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RAPPORT Nr 83

The Geological Survey of Greenland
Report No. 83

Precambrian and Tertiary geology between Kangerdlugssuaq and Angmagssalik, East Greenland

A preliminary report

by

D. Bridgwater, F. Bryan Davies, R. C. O. Gill, B. E. Gorman, John S. Myers, S. Pedersen and P. Taylor

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Abstract

The preliminary results of a reconnaissance survey of the coast between Kangerdlugssuaq and Angmagssalik are summarized. The Archaean gneiss complex between Kangerdlugssuaq and Kap Japetus Steenstrup is fairly uniform and comprises granitoid gneisses with inclusions of supracrustal rocks, layered basic igneous complexes and older gneisses. Inland areas generally show low deformation states, large scale recumbent folds, and rocks are in granulite facies, whereas a belt of stronger deformation, steep foliation and amphibolite facies matamorphism extends along the outer coast.

To the south of Kap Japetus Steenstrup, Archaean rocks are strongly deformed in the Nagssugtoqidian mobile belt and granulite facies rocks are retrograded to amphibolite facies, except in pods of low deformation, between 2800–2600 m.y. ago. Large bodies of diorite and granodiorite (the Blokken gneisses) were emplaced and metamorphosed in amphibolite facies 2400 m.y. ago, and around Angmagssalik a complex of leuco-norite and charnockite was emplaced in granulite facies and caused coarse recrystallization of the adjacent gneisses. Post-tectonic igneous intrusions ranging from ultramafic to granite were intruded 1600 m.y. ago.

Numerous Tertiary dykes and plutonic complexes ranging from gabbro to granite were emplaced along the coast between Tasîlaq and Kangerdlugssuaq 60–35 m.y. ago.

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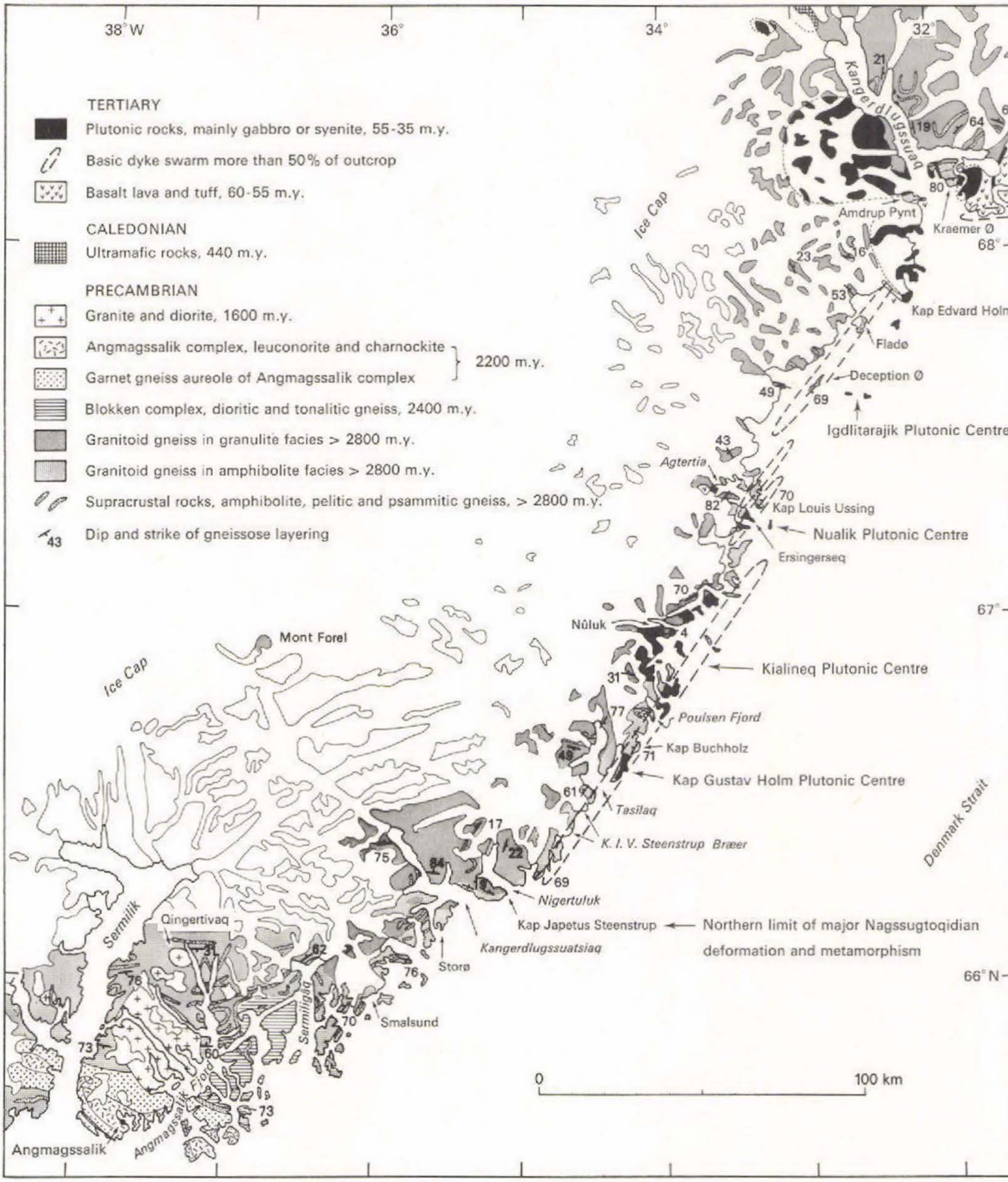

