønland. Copenhagen: Geol. Surv. Greenland.

Allaart, J. H. 1976: Ketilidian mobile belt in South Greenland. *In* Escher, A. & Watt, W. S. (edit.) *Geology of Greenland*, 121-151. Copenhagen: Geol. Surv. Greenland.

Appel, P. W. U. 1974: On an unmetamorphosed iron-formation in the Early Precambrian of South-West Greenland. *Miner. Deposita,* 9, 75-82.

Appel, P. W. U. 1984: An iron-formation in the Precambrian Tartoq Group, South-West Greenland. *Rapp. Grønlands geol. Unders.* 120, 74-78.

Appel, P. W. U. & Secher, K. 1984: On a gold mineralization in the Precambrian Tartoq Group, SW Greenland. *J. geol. Soc. Lond.* 141, 272-278.

Armour-Brown, A., Tukiainen, T. & Wallin, B. 1982: The South Greenland uranium exploration programme. Final report. Unpubl. report, Geol. Surv. Greenland, 95 pp.

Armour-Brown, A., Steenfelt, A. & Kunzendorf, H. 1983: Uranium districts defined by reconnaissance geochemistry in South Greenland. *J. geochem. Explor.* 19, 127-145.

Armour-Brown, A. & Olesen, B. L. 1984: Condensing multi-element reconnaissance geochemical data from South Greenland using geochemical data from South Greenland using empirical discriminant analysis. *J. geochem. Explor.* 21, 395-404.

Berrangé, J. P. 1966: The bedrock geology of Vatnahverfi, Julianehåb district, South Greenland. *Rapp Grønlands geol. Unders.* 3, 48 pp.

Berrangé, J. P. 1970: The geology of two small layered hornblende peridotite (picrite) plutons in South Greenland. *Bull. Grønlands geol. Unders.* 92, 43 pp.

Bølviken, B., Bergström, J., Björklund, A., Kontio, M., Lehmuspelto, P., Lindholm, T., Magnusson, J., Ottesen, R. T., Steenfelt, A. & Volden, T. 1986: Geochemical atlas of northern Fennoscandia. Uppsala: Geol. Surv. of Sweden.

Christensen, K. 1989: Joint-Venture Nanortalik Minerals A/S - Greenex A/S. Evaluering af Guldpotentiale i et område ved Nanortalik, Sydgrønland 1988, Unpublished Company Report. 14 pp.

Conradsen, K., Nielsen, B. K., Nilsson, G. & Thyrsted, T. 1984: Application of remote sensing in uranium exploration in south Greenland. Res. rep. IMSOR, Tech. Univ. Denmark 22/1984.

Ghisler, M. 1968: The geological setting and mineralisations west of Lilianmine, South Greenland. *Rapp. Grønlands geol. Unders.* 16, 53 pp.

Harry, W. T. & Oen Ing Soen 1964: The pre-Cambrian basement of Alangorssuaq, South Greenland and its copper mineralization at Josvaminen. *Bull. Grønlands geol. Unders.* 47 (also Meddr Grønland 179, 1) 72 pp.

Kalsbeek, F. & Taylor, P. N. 1985: Isotopic and chemical variation in granites across a Proterozoic continental margin - the Ketilidian mobile belt of South Greenland. *Earth planet. Sci. Lett.* 73, 65-80.

Kalsbeek, F., Larsen, L. M. & Bondam, J. in prep.: Geological map of Greenland 1:500 000, sheet 1, Sydgrønland, descriptive text. Copenhagen: Geol. Surv. Greenland.

Kunzendorf, H. 1979: Practical experiences with automated radioisotope energy-dispersive X-ray fluorescence analysis of exploration geochemistry samples. *Risø Report* 407, 24 pp.

Nielsen, B. L. 1976: Economic minerals. *In* Escher, A. & Watt, W. S. (edit.) *Geology of Greenland*, 460-486. Copenhagen: Geol. Surv. Greenland.

Nyegaard, P. & Armour-Brown, A. 1986: Uranium occurrences in the granite zone. Structural setting - genesis - exploration methods. The South Greenland Exploration Programme 1984-1986. Report no. 1. Unpubl. report, Geol. Surv. Greenland. 138 pp.

