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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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THE GRAVITY ANOMALY FIELD OF PRINCE OF WALES, SOMERSET AND NORTHERN BAFFIN ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES

A.W.J. BERKHOUT

ABSTRACT: The area of study covers approximately 360,000 km^2, comprising Somerset, Prince of Wales, and northern Baffin Islands. A total of 2700 gravity observations at intervals of 10 to 15 km are included.

Major negative anomalies occur on Borden and Brodeur peninsulas, in the area east of Agu Bay, on northeastern Somerset Island, and on northwestern Prince of Wales Island. These lows are explained by the presence of Upper Proterozoic metasedimentary rocks which underlie some of the lows, but are covered by Lower Paleozoic rocks elsewhere. An important conclusion is that during Upper Proterozoic time vast basins existed which were the sites of accumulation of clastic sediments. The observed gravity field outlines these basins and suggests that they may be interconnected.

A northerly trending gravity high is associated with the Boothia Uplift and two parallel highs occur to the west of it, all three being separated by gravity lows. The density contrast between crystalline rocks of the uplift and the adjacent Paleozoic rocks is not sufficient to explain the change of gravity over the Boothia Uplift. It is suggested that three northerly trending basement uplifts exist, separated by graben in which Upper Proterozoic quartzitic rocks occur. The Boothia Uplift became active again in Paleozoic time and overthrusts the quartzitic rocks in the west; this is reflected by observed negative anomalies along its western flank.

The gravity high over Prince Regent Inlet may reflect a basement fault block beneath the Paleozoic rocks, whereas adjacent gravity lows represent the depressed areas occupied by thick deposits of Upper Proterozoic quartzitic rocks.

The northerly and northeasterly trends of the two systems of basement fault blocks cut across the generally easterly (Archean) trend of basement structures, as on Baffin Island. Similar observations have been made in the Canadian Shield. These unusual trends may possibly originate along ancient orogenic zones with northerly and northeasterly trends.

Several smaller, local anomalies occur. Two gravity highs on Prince of Wales Island are probably caused by mafic intrusions and a gravity low on Bylot Island is explained by light Mesozoic sedimentary rocks.

RESUME: La région à l'étude comprend une superficie d'environ 360,000 km^2 dans les îles Somerset et Prince-de-Galles, et au nord de l'île Baffin. L'étude comporte un nombre total de 2,700 observations gravimétriques échelonnées sur des intervalles de 10 à 15 km.

Les plus importantes anomalies négatives se rencontrent sur la presqu'île Brodeur et la péninsule Borden, dans la région à l'est de la baie Agu, au nord-est de l'île Somerset, ainsi qu'au nord-ouest de l'île Prince-de-Galles. Ces valeurs négatives s'expliquent par la présence de roches métasédimentaires du Protérozoïque supérieur qui reposent sous quelques-unes des zones négatives, mais sont par ailleurs recouvertes de roches du Paléozoïque inférieur. Ces observations permettent de tirer l'importante conclusion qu'au cours du Protérozoïque supérieur, de vastes bassins ont été la scène d'une accumulation de sédiments clastiques. Le champ gravimétrique observé délimite ces bassins et laisse supposer qu'ils peuvent être interreliés.

Une anomalie positive, orientée surtout vers le nord, est associée au soulèvement de Boothia, et deux anomalies positives parallèles se trouvent à l'ouest du soulèvement, les trois anomalies positives étant séparées par des anomalies négatives. Le contraste entre les roches cristallines du soulèvement et les roches paléozoïques voisines ne suffit pas à expliquer l'évolution de la gravité à travers le soulèvement de Boothia. L'auteur propose l'hypothèse de l'existence de trois soulèvements du socle orientés vers le nord et séparés par un fossé d'effondrement qui renferme des roches quartzitiques du Protérozoïque supérieur. Le soulèvement de Boothia est redevenu actif au Paléozoïque et il chevauche les roches quartzitiques à l'ouest; les anomalies négatives observées le long de son flanc occidental indiquent ce phénomène.

L'anomalie positive de l'inlet Prince-Régent peut signaler la présence d'un bloc résultant de la fracturation du socle sous les roches du Paléozoïque, alors que les anomalies négatives voisines représentent les régions affaissées recouvertes d'épais dépôts de roches quartzitiques du Protérozoïque supérieur.

Les directions nord et nord-est des deux systèmes de blocs de fracturation du socle coupent les structures du socle généralement orientées vers l'est (Archéen), comme sur l'île Baffin. On a fait des observations semblables dans le Bouclier canadien; ces directions inhabituelles pourraient provenir du voisinage d'anciennes zones orogéniques à directions nord et nord-est.

On trouve aussi plusieurs anomalies locales plus petites. Deux anomalies positives de l'île Prince-de-Galles sont probablement causées par des intrusions mafiques, et une anomalie négative sur l'île Bylot s'explique par des roches sédimentaires légères du Mésozoïque.

Introduction

This report is an analysis of the results of gravity surveys made by the Dominion Observatory over Prince of Wales, Somerset and northern Baffin Islands (Figure 1). A Bouguer anomaly map of the area was compiled from about 2700 gravity observations (see Map II, in pocket). The author observed 750 stations on Prince of Wales and Somerset Islands in 1965 and an additional 620 stations on northern Baffin Island in 1966. The remaining 1300 stations were observed in 1962 by J.R. Weber of the Dominion Observatory.

A systematic reconnaissance geological survey of the Canadian Arctic has been in progress since 1955 and by 1963 much of the area described here was mapped (Fortier, *et al.*, 1963). Of particular importance, Blackadar and Christie (1963) have mapped the north-trending Boothia Arch, now called the Boothia Uplift, and the flanking sedimentary basins.