Fig. 1. Simplified geological map of the region between Kangerdlugssuaq and Angmagssalik. Compiled by J. S. Myers from GGU mapping in 1976–77, Wager (1934, 1947), Wright *et al.* (1973) and Brooks *et al.* (1976).

INTRODUCTION

In this report we summarize the results from 1977, the second field season of geological reconnaissance of the coast between Kangerdlugssuaq and Angmagssalik (fig. 1), and the first results from Rb-Sr and Pb-Pb whole rock studies on material collected in the southern part of this region in 1976 (Bridgwater *et al.*, 1977). Field work was carried out from the 80 ton cutter Tycho Brahe using 16 ft inflatable rubber dinghies. The coast was exceptionally clear of sea ice and it was possible to visit several localities which have not been accessible by sea since Wager's journey in 1930 as part of the British Arctic Air-route Expedition of 1930–1931 (Wager, 1934). This coastal reconnaissance is the first stage in the production of 1:500 000 geological maps of the region. The project is expected to extend over about 10 years. Because it will be many years before the coloured geological maps can be published, a preliminary uncoloured version of the northern map sheet (Kap Coster to Kangerdlugssuatsiaq, latitudes 66–69°N) is now under preparation together with a preliminary description of the regional geology.

GEOLOGICAL SUMMARY

The coast between Kangerdlugssuaq and Angmagssalik (fig. 1) consists of an Archaean and Proterozoic basement complex intruded by Tertiary igneous complexes and extremely numerous Tertiary dykes (Wager, 1934). It was intended that the main emphasis be placed on mapping the little known Precambrian of the area, but it became apparent that south of Kangerdlugssuaq little information has been added to Wager's 1934 sketch map of the Tertiary intrusion centres and that even for the production of a preliminary black and white map further work is necessary on the young igneous rocks. An attempt was therefore made to improve our knowledge of the extent, structure and gross petrology of the known bodies. A number of hitherto undescribed intrusions and a large area probably consisting of Tertiary basalt were also discovered.

PRECAMBRIAN BASEMENT

The gneiss complex can be divided into two main structural provinces: the area between Kangerdlugssuaq (68°30′N) and Kap Japetus Steenstrup (66°15′N) which consists of Archaean gneisses which are hardly affected by later regional deformation and metamorphism, and the area from Kap Japetus Steenstrup (66°15′N) to Angmagssalik (65°30′N) which represents the northern flank of the Proterozoic Nagssugtoqidian mobile belt (Bridgwater, 1976; Bridgwater *et al.*, 1977). The main intrusive and metamorphic events recognised in the Precambrian basement are summarised in Table 1.

Table 1. Magmatic and metamorphic events in the Precambrian between Kangerdlugssuaq and Angmagssalik

	Event	Age (m.y.)
(11)	Emplacement of post-orogenic instrusions ranging from ultrabasic to granite	1600 g
(10)	Regional amphibolite facies metamorphism in the Nagssugtoqidian belt	1900 f
(9)	Emplacement of leuco-norite–charnockite suite, Angmagssalik Ø. Could be equivalent to (8)	–
(8)	Granulite facies metamorphism in the Angmagssalik area. Mobilisation of older gneisses	1900 e
(7)	Emplacement and deformation of Blokken gneisses (diorites and granodiorites)	2400 d
(6)	E–W shear belts, and local retrogression of the Archaean granulite facies gneisses. (In border zone of the Nagssugtoqidian mobile belt)	2600 c
(5)	Late Archaean granitoid intrusions. Porphyritic adamellites and diorites. Regional granulite facies metamorphism inland, amphibolite facies near coast	2800 b
(4)	Syntectonic emplacement of granitiod intrusions	2980 a
(3)	Intrusion of layered anorthosite complexes	
(2)	Deposition of sediments, extrusion of lavas	
(1)	? Formation of older gneisses at Amdrup Pynt (this could be equivalent to (4) above)	