Nyegaard, P., Armour-Brown, A. & Steenfelt, A. 1986: Vein type uranium mineral occurrences in South Greenland. *In* IAEA (edit.) *Vein type uranium deposits*, 43-55. IAEA TECDOC-361. Vienna: The International Atomic Energy Agency.

Olesen, B.L. 1984: Geochemical mapping of South Greenland. Unpublished thesis, Department of Mineral Industry, Technical University of Denmark, 132 pp.

Patchett, P. J. & Bridgwater, D. 1984: Origin of continental crust of 1.9 - 1.7 Ga age defined by Nd isotopes in the Ketilidian terrain of South Greenland. *Contr. Miner. Petrol.* 87, 311-318.

Secher, K. & Kalvig, P. 1987: Reconnaissance for noble and base metal mineralisation within the Precambrian supracrustal sequences in the Ivigtut - Kobberminebugt region, South-West Greenland. *Rapp. Grønlands geol. Unders.* 135, 52-59

Sørensen, H., Rose-Hansen, J., Nielsen, B. L., Løvborg, L., Sørensen, E. & Lundgaard, T. 1974: The uranium deposit at Kvanefjeld, the Ilímaussaq intrusion, South Greenland. Geology, reserves and beneficiation. *Rapp. Grønlands geol. Unders.* 60, 54 pp.

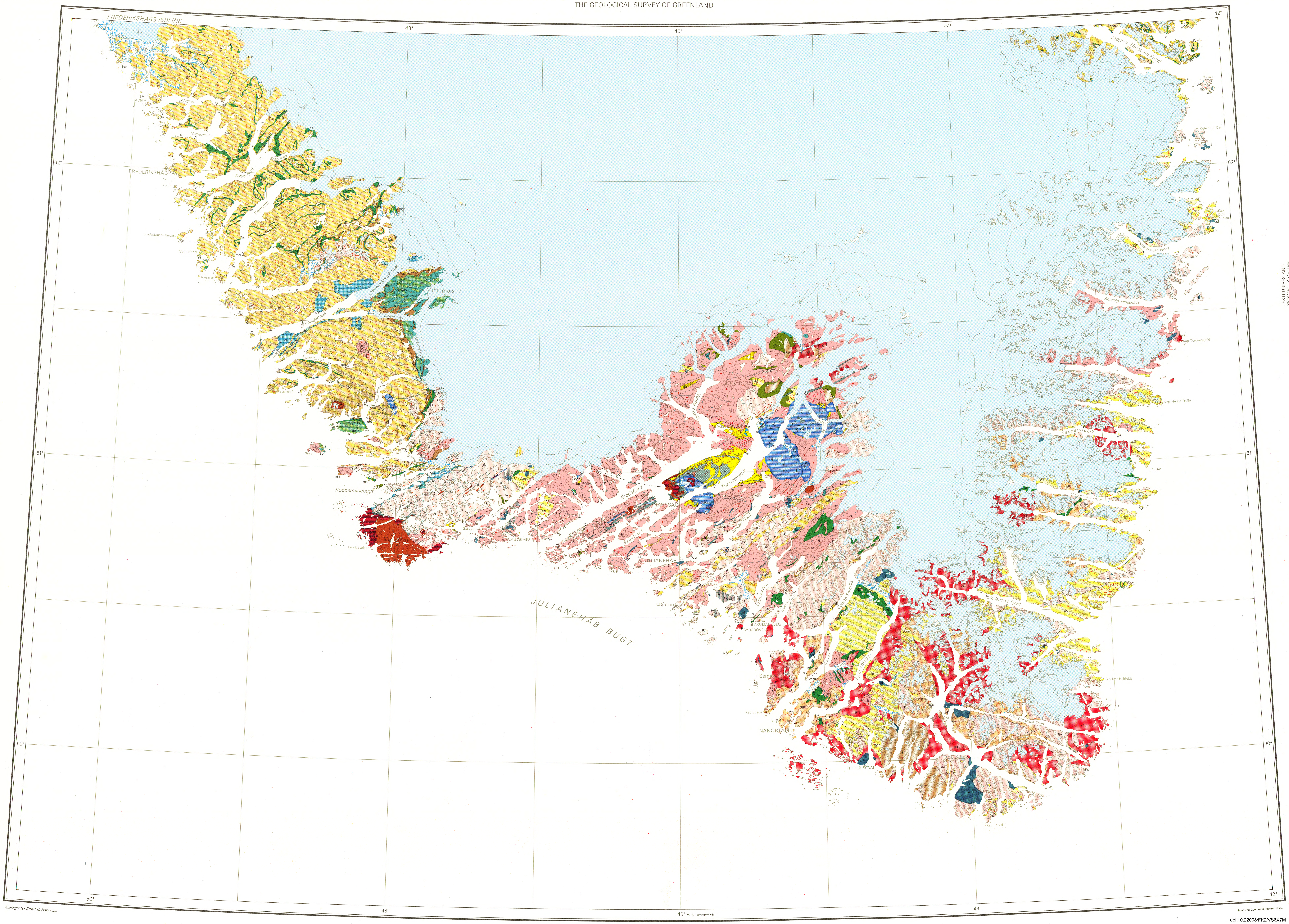
Steenfelt, A. 1987: Gold in the fine fraction of stream sediments from supracrustal sequences in West Greenland. *Open File Ser. Grønlands geol. Unders.* 87/2, 10 pp.