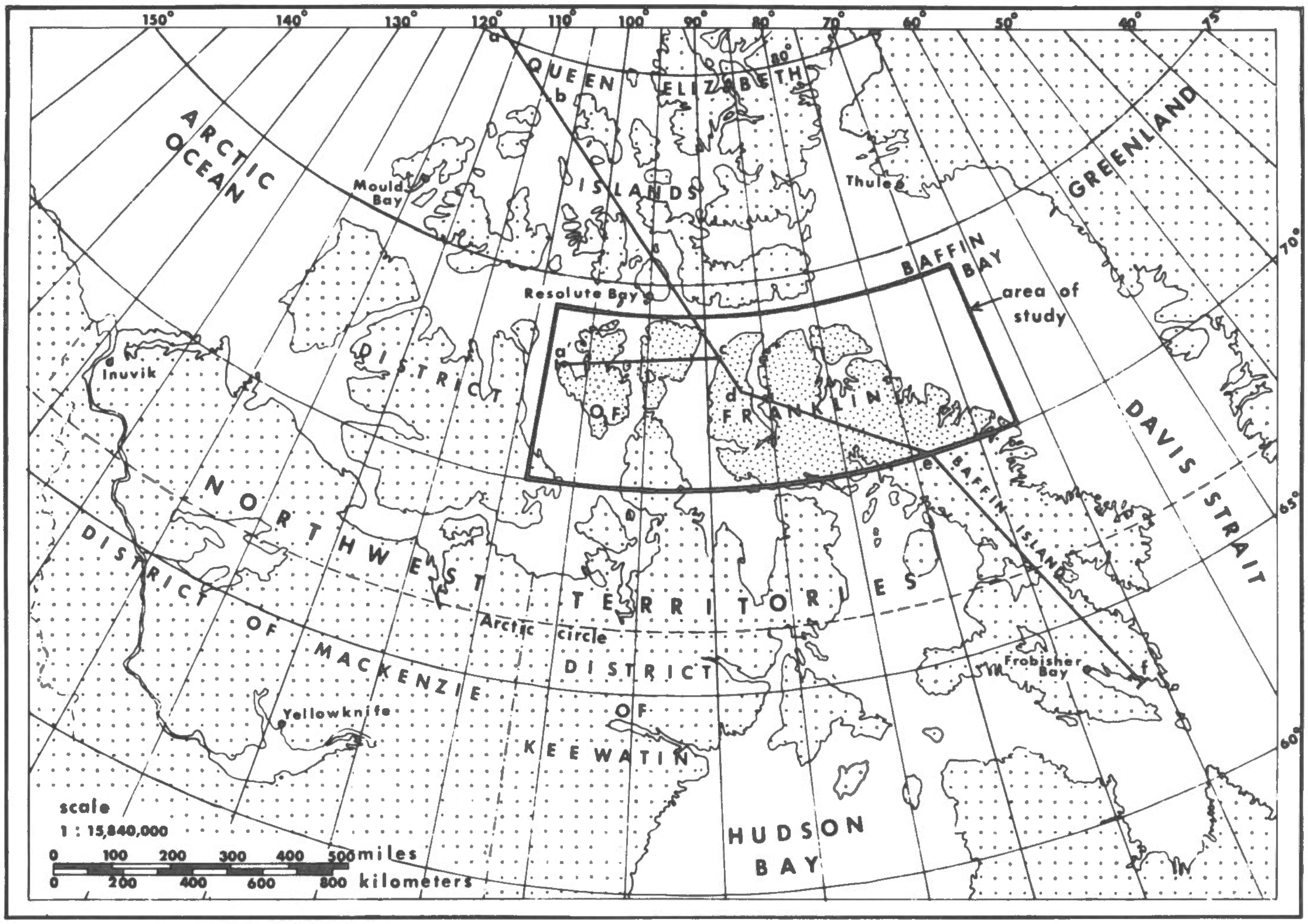

FIGURE 1. Location of the area of study.

The gravity survey was undertaken to study the relationship between the Boothia Uplift and the easterly trending Archean basement rocks on Baffin Island. Another objective was to estimate the thickness of the Upper Proterozoic sandstones and quartzites of Borden Peninsula.

Field Work

Each year, before the start of the survey, a control station network was established by the base-looping method (Nettleton, 1940). Otter aircraft were used to transport a LaCoste-Romberg gravimeter with low drift rate during this operation. All base stations were tied to Resolute Bay which, as part of the national network of control stations, is connected to the world system through the National Gravity Reference Pier at Ottawa. Network adjustments were made using the method outlined by Hamilton (1965); closure errors were generally about 0.03 mgal and not in excess of 0.10 mgal.

Gravity observations for the regional surveys were made with a temperature-controlled Worden gravimeter (W573), a heavily damped instrument with a scale constant of approximately 0.4 mgal per division. Transportation was provided by a Bell 48G2A helicopter in 1965, and by a slightly heavier type, the Bell 47G4, in 1966. At each station the gravimeter, two altimeters, a dry-bulb thermometer, and, when above freezing, a wet-bulb thermometer were read. Knowledge of the air temperature was necessary to obtain a correction factor for the altimeter readings and thus improve the accurary of the elevations. Because of the widely spaced stations (10 to 15km), the regional atmospheric pressure often changed considerably in a traverse and control readings at sea level were frequently made.

In the mountains of Bylot Island, where elevations exceed 1800 m, temperature inversions with altitude were occasionally encountered, which added to the problem of obtaining a reliable reference level. Preselected points of known or calculated radar elevation, which are accurate to about 4.5 m, were used where possible. The estimated average elevation error in areas of moderate elevation is about 3 m, with a range of 1.5 to 4.5 m. In mountainous areas, the estimated average error is 6 m, ranging from 3 to 15 m.

The stations were generally chosen at easily recognized landmarks such as bends in rivers, or bays of lakes. Points were transferred from aerial photographs to maps at a scale of 1:125,000 or 1:168,000, on which UTM grids had been drawn at intervals of 10 km. The latitude and longitude of each station could then be determined, with an estimated accuracy of 100 to 150 m.

Data Reduction

Bouguer anomalies were calculated in the field after each traverse to provide continuous control. Correction factors for the altimeter readings were estimated from charts, and linear drift was assumed for both gravimeter and altimeter. The Bouguer anomalies were then computed by the formula:

$$\text{B.A.} = g_0 + 0.1967\,h - \gamma_0$$

The term g_0 is the observed gravity at the station and $0.1967\,h$ represents a correction term, consisting of the free air effect ($0.3086\,h$) and the Bouguer effect ($-0.1119\,h = -0.0419\,\rho\,h$) where the density $\rho = 2.67$ g/cm^3 and h is the elevation in meters. The term γ_0 is the theoretical gravity at the latitude of the station obtained from tables. All anomalies were subsequently recalculated using the computer system described by Tanner and Buck (1964).

The estimated error in the Bouguer anomalies from the average error in elevation is 0.6 mgal in the plains and 1.3 mgal in the mountains. Instrument errors are generally much smaller.

As a general rule in this area, the terrain has no significant influence on the Bouguer anomalies. Terrain corrections calculated for stations along Peel Sound, at Prince Regent Inlet, and at several points in the interior of the islands, including mountainous Bylot Island, are less than 1 or 2 mgal. A few stations along Admiralty Inlet, on the tops of steep cliffs, and with deep water near shore have large corrections, with a maximum of 28 mgal. It was realized in the field that readings at such stations would be affected by terrain, but the only possible helicopter landing sites were in these unfavourable locations. Terrain corrections were calculated for 66 stations lying within a test area along Admiralty Inlet near Arctic Bay (Map II). An anomaly with a questionable easterly trend was completely removed when the corrections were applied.

The principal facts and location sketches of control stations used in the surveys are available on request from the Gravity Division, Dominion Observatory, Ottawa.