Notes

There are several epidodes of basic dyke injection between events (7) and (11). Some of the dykes within the Nagssugtoqidian mobile belt appear to have been emplaced under regional metamorphic conditions.

The previously unpublished ages are preliminary and can only be used as guides to the timing of events. They are therefore given to the nearest 100 m.y. and without errors. It is probable that particular metamorphic and igneous events are diachronous.

Rb-Sr whole rock ages (Pedersen) are given using a decay constant of $\lambda = 1.42 \times 10^{-11}y^{-1}$.

Pb-Pb whole rock ages (Taylor) are given using decay constants of $^{238}U\ \lambda = 0.155125 \times 10^{-9}y^{-1}$, $^{235}U\ \lambda = 0.98485 \times 10^{-9}y^{-1}$ and $^{238}U/^{235}U = 137.88$ (Jaffey *et al.*, 1971).

a: Leeman *et al.* (1976).

b: Pb-Pb whole rock isochron on Archaean granulite facies rocks, Kangerdlugssuatsiaq.

c: Rb-Sr whole rock isochron ($Sr_0 = 0.7014$) on E–W shear belt and country rocks, Storø. Both country rocks and highly sheared rocks lie on the same isochron.

d: Pb-Pb whole rock isochron on intrusive suite ranging from diorite to granodiorite (Blokken gneisses).

e: Rb-Sr whole rock on garnet gneisses, Angmagssalik Ø. The high initial ratio ($Sr_0 = 0.7055$) suggests involvement of relatively Rb-rich material probably derived from Archaean sediments.

f: Rb-Sr whole rock on highly deformed gneisses from Angmagssalik Ø. ($Sr_0 = 0.705$). Both whole rock and individual layers from gneisses fall on the same errorchron. Interpreted as Nagssugtoqidian rehomogenisation of Archaean gneisses.

g: Rb-Sr whole rock isochron on diorite-granite suite from Qingertivaq, inner Angmagssalik Fjord. ($Sr_0 = 0.7035$).

Archaean gneiss complex

The Archaean gneiss complex consists of three main components: (1) rocks of demonstrable supracrustal origin; (2) remnants of layered basic igneous bodies, and (3) granitoid gneisses. The granitoid gneisses make up over 90 per cent of the outcrop and show considerable range in composition. They are intrusive into the supracrustal rocks and layered basic igneous bodies which they enclose as trains of xenoliths. The granitoid gneisses, supracrustals and layered basic igneous bodies are all cut by thin metamorphosed basic

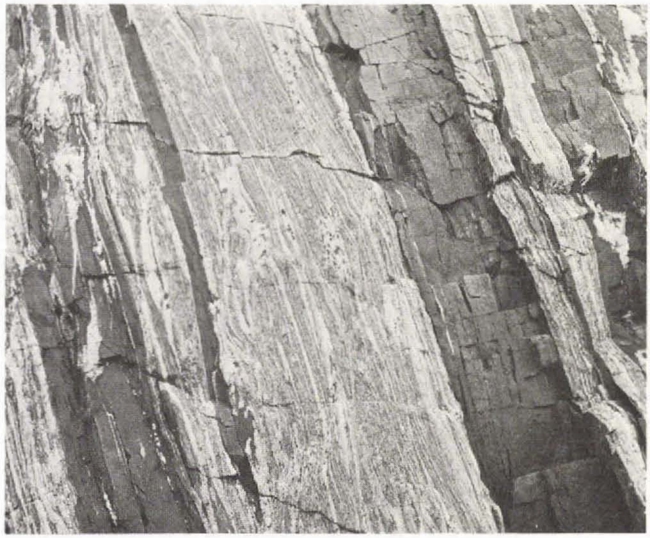

Fig. 2. Strongly deformed gneiss and amphibolite dykes, both older than the main gneiss of the region (fig. 4) and amphibolite dykes (figs 5 & 6). Height of cliff section is about 2 m. North side of Amdrup Pynt.

dykes which locally occur in swarms (figs 5 & 6). In general, the basic dykes are apparently younger than all the major rock units mapped, and they cannot be used as a means of chronological subdivision of the gneisses (c f. McGregor, 1973). However, an outcrop of veined gneisses cut by well preserved amphibolite dykes on the north side of Amdrup Pynt (68°08′N) shows a complex history of gneiss formation, dyke injection and later injection of granitic material (fig. 2). The older gneisses and dykes at this locality show field characters resembling the Amîtsoq gneisses and Ameralik dykes of West Greenland (McGregor, 1973).