Steenfelt, A. & Armour-Brown, A. 1988: Characteristics of the South Greenland uranium province. *In* IAEA (edit.) *Recognition of uranium provinces*, 305-335. Vienna: International Atomic Energy Agency.

Tukiainen, T. 1988: Niobium-tantalum mineralisation in the Motzfeldt Centre of the Igaliko Nepheline Syenite Complex, South Greenland. *In* Boissonnas, J. & Omenetto, P. (edit.) *Mineral deposits within the European Community*, 230-246. Berlin, Heidelberg: Springer Verlag.

Upton, B. G. J. & Emeleus, C. H. 1987: Mid-Proterozoic alkaline magmatism in South Greenland: The Gardar Province. *In* Fitton, J. G. & Upton, B. G. J. (edit.) *Alkaline igneous rocks. Spec. Publ. geol. Soc. Lond.* 30, 449-471.

GRØNLANDS GEOLOGISKE UNDERSØGELSE
THE GEOLOGICAL SURVEY OF GREENLAND



Kartografi: Birgit H. Petersen.

Trykt ved Geodætisk Institut 1975.

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- ICE
- QUATERNARY, undifferentiated deposits
- Th DOLERITE, dykes of 3 km broad Mesozoic coast-parallel swarm

GARDAR INTRUSIVE ROCKS

- ALKALI GRANITE, members of Narssaq, Ilímaussaq, Nunarssuit and Puklen intrusions
- γ GRANITE *(sensu stricto)*, member of Nunarssuit intrusion
  Xenolith inclusion zones (mainly basic metavolcanic rocks) in Nunarssuit intrusion
- σ SYENITE, quartz syenite of composite giant dykes of Isortoq; various quartz syenite members of Tugtutôq central complex; quartz syenites of Narssaq, Ilímaussaq and Nunarssuit intrusions, saturated pyroxene-fayalite syenite of Kûngnât complex, and larvikitic and quartz syenites of Klokken intrusion. Xenolith inclusion zones in Nunarssuit intrusion
- λ SYENITE, just-undersaturated augite syenite of composite giant dykes of Tugtutôq and Isortoq; augite syenite, heterogeneous syenite and pulaskite of Ilímaussaq intrusion
- χ AGPAITIC NEPHELINE SYENITE, members of Ilímaussaq intrusion
- ψ NEPHELINE SYENITE, members of Igaliko intrusion (main members: Motzfeldt Centre ψ_1, North Qôroq Centre ψ_2, South Qôroq Centre ψ_3, Igdlerfigssalik Centre ψ_4
- σ MICROSYENITE DYKES
- δ DOLERITE
- δ GABBRO, sills of olivine-free basalt in lower part of Eriksfjord Formation; mildly alkaline olivine gabbro dykes of Nunarssuit and Tugtutôq-Narssarssuaq areas

EXTRUSIVES AND SEDIMENTS OF THE ERIKSFJORD FORMATION

- τ SATURATED EFFUSIVES WITHOUT QUARTZ (trachyte)
- β BASALT
- μ CARBONATITE. Calcareous tuffs
- q SANDSTONE