Regional Geology

The western part of the area lies within the Arctic Lowlands Structural Province and the eastern part is mainly underlain by crystalline rocks of the Canadian Shield (Map I). The Arctic Lowlands lie between the Shield to the south and the Franklinian Miogeosyncline to the north (Thorsteinsson and Tozer, 1960). The province is underlain by flat-lying sedimentary rocks, disrupted by several salients of Precambrian rocks which extend northward from the main Shield area. One of these salients, the Boothia Uplift, is a major structure of the area of study. Formerly called the Boothia Arch, the Boothia Uplift was found to be an arch in the south and predominantly a horst in the north (Kerr and Christie, 1965). The uplift is flanked by the Victoria Strait sedimentary Basin to the west and the Jones-Lancaster Basin to the east. The former basin is located in Prince of Wales Island, M'Clintock Channel, and part of Victoria Island, whereas the Jones-Lancaster Basin is located in eastern Somerset Island and Boothia Peninsula, Prince Regent Inlet and the Gulf of Boothia, and Brodeur Peninsula (Map I); it extends northward into Devon Island. The major lithological units in the area will be described in turn.

Crystalline Rocks of the Basement

The crystalline rocks of the Boothia Uplift, mainly gneisses and granites, have been dated at 1,635 and 1,670 m.y., suggesting a Middle Proterozoic (Helikian) metamorphic age (Stockwell, 1964). The gneissic rocks were mapped as generalized units of biotite-hornblende gneiss and quartz-feldspar gneiss, but because control was poor and many geological boundaries were interpolated, this represents an oversimplification of the geology (Blackadar and Christie, 1963).

The crystalline rocks of northern Baffin Island are less varied than those of southern Baffin Island and are composed mainly of complexly folded granitic gneisses. Not much of northern Baffin Island is mapped in detail, but a summary of regional observations and more detailed surveys is published (Blackadar and Fraser, 1960). Near Clyde Inlet (Map I), granitic gneiss with biotite or hornblende is associated with lenses, bands, or patches of amphibolite, thought to be derived from dykes and sills (Kranck, 1955). Lithology similar to that of the Clyde Inlet area prevails in the Admiralty Inlet region and the Pond Inlet area. The first region is mapped in more detail (Lemon and Blackadar, 1963; Blackadar, 1965). Biotite gneiss, banded biotite and granitic gneiss, biotite-garnet gneiss, and irregular masses of biotite granite which cut the gneissic rocks, occur here. South of Admiralty Inlet and northeast of Agu Bay, the gneissic rocks were found to be mainly granitic in composition (Blackadar, 1958).

Near the Mary River iron deposits of Baffin Island, 90 km southeast of Milne Inlet, the crystalline basement has also been studied (Gross, 1966). Here a group of volcanic and metasedimentary rocks, including the iron formation, is folded and faulted within a granitoid massif. Ultramafic rocks altered to serpentine and mafic sills and dykes as well as granitized rocks were found.

Five specimens of the crystalline rocks on northern Baffin Island were dated by the Geological Survey of Canada. The results, 1590, 1700, 1730, 1730 and 1975 m.y., suggest that the rocks are part of the Churchill Province of the Canadian Shield. According to the presently adopted nomenclature (Stockwell, 1963), the dates assign to them a Lower to Middle Proterozoic (Aphebian to Helikian) metamorphic age.

Table 1

FORMATIONS ON NORTHERN BAFFIN ISLAND
(after Blackadar, 1965; and Trettin, 1965)

Formation Name	Thickness in metres	Group Name	Age	Lithologies
Cape Crauford	400	Brodeur	Middle Silurian and (?) younger	dolomitic limestone calcareous dolomite
Baillarge	480		Late Middle Ordovician to Middle Silurian	dolomitic limestone, shaly carbonate, shale
		local or regional disconformity		
Ship Point	45 – 270		Early and early Middle Ordovician	dolomite (shaly, silty) sandstone, siltstone and shale
Turner Cliffs	0 – 300	contact relationships uncertain	Early Ordovician and/or Cambrian	dolomite (shaly, silty) sandstone, siltstone and shale
minor hiatus?		Admiralty		
Gallery	0 – 340			sandstone (quartzose) siltstone, shale, conglomerate
		angular unconformity		
Elwin	1,500	Uluksan (6,900 m)	Upper Proterozoic	sandstone, siltstone shale
Strathcona Sound	1,200			siltstone, mudstone
Athole Point	1,500			limestone
Victor Bay	480			dolomite, minor shale and conglomerate
Society Cliffs	300			dolomite
Fabricius Fjord	1,620			quartzite, shale, conglomerate
Arctic Bay	300			calcareous shale, dolomite
		conformable (gradational) contact		
(Borden Peninsula) Quartzite member	1,200	Eqalulik (1,500 m)	Upper Proterozoic	quartzite, minor conglomerate
Volcanic member	300			andesite and basalt flows, tuff
(Agu Bay) Quartzite member	4,950	Eqalulik (4,950 m)	Upper Proterozoic	quartzite, overlain by siltstone and minor shale, dolomite
		erosional disconformity		
Basement			Middle Proterozoic	granitic gneiss

Upper Proterozoic Rocks

Upper Proterozoic rocks occupy most of northern Borden Peninsula and the area east of Agu Bay (Map I). On Borden Peninsula they consist of the Eqalulik Group, conformably overlain by the Uluksan Group. The Eqalulik Group comprises a volcanic member overlain by a quartzitic member; the Uluksan Group consists of seven formations of variable lithology including sandstone and quartzite, dolostone, limestone and shale. The total thickness of both groups is estimated at 8400 m (Blackadar, 1965). A detailed description of the formations and their lithologies is given in Table 1. The outcrops east of Agu Bay consist of southerly dipping Eqalulik equivalents, mainly quartzite and sandstone, with an estimated total thickness of 4950 m.

Upper Proterozoic (?) rocks with lithologies similar to those of Borden Peninsula, occur at Aston Bay on Somerset Island, and on Prescott Island, west of the Boothia Uplift (Map I). The Aston Formation (mainly quartzitic) and the Hunting Formation (dolostone and shale) are generally considered to be equivalents of the Eqalulik and Uluksan groups of Baffin Island, and thus to be Upper Proterozoic (Blackadar, 1957). A possible Paleozoic age for at least the Hunting Formation was suggested on the basis of lithological correlation with Boothia Peninsula rocks containing Cambrian fossils (Tuke, *et al.*, 1966).

Gabbro

Gabbroic dykes and sills intrude the Lower Proterozoic gneisses of the Boothia Uplift, as well as the Aston Formation and part of the Hunting Formation. They are similar to those occurring on Baffin Island, where dykes and sills also intrude the gneissic complex and Upper Proterozoic rocks. Material from these dykes was dated at 1140 m.y., indicating an Upper Proterozoic age (Blackadar, 1965).