Supracrustal rocks

Supracrustal units up to 1 km thick occur on Kraemer Ø, on Amdrup Pynt, on the mainland WSW of Fladø and in the inner parts of Tasîlaq and Poulsen Fjord (fig. 1). Scattered and broken up remnants occur in the gneisses throughout the area but rarely form well defined horizons mappable on a regional scale. In contrast to the successions described from the main Archaean block south of the Nagssugtoqidian mobile belt, the majority of supracrustal successions are dominated by metasediments. Amphibolites and pyroxene amphibolites of basic igneous origin are subordinate. The sediments include pelitic and semipelitic units (biotite, garnet, cordierite, sillimanite schists and veined gneisses), thin magnesian amphibolites (anthophyllite schists), psammitic schists and locally almost pure quartzites which preserve bedding structures. Thin metamorphosed quartz-banded ironstones and garnet-rich horizons occur in many of the successions. Metabasaltic and meta-ultrabasic rocks occur within most of the larger supracrustal horizons. The amphibolites locally show variations in grain size suggesting they may have formed from tuffaceous material. Some contain pods and streaked out lenses of diopside-garnet amphibolite which resemble relict pillow lava structures.

Fig. 3. Fragments of little deformed leucogabbro in gneiss. Head of Tasîlaq, on west side of fjord. The hammer is 28 cm long.

The depositional environment of the supracrustal suites is probably submarine but there are very few primary features preserved except for the gross compositional layering. The successions are more siliceous and less aluminous than those commonly noted in the Archaean of West Greenland.

Layered basic intrusions

Metamorphosed remnants of gabbro, leucogabbro and anorthosite derived from layered basic complexes occur sporadically within the gneiss complex, generally in spatial association with the supracrustals. They are particularly abundant in the inner parts of Tasîlaq and Nigertuluk fjords. With the exception of the Nigertuluk occurrence which forms continuous layers, the anorthositic rocks are found as inclusion trains broken up by later tonalitic and granodioritic gneiss (fig. 3). Original igneous textures are generally well preserved and the range of rock types are similar to those in the well preserved anorthosite complexes of West Greenland such as the Fiskenæsset complex (Myers, 1975).

Quartzo-feldspathic gneisses

The quartzo-feldspathic gneisses are a polyphase suite of intrusive rocks ranging from diorites and tonalites to granodiorites and adamellites. The most widespread component of the gneisses is a medium grained tonalitic to granodioritic gneiss which, in regions of low deformation (fig. 4), consists of a finer grained darker phase net-veined by a coarser grained lighter phase, and closely resembles the Grædefjord gneiss which forms a large part of the Fiskenæsset region of SW Greenland (Myers, 1976, and in press). This rock forms most of the gneiss complex between Kap Edvard Holm and Kap Japetus Steenstrup, a distance of 250 km.

At several localities, especially those where supracrustal rocks occur, this gneiss con-

Fig. 4. Little deformed gneiss with irregular network of coarse grained leucocratic veinlets. Typical of much of the gneiss between Kap Edvard Holm and Kap Japetus Steenstrup, in a zone of low deformation. Mainland SW of Deception Ø.

tains fragments of older gneiss (fig. 2). The older gneiss veins and fragments the supracrustal rocks, and they were deformed together before being fragmented by the younger gneiss. Fairly uniform diorite occurs in many localities as both small fragments and large bodies within the younger gneiss. The relative age relations between the diorites and older gneiss and supracrustals was not seen. At Amdrup Pynt and Nûluk large conformable bodies of deformed, uniform coarse grained porphyritic granite associated with diorite occur and seem to be the youngest major components of the gneiss complex.

The impression gained in the field together with the available isotopic and geochemical evidence suggest a massive introduction of new granitoid material into this part of the crust at about 2800–3000 m.y. ago. We have no evidence that this introduction took place along a pre-existing continental margin.