KETILIDIAN MOBILE BELT

LATE GRANITES

- grl GRANITE *(sensu lato)*, rapakivi suite of the Sydprøven-Kap Farvel-Kangerdluluk area
- sgl PYROXENE- AND GARNET-BEARING QUARTZ MONZONITE of variable composition; with local gneissose foliation
- gl GRANITE *(sensu lato)*, allochthonous granites outside the area of Julianehåb granite and foreland granites in Ivigtut area; biotitic, biotitic foliated, biotite-rich enclaves, hornblendic, hornblendic foliated, amphibolitic enclaves
- gjl GRANITE *(sensu lato)*, granodiorite to adamellite; in some areas poor in quartz, late members of the Julianehåb granite, occurring between Kobberminebugt and Igaliko Fjord in the south-west and between the fjords Kangerdluluk and Napassorssuaq in the east; biotitic, biotitic foliated, hornblendic, hornblendic foliated. The Julianehåb granite on the east coast consists of several generations between which major boundaries have not been mapped. Correlation with the west coast is uncertain
- gl APLITIC GRANITE

EARLY GRANITES

- gje GRANITE *(sensu lato)*, early, gneissose granite, members of Julianehåb granite; biotitic, hornblendic
- ge GRANITE *(sensu lato)*, early granites outside Julianehåb granite, biotitic, hornblendic,
- ge LEUCOCRATIC GRANITE *(sensu lato)*, garnet-bearing alaskite and biotite-bearing charnockite south-east of Tasermiut

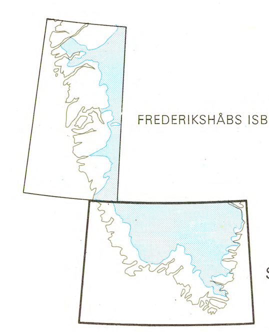
- pd APPINITIC ROCKS, basic to intermediate intrusions with intimate connections to plutonic and granitic activity
- nr HYPERSTHENE GABBRO, belonging to rapakivi suite
- dg DIORITIC ROCKS, usually migmatitic associated with appinitic intrusions in the Qagssimiut area; composite granite-diorite intrusion between Sârdloq and Sydprøven; unfoliated dioritic rocks north of Lichtenau Fjord
- di DIORITE, marginal components of zoned diorite-monzonite intrusions north and east of Narssarssuaq; other independent intrusions north and east of Narssarssuaq, around Julianehåb and at Kobberminebugt
- sgi PYROXENE-BIOTITE MONZONITE, central components of zoned monzonite-diorite intrusions (two independent occurrences) north and east of Narssarssuaq
- au BASIC ROCKS OF UNKNOWN ORIGIN, bodies occurring in the Julianehåb granite, north-east of Sydprøven and on Amitsoq
- rh ACID METAVOLCANIC ROCKS with occasional components of intermediate rocks from the area north-east of Narssarssuaq
- de INTERMEDIATE VOLCANIC ROCKS often of mixed character
- ae BASIC METAVOLCANIC ROCKS, often with pillow structure and including hyaloclastites (Sortis Group of the Midternæs-Grænseland area and the Arsuk Group of the Arsuk Ø area
- ai BASIC INTRUSIVES. Metamorphosed sills of the Sortis Group and Arsuk Group; occasional sills in Ketilidian sediments underlying Sortis and Arsuk Groups; intrusive bodies in the Julianehåb granite; metamorphosed basic sills in meta-arkoses west of Tasermiut
- a BASIC METAMORPHIC ROCKS, metavolcanic rocks mixed with meta-intrusives; (south of Arsuk Bræ: Sortis Group, Arsuk Ø: Arsuk Group); volcanics of the Ilordleq Group (Kobberminebugt); Tasermiut volcanic rocks
- vsk METAVOLCANIC ROCKS MIXED WITH METASEDIMENTS belonging to the Ilordleq Group
- ms METASEDIMENTS of the Vallen Group of the Midternæs-Grænseland area and of the Ikerasârssuk Group of the Arsuk Ø area
- mss MICA SCHIST in part highly metamorphosed Vallen Group; mica schists of Ilordleq Group at Kobberminebugt
- sp METAMORPHOSED SEMIPELITES of the Qipisarqo Group
- c CARBONATE ROCKS
- qs META-ARKOSES, partly with acid volcanic rocks and volcanogenic sediments from the Tasermiut region and the east coast; siliceous metasediments of the Qipisarqo Group north of Kobberminebugt
- qgn QUARTZO-FELDSPATHIC GNEISS with relics of quartzitic or acid volcanic rocks; leucocratic gneisses and aplitic gneiss in the Julianehåb granite; the brown symbols indicate pelitic gneiss horizons north-east of Lindenows Fjord
- pgn PELITIC TO SEMIPELITIC GNEISS (Late Archaean or Early Proterozoic), often with considerable pegmatite migmatisation, generally with cordierite and sillimanite and in the westernmost occurrences on Sermersôq also andalusite; the blue symbols indicate lenses of calc-silicate rock or marble
- gnk GNEISS, mainly granodioritic or quartz dioritic; biotitic, hornblendic