Table 2

FORMATIONS IN THE SOMERSET AND PRINCE OF WALES ISLANDS REGION

(after Blackadar and Christie, 1963; Tuke, *et al.*, 1966; and Kerr and Christie, 1965)

Formation name	Lithology	Age
Peel Sound Formation (270 to 600 m)	conglomerate, sandstone	Early Devonian
Read Bay Formation (± 300 m)	limestone, limy dolomite, shaly and silty limestone	Middle Silurian to Early Devonian
Unnamed equivalent of the Allen Bay and Cornwallis formations of Cornwallis Island (300 to 600 m)	dolomite and dolomitic sandstone	Ordovician to Middle Silurian
Unnamed sandstone formation (± 90 m)	sandstone, sandy dolomite, shaly dolomite, conglomerate	Cambrian
Hunting Formation (2,250 m)	dolostone, sandy dolostone, partly intruded by gabbro	Cambrian(?) or Upper Proterozoic
Aston Formation (± 780 m)	quartzite, sandy shale, conglomerate intruded by gabbro	Upper Proterozoic
	angular discordance	
Crystalline basement	biotite-hornblende gneiss, quartz-feldspar gneiss, granite, gabbroic intrusions	Middle Proterozoic

Paleozoic Rocks

Paleozoic rocks occur in the basins flanking the Boothia Uplift. The main rock types are limestone, dolostone, sandstone and conglomerate varying in age from Cambrian to Devonian (Blackadar and Christie, 1963; Kerr and Christie, 1965; Trettin, 1965). Near the uplift the strata are overturned, but away from it they are generally flat-lying, except for the gently northwesterly dipping Brodeur Homocline. The Paleozoic rocks of Brodeur Peninsula form part of the Jones-Lancaster Basin and have lithologies similar to the rocks occurring near the Boothia Uplift. Different formation names are used, however, for both areas; detailed descriptions are given in Table 1 (Baffin Island) and Table 2 (Somerset and Prince of Wales islands).

Outliers of Paleozoic rocks occur on Borden Peninsula, comprising the same formations as on Brodeur Peninsula, but include some older formations; they overlie the Precambrian basement with angular unconformity (Trettin, 1965).

Mesozoic and Younger Rocks

Late Cretaceous or early Tertiary sedimentary rocks, resembling the Eureka Sound Formation of Ellesmere Island, are preserved as small outliers on the gneisses of the Boothia Uplift (Dineley, 1965 and 1966). Mesozoic rocks have also been mapped on southwestern Bylot Island at the foot of the Bylot Island mountains.

Structural Features

The eastern border zone of the Boothia Uplift, 25 to 35 km wide, has a step-like structure with linear belts of steeply dipping rocks, separated by broad belts of gently undulating beds. Reverse faulting in the basement has been postulated (Kerr and Christie, 1965). Numerous faults cut both the uplift and the adjacent regions. Kerr and Christie cite evidence for periods of uplift of the Boothia structure in Precambrian, Cambrian, and Early Devonian time and evidence for prominent faulting in Late Tertiary time. The Early Devonian uplift has probably been differential, and is reflected in conglomerate beds of the Peel Sound Formation occurring west but not east of the uplift (J.L. Usher, personal communication).

A major structure on northern Baffin Island is the Central Borden Fault Zone which separates crystalline rocks from metasedimentary and volcanic rocks. It passes through central Borden Peninsula with an easterly to southeasterly trend (Map I). A second structure, a horst of crystalline rocks surrounded by rocks of the Uluksan Group, is located near Navy Board Inlet and is called the Navy Board High. These two structures have played an important role in the history of sedimentation of northern Borden Peninsula, especially during Upper Proterozoic time (Trettin, 1965).

Faulting has taken place within the Upper Proterozoic rocks and, locally, the Eqalulik Group has been upfaulted against the younger Uluksan Group to reach the surface (Map I). Post-Silurian deformation produced the gently dipping Brodeur Homocline which has a northeasterly strike and a group of steeply dipping faults with northwesterly trend on Borden Peninsula. These faults conform to the regional trend of dyke swarms and lineaments outlining the northeastern and southwestern coasts of Baffin Island. The two structural trends, the northeasterly striking Brodeur Homocline and the northwesterly trending faults, meet at right angles north of Agu Bay, where they are separated by a major fault (Map I).

Density Measurements

Sampling Techniques

Rock samples were collected during the course of all gravity surveys, and density determinations were made in the field. The accuracy of the balance used was about 0.5 g, but since samples generally weighed about 500 g, the calculated densities are probably accurate to within 0.01 g/cm^3. Additional samples were provided by R.G. Blackadar of the Geological Survey of Canada. Their densities were determined in the laboratory with a more sensitive balance accurate to about 0.05 g. The locations of rock samples used for density determinations are indicated on Map III (in pocket).

Samples were weighed dry, as collected in the field, and wet, after saturation in water for several days to one week. In