Metamorphism and structure

The structural and metamorphic pattern is surprisingly uniform over the whole coastal region between Kangerdlugssuaq and Kap Japetus Steenstrup. The inland areas consist of granulite facies gneisses with large scale, flat-lying folds, whereas the outer coast comprises amphibolite facies rocks with steep, coast-parallel foliation and few obvious fold structures. A marked increase in degree of deformation is seen between the granulite and amphibolite facies rocks. The deformation state of the gneisses in granulite facies is generally low, whereas the amphibolite facies rocks of the outer coast show a high state of deformation.

On a regional scale the western part of the amphibolite facies zone shows retrograde reactions from granulite facies. On individual outcrops however, prograde reactions from amphibolite to granulite facies are seen in the eastern part of the granulite facies region (figs 5 & 6) and within patches of granulite facies rocks enclosed by retrograded granulites. This suggests that the present transition marks an original prograde boundary along which there was subsequent retrogression.

The deformation and metamorphism are thought to be Archaean and to have occurred

Fig. 5. Boudinaged relic porphyritic dyke cutting gneiss. Note dehydration rim of hypersthene-plagioclase around amphibolite dyke boudins indicating prograde granulite facies metamorphism after boudinage of the dyke. Same locality as fig. 3. The pen is 13 cm long.

soon after the emplacement of most of the gneisses about 2800 m.y. ago. In the southern part of this region the gneisses are cut by garnet amphibolite dykes with relic ophitic textures which resemble many of the Scourie dykes of Scotland. The Tertiary coast-parallel dyke swarm and zone of plutonic centres follow this late Archaean zone of strong deformation, steep foliation and amphibolite facies metamorphism, and suggest that this late Archaean structure may have influenced the site of the late Phanerozoic rift between Greenland and Europe.

Nagssugtoqidian mobile belt

The southern part of the region, part of which was mapped in 1977, provides a section at a high angle through the northern part of the Nagssugtoqidian mobile belt.

A few isolated E–W sub-vertical belts of high deformation were seen cutting across the Archaean structures, the most northerly seen being at 68°20′N in Kangerdlugssuaq and some of these belts contain foliated and deformed amphibolite dykes. In the Kangerdlugssuaq area the shear belts contain epidote amphibolite facies mineral assemblages and appear to have formed at a relatively high level in the crust.

Between K. I. V. Steenstrup Bræer (66°28′N) and Kap Japetus Steenstrup (66°16′N) the Archaean gneisses are affected by low-dipping zones of high deformation some of which contain amphibolite sheets and sills. The low-angle shear zones divide the gneiss complex into a series of imbricate blocks.

Just south of Kap Japetus Steenstrup (66°16′N) the Archaean gneisses are crossed by an E-W vertical zone of high deformation about two kilometres wide. Traced inland, this structure bends northwards around a major augen of Archaean granulite facies gneisses

Fig. 6. Amphibolite dyke cutting moderately deformed gneiss. Note prograde granulite facies reaction – dehydration rim of hypersthene-plagioclase around hornblende-plagioclase dyke. Same locality as figs 3 & 5. This dyke post-dates the boudinage of the dyke in fig. 5.

which outcrops in the inner part of Kangerdlugssuatsiaq. We regard this structure (first recognised by Wager, 1934, 1947) as the northern margin of the Nagssugtoqidian mobile belt.

In contrast to earlier descriptions of the Nagssugtoqidian mobile belt in East Greenland (Bridgwater, 1976; Bridgwater *et al.*, 1977) we now consider a part of the quartzo-feldspathic gneisses within the belt to be new sialic material emplaced during an early Proterozoic episode rather than all representing reworked Archaean gneisses. The reasons for this change of opinion is based partly on isotopic grounds which suggest that some suites of gneisses within the Nagssugtoqidian belt are unlikely to have been derived from sialic rocks formed much before 2400 m.y. and partly on field evidence that the area between Sermiligâq (65°50′N) and Angmagssalik Fjord consists largely of a suite of quartzo-feldspathic gneisses (here called the Blokken gneisses) which are lithologically distinct from the Archaean gneisses to the north. Smaller bodies of rocks thought to belong to the Blokken gneiss group are found as concordant layers in a sequence of gneisses with a more complex history and supracrustal rocks at Smalsund (65°55′N). The Blokken gneisses range from hornblende-rich diorites to granodiorites with leucocratic veins.They show primary igneous textures at many localities. They are deformed and recrystallised but have not been affected by regional granulite facies metamorphism. Compared to the Archaean gneisses to the north they are comparatively free of inclusions. Where there are rafts of supracrustal material these are generally well preserved and less brecciated than comparable units in the Archaean complex. Neither the composition of the gneisses (which is rather hornblende-rich compared to the Archaean gneisses) nor the Pb-Pb data suggest that this group of rocks could be formed from remobilised older sialic crust and the age of 2400 m.y. is interpreted as that of separation of this magma from a more basic source.