- md METADOLERITES

ARCHAEAN BLOCK

- vs METAVOLCANIC ROCKS MIXED WITH METASEDIMENTS, belonging to the Tartoq Group
- qga QUARTZO-FELDSPATHIC GNEISS with relics of quartzitic or acid volcanic rocks (Ikermit supracrustal series; Rb/Sr whole rock isochron: 2600 ± 35 m.y.)
- aa AMPHIBOLITE, marker horizons in gneiss
- msa MICA SCHIST (garnet, cordierite, sillimanite bearing)
- gna GNEISS, mainly granodioritic or quartz dioritic; biotitic, hornblendic, muscovite-bearing, with agmatites and enclaves of Tartoq Group greenschists. A concentration of the biotitic and hornblendic symbols east of Grønnedal indicates the Ika gneiss series, consisting of banded supracrustal rocks with calc-silicate lenses of unknown age
- ga GNEISS with abundant gabbro-anorthositic enclaves. The matrix is mainly granodioritic to quartz dioritic
- gg GRANITE *(sensu lato)*, biotitic, foliated biotitic, with enclaves of mica schist; with amphibolitic enclaves

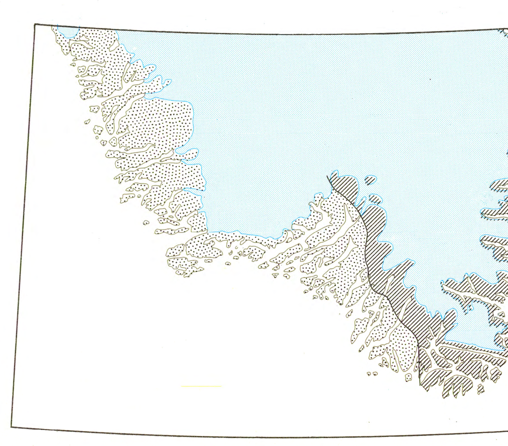
- MIGMATISATION



SHEET 2
FREDERIKSHÅBS ISBLINK - SØNDRE STRØMFJORD

SHEET 1
SYDGRØNLAND

Topography based on maps of the Geodetic Institute, Denmark, and reproduced with permission A. 649/72.



Geological mapping mainly on scale 1:20 000 carried out by GGU teams 1958-1969.

Geological mapping by GGU teams on scales of 1:40 000 or smaller 1966-1970, and by R. H. Wallis with the St. Andrews University South Greenland Expedition 1960 and the Birmingham University Expedition to South Greenland 1961.

General compilation by J. H. Allaart.