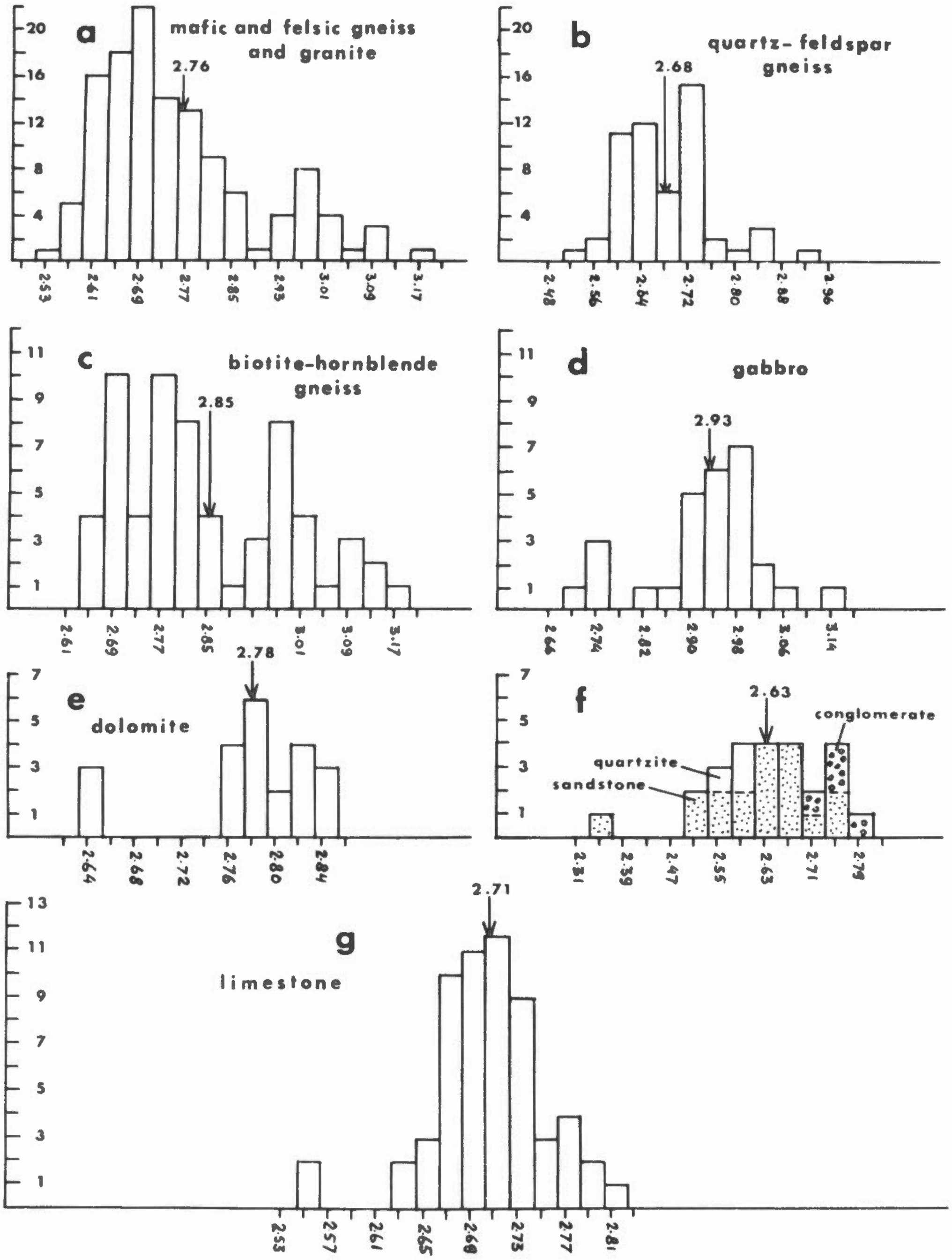

FIGURE 2. Frequency distributions of the densities of various rock types, collected on Somerset and Prince of Wales islands, with class intervals of 0.02 or 0.04 g/cm^3. Mean densities in g/cm^3 are indicated by arrows.

general, except for some porous sandstones, the saturated weight of the rock differed little from the dry weight. This could mean that either the rock, as occurring in the field, is nearly saturated, or, provided the rock is sufficiently permeable, that the porosity is so low that no more water can be absorbed. In either case, the saturated density must represent a value close to the actual density in the field and this value was used for calculations. For porous sandstone the saturated density value was also adopted, assuming near-saturation in the Arctic outcrops.

Densities for Somerset and Prince of Wales Islands

Mean densities were calculated for each rock type (Table 3), but in addition, histograms were plotted to permit study of the distribution of the densities. The saturated density values were divided into class intervals of 0.02 or 0.04 g/cm^3, depending on the range of the distribution. Results of this analysis for various rock types are presented in Figure 2, in which the mean densities are indicated.

Granite, Felsic Gneiss and Mafic Gneiss. The mean density of all gneisses and granite is 2.76 g/cm^3, but the standard

Table 3

SUMMARY OF THE DENSITY RESULTS FOR THE SOMERSET AND PRINCE OF WALES ISLANDS REGION (see Figure 2)

Histogram	Rock Type	Total Frequency	Class Interval	Mean Density	Mode	Standard Deviation
			(g/cm^3)	(g/cm^3)	(g/cm^3)	(g/cm^3)
2 a	mafic and felsic gneiss, and granite	126	0.04	2.76	2.695 2.975	0.13
2 b	quartz-feldspar gneiss	54	0.04	2.68	2.725	0.08
2 c	biotite-hornblende gneiss	61	0.04	2.85	2.775 (closest to mean)	0.14
2 d	gabbro	28	0.04	2.93	2.985	0.10
2 e	dolomite	22	0.02	2.78	2.785	0.06
2 f	sandstone, quartzite, and conglomerate	25	0.04	2.63	2.635	0.10
2 g	limestone	59	0.02	2.71	2.715	0.05

deviation of 0.13 g/cm^3 indicates a large dispersion around this mean. However the frequency distribution of gneissic rocks and granite combined is bimodal (Figure 2a), suggesting that two types of gneisses with different densities may exist. This conforms to the field observation that there is a recognizable distinction between quartz-feldspar (felsic) gneiss and biotite-hornblende (mafic) gneiss. Therefore separate distributions are plotted for felsic and for mafic gneisses, the distinction being made on the basis of visual estimates of the amount of mafic constituents of the specimens (Figure 2b and c).

Figure 2b shows the histogram of densities for the felsic gneisses. The calculated mean for this group is 2.68 g/cm^3, with a standard deviation of 0.08 g/cm^3. This value is quite close to the lower mode of the bimodal distribution (2.695 g/cm^3) in Figure 2a.

Figure 2c shows the histogram of densities for mafic gneiss. The mean of the distribution is 2.85 g/cm^3, and is much lower than the value of 2.975 g/cm^3 which is the highest mode of the combined histogram (Figure 2a). The densities for this rock type vary considerably, as expressed by a high standard deviation of 0.14 g/cm^3.

Granites are confined to local intrusions into the gneissic complex and, since only 11 samples were analysed, a separate histogram is not shown. The mean density of granite is 2.64 g/cm^3, a figure very close to that of felsic gneiss and the rock types cannot be distinguished in the combined histogram (2a).

Gabbro. Twenty-eight samples form an almost normal frequency distribution (Figure 2d) with a mean of 2.93 g/cm^3 and a standard deviation of 0.10 g/cm^3. This mean value is identical to the mean for gabbro samples from the entire area of study (Figure 4a).

Dolomite. Density values for 22 samples of dolomite, all from the formation on Somerset Island, equivalent to the Allen Bay Formation (Table 2), are shown in Figure 2e. The mean is 2.78 g/cm^3 and the standard deviation is 0.06 g/cm^3. This mean correlates well with that of 2.79 g/cm^3 for the entire area of study (Figure 4d). The histogram indicates that several impure dolomites with lower density are represented in the group.

Sandstone, Quartzite and Conglomerate. Twenty-five samples were collected from Paleozoic sandstone and conglomerate outcrops and from Upper Proterozoic quartzitic rocks. The densities are grouped in classes at intervals of 0.04 g/cm^3, and the histogram indicates over which classes the three rock types are distributed (Figure 2f). The mean value of 2.63 g/cm^3 is probably a good representation for the Paleozoic sandstone and conglomerate, but it may be too high for the quartzitic rocks. The reason for this high value lies in the conglomerate samples, which contain pebbles derived from the crystalline basement, and which therefore have higher densities. The mean density of 2.58 g/cm^3, calculated for the quartzitic rocks from Baffin Island (Figure 3c), is probably also representative of the quartzitic rocks of this area.

Limestone. Fifty-nine samples of limestone were collected from Somerset Island. Their densities are grouped in classes at intervals of 0.02 g/cm^3, yielding a near-normal frequency distribution with a mean of 2.71 g/cm^3 and a standard deviation of 0.05 g/cm^3 (Figure 2g).