A major 1900–2000 m.y. event in the Nagssugtoqidian of East Greenland is demonstrated by a Rb-Sr whole rock isochron from the garnet gneisses of Angmagssalik Ø. We regard these gneisses as derived from recrystallised and partially remobilised Archaean supracrustal rocks and granitic gneisses which were injected by part of the Blokken gneiss suite. Whether the *c.* 2000 m.y. age reflects the injection of the Blokken gneiss or whether it could reflect a later remobilisation related to the emplacement of the Angmagssalik norite-charnockite suite (Bridgwater, 1976) is unknown.

A younger thermal event is recorded from highly deformed gneisses on the west coast of Angmagssalik Ø which gives a Rb-Sr whole rock errorchron age of 1875 m.y. (Sr_0 = 0.0705). Major igneous activity continued to about 1580 m.y. in the area (Rb-Sr whole rock isochron age of a post-tectonic intrusive complex from Qingertivaq, inner Angmagssalik Fjord).

There is a marked increase of supracrustal rocks in the area affected by Nagssugtoqidian deformation compared to the Archaean area to the north, as noted by Wager (1934, 1947). U-Pb determinations on zircons from an anorthosite associated with supracrustal rocks gave a concordia intercept at 2700 m.y. (Nunes *et al.*, 1974) which is a minimum age for the sediments and volcanic rocks associated with the anorthosite. We therefore consider the supracrustal sequences found in the Nagssugtoqidian to be Archaean rocks preserved in Nagssugtoqidian thrust slices.

Proterozoic dykes

No major swarms of Proterozoic dykes have been identified north of 66°15′N. Identification in the area north of the Nagssugtoqidian belt is hampered by the presence of very numerous Tertiary dykes of several different trends, the oldest generations of which are commonly slightly altered. Sporadic little deformed garnet amphibolite dykes occur as far north as inner Tasîlaq (66°42′N) and are correlated with similar dykes thought to have been emplaced under regional metamorphic conditions within the Nagssugtoqidian mobile belt. The garnet amphibolite dykes are cut by thick dolerites which are themselves cut at a high angle by the coast parallel Tertiary dyke swarm. Many of the early dolerites contain clouded feldspars which give the outcrop a characteristic dark colour, a feature which is common in the Proterozoic dyke swarms from the Archaean gneiss complex south of the Nagssugtoqidian belt.

The dyke chronology within the area affected by Nagssugtoqidian deformation and metamorphism is complex. On Storø (66°11′N) garnet amphibolites with primary ophitic textures preserved were injected under regional metamorphic conditions along sub-vertical shear zones cutting gneisses which originally crystallised under conditions transitional between amphibolite and granulite facies. Geochemical studies suggest that deformation was accompanied by a marked influx of rubidium and potassium into the shear zones and amphibolite facies gneisses immediately adjacent to them. Total strontium remained constant. Granulite facies gneisses approximately 1 km away from the shear zones, amphibolite facies gneisses within 20–30 m from the shear zones and sheared rocks with markedly higher Rb contents all give points which fall on the same 2630 m.y. Rb-Sr isochron. Unless there has been a marked addition in ^{87}Sr to the sheared rocks proportional to the gain of Rb in individual samples this implies that the shearing occured within a short time of the granulite facies metamorphism of the country rocks. Furthermore since the basic dykes found within the shear zones are affected by movements within the same fissures and crystallised under similar metamorphic conditions this suggests that these dykes are also late Archaean in age.

Further south the 2400 m.y. Blokken gneisses are intruded by large garnet amphibolite dykes while other smaller bodies show crenulate margins and sinuous outcrop forms and appear to have been emplaced while the Blokken gneisses were mobile.

TERTIARY IGNEOUS ACTIVITY

A summary of the Tertiary igneous activity in East Greenland is given by Deer (1976). Brief notes on the Kialineq Plutonic Centre have been published by Brooks (1977) and Brown *et al.*, (1977). We can add information about the following intrusions.

Basic bodies in inner Kangerdlugssuaq

Two small intrusions (marked as gabbro by Deer, 1976) intrude granulite facies gneisses on the east coast of Kangerdlugssuaq at approximately 68°24′N. These consist of olivine- and clinopyroxene-rich rocks in which early mafic minerals are enclosed by later poikilitic plagioclase. The border zones are locally ultramafic, with spectacular harrisitic olivine.