GEOLOGICAL MAP OF GREENLAND
SHEET 1
SYDGRØNLAND

1:500 000

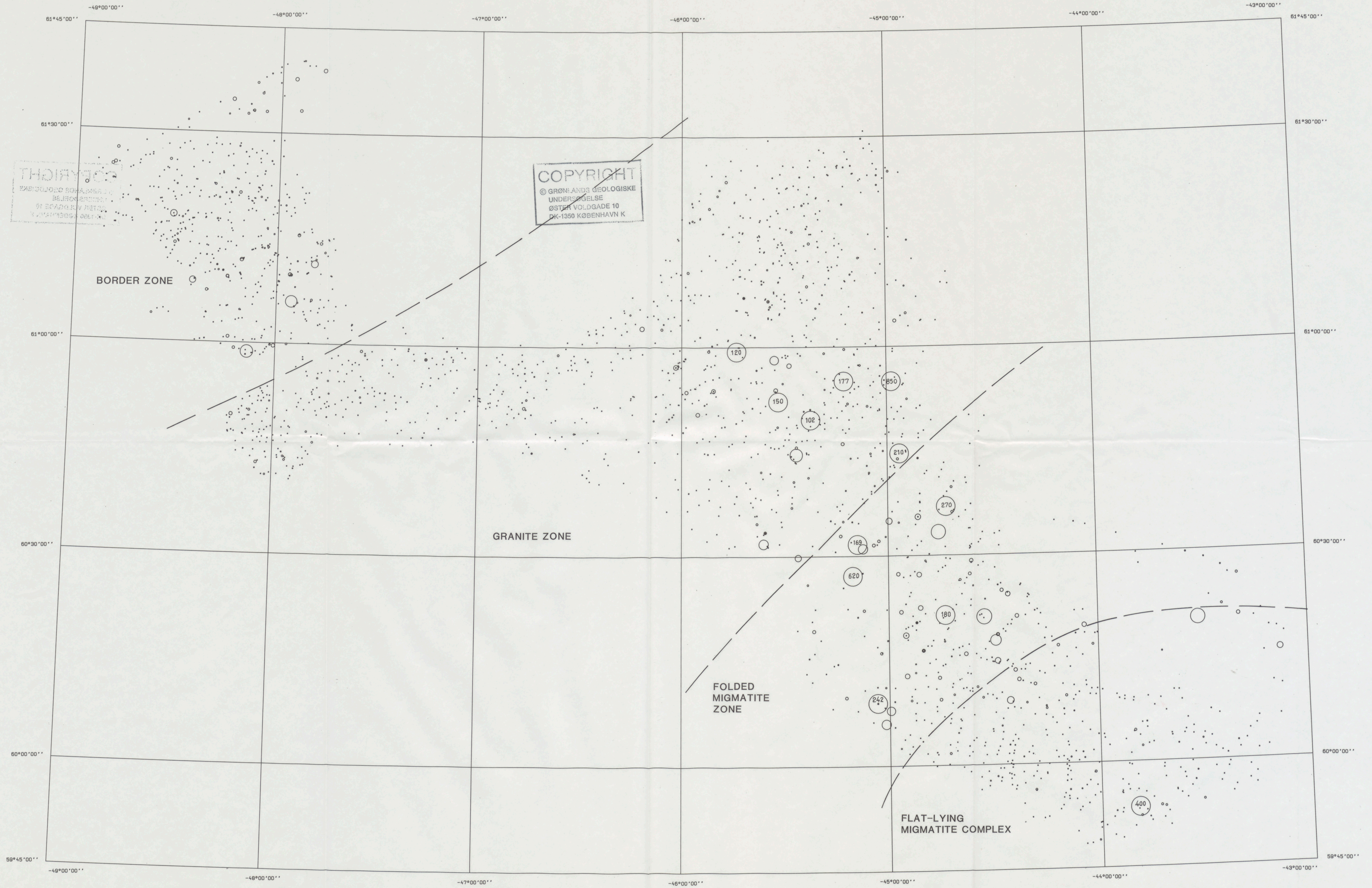
5 0 25 50 75 km

5 0 10 20 30 40 statute miles

Højdeforskellen mellem kurverne 200 m

Contour interval 200 m

- BOUNDARY, established
- BOUNDARY, inferred
- STRIKE AND DIP of lithological layering of any origin
- STRIKE AND DIP of foliation
- FAULT AND MYLONITE
- THRUST
- UNCONFORMITY
- CONGLOMERATE
- AUGEN TEXTURE
- PORPHYRITIC TEXTURE
- MINE, abandoned