It is interesting to calculate the mean density of the rocks in this region, and to compare this value with the assumed Bouguer density of 2.67 g/cm^3. If weighting factors are assigned to the crystalline rocks according to areal distribution and to the sedimentary rocks according to thickness (Table 2), a mean density of 2.74 g/cm^3 is calculated.

Densities for Northern Baffin Island

Mean densities were calculated again for each rock type (Table 4), and frequency distributions were plotted to establish the dispersion (Figure 3). The saturated densities are divided into classes at intervals of 0.02 g/cm^3, or 0.04 g/cm^3 depending on the range of the distribution.

Gabbro and Volcanic Rocks. Samples of gabbro were collected from dykes and sills which intrude the crystalline rocks and the Upper Proterozoic metasedimentary rocks. Volcanic rock specimens were taken from outcropping basalt and andesite flows. Because of the small number of samples of volcanic rocks, the two rock types are combined in one histogram, which gives an idea of the distribution of these heavy rock types with similar densities. The mean densities

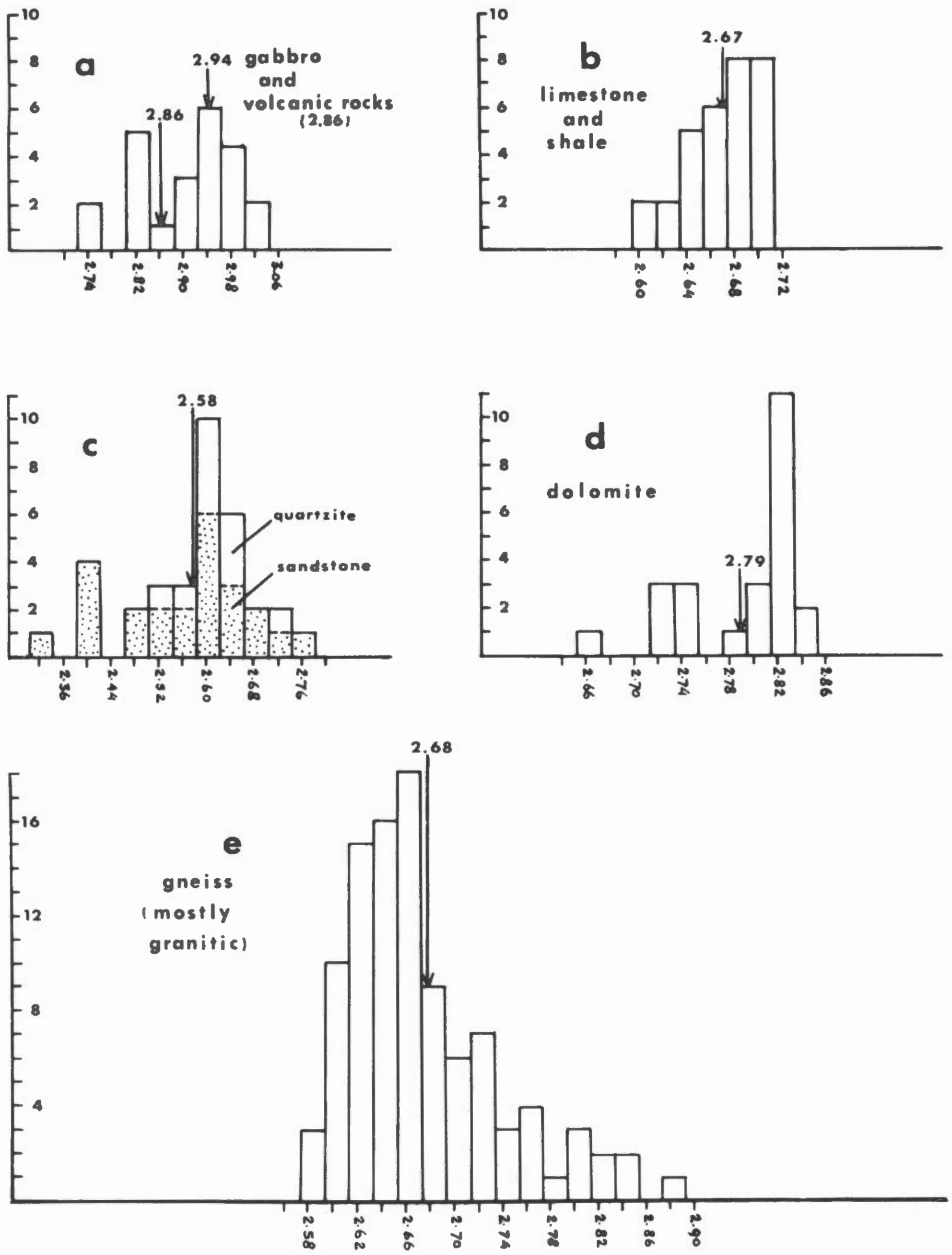

FIGURE 3. Frequency distributions of the densities of various rock types, collected on northern Baffin Island, with class intervals of 0.02 or 0.04 g/cm^3. Mean densities in g/cm^3 are indicated by arrows.

were calculated separately for gabbro (2.94 g/cm^3) and for the volcanic rocks (2.86 g/cm^3), and are indicated in the histogram (Figure 3a).

Limestone and Shale. Most specimens of this group are limestone. A few samples of shale are included because bands of shale occur within the carbonate deposits.

Thirty-one samples form a negatively skewed frequency distribution with a mean of 2.67 g/cm^3, a mode of 2.695 g/cm^3, and a standard deviation of 0.05 g/cm^3 (Figure 3b).

Quartzite and Sandstone. Thirty-four samples of quartzite and sandstone were collected on Borden Peninsula. Their saturated densities are grouped in classes at intervals of 0.04 g/cm^3, forming an approximately normal frequency distribution (Figure 3c). The mean is 2.58 g/cm^3 and the standard deviation is 0.10 g/cm^3. This may indicate that sandstone and quartzite should be treated separately; quartzite densities are in the upper ranges, while sandstone densities occur in the lower class intervals (3c). Since both rock types form part of the Upper Proterozoic sedimentary lithology on Borden Peninsula, the mean of 2.58 g/cm^3 may be adopted while bearing in mind that variations can occur.