Igdlitarajik Plutonic Centre

The Igdlitarajik Plutonic Centre consists of two main intrusive suites: (1) A leucogabbro on the western island of the Igdlitarajik Centre which was emplaced into basaltic lavas. Thin sheets of granitic material occur along the contact zone and net vein the lavas (Wager, 1934). The leucogabbro is cut by part of the coastal dyke swarm and is therefore thought to be an early Tertiary body. (2) A younger gabbroic body with spectacular mineral graded layering, trough banding and cross-bedding occurs on the eastern island of the Igdlitarajik Centre and nearby skerries to the north. This is not seen to be intruded by dykes and contains fragments of basaltic lava and leucogabbro.

Nualik Plutonic Centre

On the promentary south of Ersingerseq (67°17′N) a body of quartz diorite intrudes basaltic rocks overlying basement cut by a high concentration of the Tertiary coast parallel dyke swarm, (Wager, 1934). The basalts near the contact are highly hornfelsed and altered. They show chaotic structures and contain a large amount of siliceous material thought to have been derived from cherts interlayered with pillow lavas. Blocks of basalt, gneiss and dyke material are common in the marginal part of the intrusion. The gneisses are partly remobilised and intrude their host rocks. On Ersingerseq the main rock mass is a diorite which locally shows igneous layering. The dark coloured diorite is broken up into irregular rounded lumps by a more leucocratic diorite. Many of the lumps show a diffuse margin and composite fragments with dark fine-grained centres surrounded by successive shells of

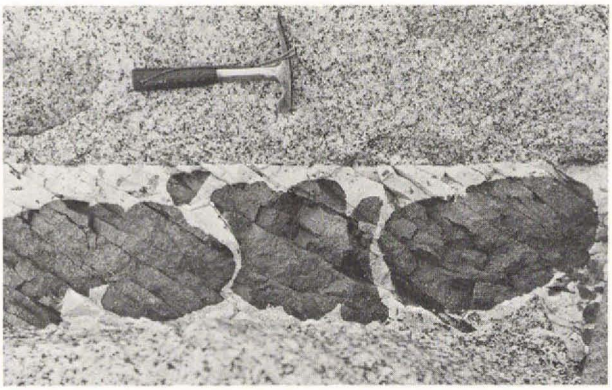

Fig. 7. Tertiary syenite dyke containing pillows of a basic dyke intruded along the same fissure after emplacement of the syenite. Cutting Tertiary leucogabbro at Kap Louis Ussing. Such pillowed basic dykes within dykes of syenite or granite are abundant in most of the plutonic centres from Kangerdlugssuaq to Kap Gustav Holm.

lighter material are common. This complex of diorite and leucodiorite is brecciated by numerous granite sheets some of which are composite. The composite sheets consist of quartz syenite or granite intruded by basic magma which broke up into pillows with cuspate fine-grained margins (fig. 7).

On Kap Louis Ussing the basement and Tertiary dyke swarm are cut by gabbro with spectacular mineral-graded layering and slumped trough banding. A large body of leucogabbro with mineral-graded layering was discovered on the mountain at the head of Agtertia (67°22′N). To the west the same mountain is capped by several hundred metres of flat lying lavas; the southernmost major outcrop of lava so far recorded in East Greenland.

Kialineq Plutonic Centre

The Kialineq Plutonic Centre has been described earlier by Wager, 1934; Deer, 1976; Brown & Farmer, 1972, and Brown *et al.*, 1977.

This plutonic centre is large and complex. It consists of several different phases of igneous activity ranging from early gabbros cut by at least part of the coastal dyke swarm, to post-dyke syenites, diorites, granites and late minor basic intrusions. The diorites are spectacularly net-veined by syenites and granites (Wager, 1934; Deer, 1976; Brooks, 1977).

The Imilik gabbro in the south-eastern part of the Plutonic Centre comprises at least three separate gabbro intrusions which show rhythmic layering, trough banding, cross-bedding and slump structures. The gabbro on the south side of Poulsen Fjord intrudes pillow basalts and minor cherty sediments and is intruded by large numbers of dykes. The syenites are considerably more extensive than was known previously, and show several phases of intrusion which preserve screens of earlier phases between them. The net veined diorite complexes show many of the same features seen in the Nualik Centre with a number of episodes of injection of diorite, basalt, syenite and granite. As noted by Brooks (1977) hybridisation takes place between some acid and basic phases but in our opinion is not the main factor controlling the development of the rock types found in the diorite-granite complexes.