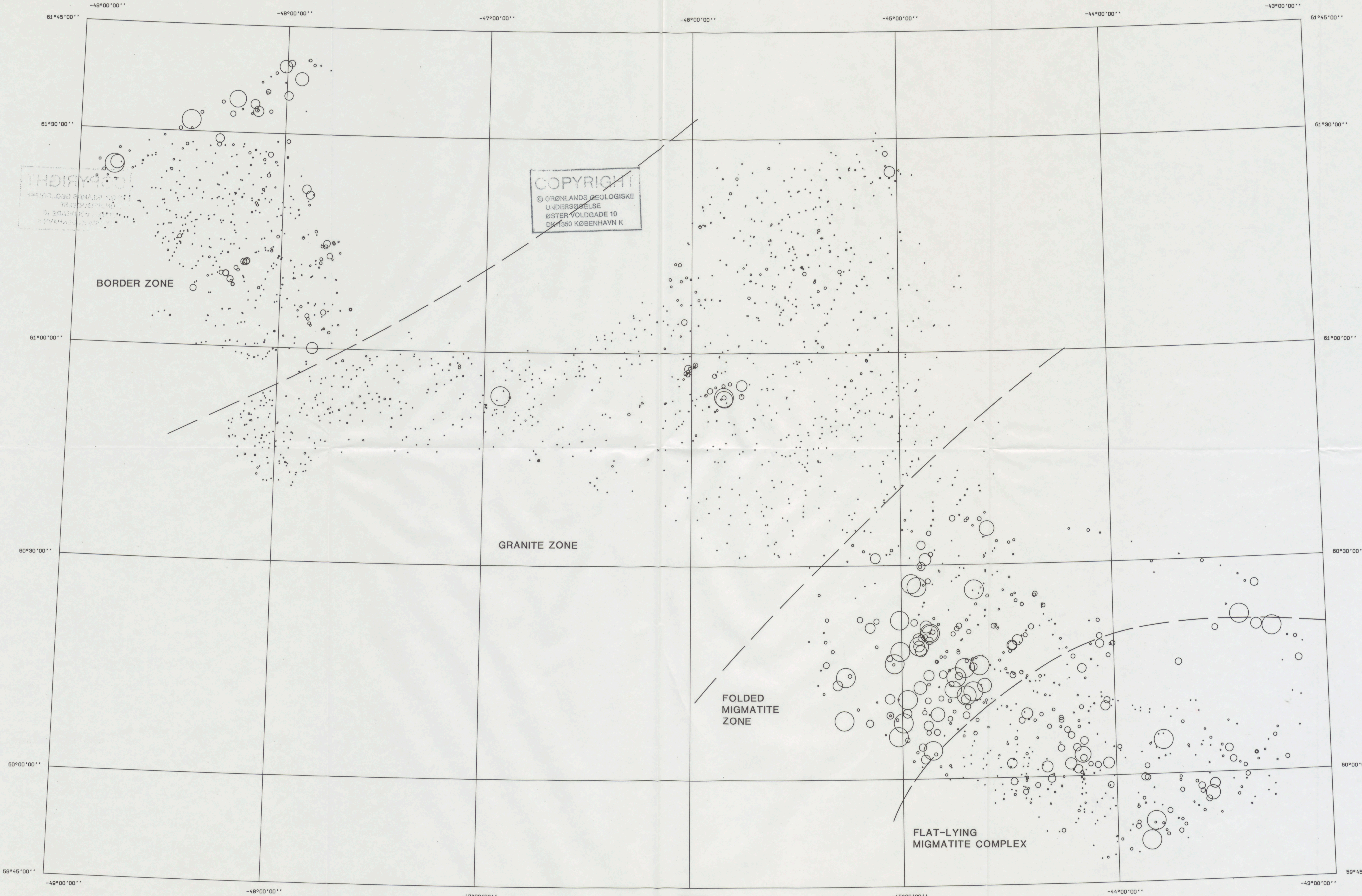


SCALE 1:500000

SOUTH GREENLAND STREAM SEDIMENTS
GRAIN SIZE FRACTION < 100 MICRON

ELEMENT	UNIT	SC.FACT	MAX	MIN
AU	PPB	0.005	0.5	0.02

PROJECTION: LAMBERT'S CONICAL ORTHOMORPHIC.
ELLIPSOID: INTERNATIONAL. A = 6378388M. F = 1/297.
STANDARD PARALLEL: 60G 45' 00" N



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