Dolomite. Twenty-four samples, collected on Brodeur and Borden peninsulas, form an apparently bimodal distribution with an arithmetic mean of 2.79 g/cm^3, and a standard

Table 4

SUMMARY OF THE DENSITY RESULTS FOR NORTHERN BAFFIN ISLAND

(see Figure 3)

Histo-gram	Rock Type	Total Frequency	Class Interval	Mean Density	Mode	Standard Deviation
			(g/cm^3)	(g/cm^3)	(g/cm^3)	(g/cm^3)
3 a	gabbro and volcanic	17	0.04	2.94	2.945	0.08
	rocks	7		2.86	2.825	0.07
3 b	limestone and shale	31	0.02	2.67	2.695	0.03
3 c	quartzite and sandstone	34	0.04	2.58	2.605	0.10
3 d	dolomite	24	0.02	2.79	2.825	0.05
3 e	gneiss	101	0.02	2.68	2.6651	0.06

Table 5

SUMMARY OF THE DENSITIES OF ROCK TYPES REPRESENTING THE ENTIRE AREA OF STUDY

(see Figure 4)

Histo-gram	Rock Type	Total Frequency	Class Interval	Mean Density	Mode	Standard Deviation
			(g/cm^3)	(g/cm^3)	(g/cm^3)	(g/cm^3)
4 a	gabbro	45	0.04	2.93	2.985	0.09
4 b	limestone and shale	90	0.02	2.70	2.685	0.05
4 c	quartzite, sandstone, and conglo-merate	59	0.04	2.60	2.608	0.10
4 d	dolomite	46	0.02	2.79	2.815	0.05

deviation of 0.05 g/cm^3 (Figure 3d). If, however, the results for the Somerset and Prince of Wales islands region are included, the bimodal distribution becomes a unimodal negatively skewed distribution (Figure 4d). The bimodal distribution may be caused by impure dolomites, similar to those observed in the distribution for Somerset and Prince of Wales islands (Figure 2e).

Gneiss and Granite. Rock samples from the crystalline basement complex were collected throughout the Shield area of northern Baffin Island (Map III). The frequency distribution of 101 samples is positively skewed, which indicates that, in addition to the majority of felsic gneisses, heavier mafic gneisses are present. The mode of the distribution is 2.665 g/cm^3, and the mean 2.68 g/cm^3, while the standard deviation is 0.06 g/cm^3 (Figure 3e).

The results for northern Baffin Island are summarized in Table 4. As in the Somerset and Prince of Wales islands region, the mean density of the upper crustal rocks of northern Baffin Island was calculated by assigning weighting factors to the various rock types. The mean density of the crystalline rocks (2.68 g/cm^3) is very close to the Bouguer density (2.67 g/cm^3), and probably represents the best value for most of northern Baffin Island. For the areas occupied by sedimentary rocks, however, the mean density, after assigning weighting factors according to thickness (Table 1), was calculated to be 2.65 g/cm^3, lower than that for the Shield area, but still quite close to the Bouguer density.

Densities for the Whole Area

The preceding results for the separate regions of northern Baffin Island and Somerset-Prince of Wales islands are combined in histograms for the entire area (Figure 4) and are shown in Table 5.

The crystalline rocks of both areas differ considerably in that the Boothia Uplift region comprises a larger percentage of mafic gneisses than northern Baffin Island, and hence has a higher mean density. The density values are therefore not combined into one histogram, but their arithmetic mean was calculated at 2.72 g/cm^3 (for 227 gneisses and granites); this figure cannot be used in the separate areas but may be used for regional calculations.

Densities of Paleozoic sedimentary rocks from Somerset and Prince of Wales islands are combined with those from Brodeur and Borden peninsulas; they were expected to be quite similar since most of them occur in the same basin (Jones-Lancaster Basin). Upper Proterozoic sedimentary rocks are included in the combined histograms as they are subdivided by lithology. In the case of quartzite and sandstone this does not give a true representation of the mean density, and Paleozoic and Upper Proterozoic rocks should be treated separately.

Intrusive rocks of gabbroic composition from both areas are considered to be part of the 'diabase series' of Arctic Canada (Blackadar and Christie, 1963), and were expected to have similar densities.

Gabbro. A total of 45 samples, grouped in classes at intervals of 0.04 g/cm^3, forms an almost normal distribution, with a mean of 2.93 g/cm^3 and a standard deviation of 0.09 g/cm^3 (Figure 4a). This mean does not deviate much from those for the separate regions (Tables 3 and 4).

Limestone and Shale. The frequency distribution for 90 samples of these rock types (mainly limestone) is close to normal, and not skewed as the one for northern Baffin Island alone (Figure 3b). The mean of this distribution (Figure 4b) is 2.70 g/cm^3, with a standard deviation of 0.05 g/cm^3, which is again quite close to the means for the individual regions (2.71 and 2.67 g/cm^3, respectively).

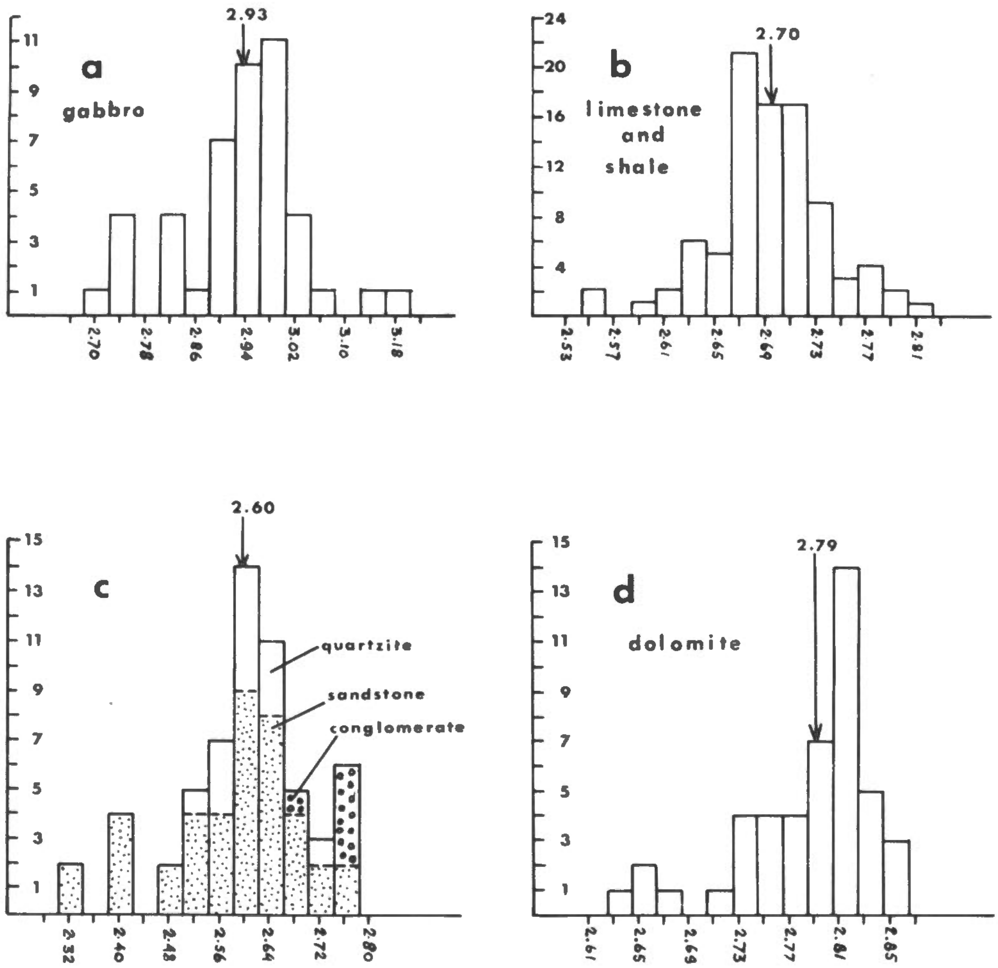

FIGURE 4. Frequency distributions of the densities of various rock types, representing the entire area of study, with class intervals of 0.02 or 0.04 g/cm^3. Mean densities in g/cm^3 are indicated by arrows.