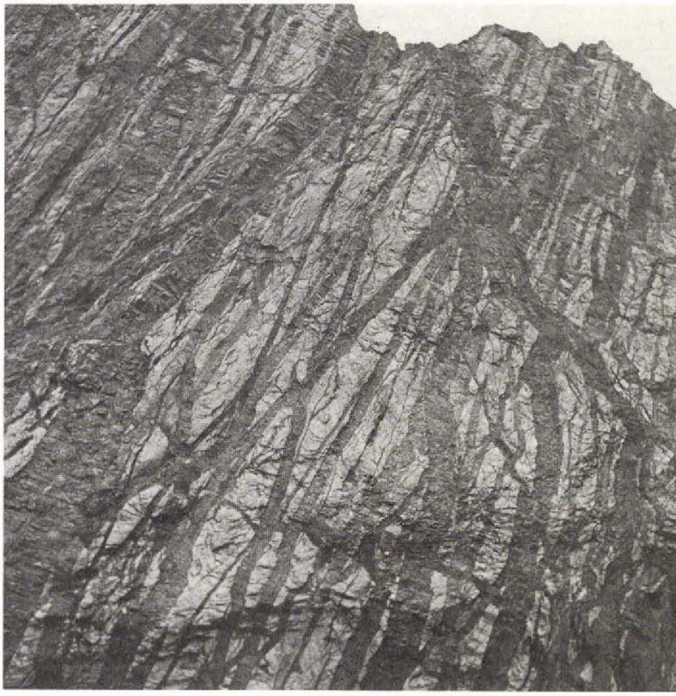

Fig. 8. Tertiary dykes in the centre of the coastal dyke swarm on Store Tindholm, an island east of the Kialineq Plutonic Centre. Height of cliff section is about 300 m.

Kap Gustav Holm Plutonic Centre

This plutonic centre was found to be more extensive and complex than was previously recorded. It comprises gabbros, syenite, granite and basic dykes which intrude basalt lavas and sediments resting on the basement. The gabbros are older than the syenites but all the plutonic rocks post-date most of the coastal dyke swarm which is dense in this vicinity. Locally net-vein complexes occur (as noted by Bridgwater, 1966) similar to those of the Nualik and Kialineq Centres, with contemporaneous intrusion of acid and basic magmas (fig. 7).

Coastal dyke swarm

The outcrop of basic igneous rocks formed by the dykes is considerably greater than that of all the known plutonic centres together (fig. 8). At some localities such as Kap Buchholz (66°39′N) the dykes are so dense that they form a sheeted dyke complex containing less than 1 per cent of pre-dyke basement. The concentration of dykes varies sharply both across strike and along strike. The dyke swarm as a whole is emplaced in a series of major en echelon zones (fig. 1). Dips vary markedly from one part of the coast to another. The observation (Nielsen, 1975) that older dykes at any one locality tend to dip at a moderate angle to the west while younger dykes are more nearly vertical is a general rule in the area as far south as 66°30′N. This change in dip is thought to reflect coastal flexuring between different generations of dyke injection. If original unconformities between basalt and basement, (for example at Poulsen Fjord) which now dip steeply south-eastwards are rotated to the horizontal then the early dykes would be approximately vertical.

The majority of dykes are early in the Tertiary development of the area. Material collected in 1976 suggests several phases of Phanerozoic dyke injection in the area south of Kangerdlugssuatsiaq with a Tertiary phase of injection at about 62 m.y. (Mitchell, in press). This is earlier than one major period of dyke emplacement further north between the intrusion of Skaergaard (54.6±1.7 m.y., Brooks & Gleadow, 1977) and the Kangerdlugssuaq intrusion (50.0±0.4 m.y., Pankhurst *et al.*, 1976).

Later dyke swarms are concentrated around the main plutonic centres and show a range in composition from basic to syenitic and granitic. A widespread suite of late lamprophyres some of which contain conspicuous large olivine and bright green pyroxene phenocrysts occur in the area between Kap Japetus Steenstrup and Tasîlaq. These dykes are generally composite with a late leucocratic (possibly carbonate-bearing) phase in the centre of the dykes brecciating and veining the more basic margins. Pillow structures indicating the presence of two contemporaneous magmas are found in some dykes.

The youngest thermal activity recognised in the area was widespread alteration along fissures parallel to the coast. The alteration was accompanied by carbonate infilling.

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