Quartzite, Sandstone and Conglomerate. The conglomerate densities are included (Figure 4e) to compare this histogram with the individual distributions (Figures 3c and 2f), but they occur only in the Prince of Wales and Somerset islands region.

The frequency distribution of the total group, divided into classes at intervals of 0.04 g/cm^3, is almost normal and yields a mean of 2.60 g/cm^3, with a standard deviation of 0.10 g/cm^3. The histogram indicates again how the three rock types are distributed over the classes (Figure 4c). The mean value is probably too high for Upper Proterozoic quartzite and sandstone which, as indicated by Figure 3c, may be closer to the value of 2.58 g/cm^3. Figure 2f, which represents mainly Paleozoic sandstone and conglomerate, indicates a mean of 2.63 g/cm^3. Apparently, for quantitative calculations, the Paleozoic and Upper Proterozoic quartz-bearing sedimentary rocks have to be treated separately.

Dolomite. The bimodal distributions for the individual areas (Figures 2e and 3d) become a slightly skewed distribution for the combined group (4d). The mean density of 2.79 g/cm^3, with the standard deviation of 0.05 g/cm^3, agrees well with the individual means for this rock type in the Somerset-Prince of Wales islands and northern Baffin Island regions (2.78 and 2.79 g/cm^3, respectively). The negative skewness is probably caused by the presence of sandy or shaly or other impure dolomites. The density results for each rock type, frequency, mode, mean and standard deviation are summarized in Table 5.

The mean density for the entire area of study may now be calculated, to compare it with the mean density of 2.67 g/cm^3, which is assumed for crustal rocks when applying the Bouguer correction. This mean density, based on the previously calculated mean densities for the separate regions, and taking into account the fact that northern Baffin Island occupies twice as large an area as the Somerset-Prince of Wales islands region, is 2.69 g/cm^3, which suggests that the assumed Bouguer density is correct.

Density Measurements in a Drill Hole near Resolute Bay

The densities of chips from a drill hole near Resolute Bay on Cornwallis Island, north of the area of study (Figure 1), were measured by L.W. Sobczak of the Dominion Observatory (Sobczak, *et al.*, in press).

The drill hole, with a total depth of 1452 m, penetrated first the dolomitic Allen Bay Formation and then the Cornwallis Formation of limestone and shaly limestone. The lowest part of the section is again dolomitic. The time equivalent of these formations on Somerset Island is an unnamed unit of dolomite and dolomitic sandstone (Table 2). The overlying Read Bay Formation (Silurian) has been removed by erosion at the location of the drill hole.

Altogether, 91 samples taken at 15 meter intervals were used for density determinations. The upper 885 m, consisting of dolomite, is subdivided into an upper part, 450 m thick, with a mean density of 2.74 $\pm$0.06 g/cm^3, and a lower part of 435 m with a mean density of 2.81 $\pm$0.03 g/cm^3. This could indicate that either the dolomite is less impure at depth than at surface, or that the higher density is due to compaction. The mean density for the total column of dolomite is 2.77 $\pm$0.06 g/cm^3, a value close to that for dolomite on Somerset Island, 2.78 g/cm^3 (Table 3).

The middle 540 m of limestone has a mean density of 2.71 $\pm$0.03 g/cm^3, which is identical to the mean density for limestone from Somerset and Prince of Wales islands (Table 3). Shaly horizons do not affect the gross density of this section of limestone because the density of the shale is very close to that of the limestone.

The lowest 27 m of the drill hole consisting of dolomitic rocks has a mean density of 2.84 g/cm^3 which again illustrates the increase in density of the dolomite with depth.

General Description of the Bouguer Anomaly Field

The Bouguer anomaly map can be divided into four separate regions with approximately similar trends and horizontal gravity gradients. These regions, called subareas A,B,C, and D, are outlined on Map II, the Bouguer anomaly map. In this section, the gravity field of each of the subareas will be briefly described, and compared with the geological trends. The division of the Bouguer map into subareas does not imply a similar subdivision of the geology, although in some places the boundaries of subareas and of geological subprovinces do coincide.

Subarea A

This subarea occupies that part of northern Baffin Island between latitudes 70° and 72°N, excluding the eastern coastal region (see Map II). Trends are easterly and Bouguer anomalies increase from −60 mgal in the south to +15 mgal in the north. The northern boundary of this subarea follows a steep gravity gradient which has an easterly to southeasterly trend.

The geology is mainly represented by crystalline rocks of the Canadian Shield (Map I). The central Borden Fault Zone coincides with part of the steep gravity gradient mentioned above. The easterly trends of the gravity field probably reflect the presence of easterly trending Archean structures in the crystalline rocks. Upper Proterozoic metasedimentary rocks occur in the southern portion of the subarea at Agu Bay, where an easterly trending gravity low is present. Easterly trends also occur in areas of Paleozoic rocks (Brodeur Peninsula), suggesting that the easterly trends of the crystalline basement continue there and that the Paleozoic cover does not affect the gravity field.

Subarea B

Subarea B comprises a zone about 120 km wide along the east coast of Baffin Island, and includes Bylot Island in the north. Bouguer anomaly trends are northwesterly parallel to the coast line. The anomalies are −60 mgal or less in the central part of this zone but they rise rapidly towards the east coast; positive anomalies of +35 mgal occur on eastern Bylot Island. A series of small negative anomalies, all lying along a northwesterly trending line, occurs in the central portion of the subarea. Terrain corrections, if applied, would probably remove many of these lows, particularly those over fjords. However, the low in southwestern Bylot Island, coincides with an area of Mesozoic sediments that may contribute to the anomaly.

The positive Bouguer anomalies parallel to the coast are similar to those found along the Atlantic and Pacific coasts of Canada. They may indicate the margin of the continental crust with an oceanic crust to the east in Baffin Bay. However, Kerr (1967) suggests that the crust in Baffin Bay may be continental.

Subarea C

The third region with uniform trends, subarea C, covers the northern parts of Borden and Brodeur Peninsulas. It extends westward into the northern parts of Somerset and Prince of Wales islands. The area is marked by a series of alternating highs and lows trending northeasterly to easterly (Map II). On Borden Peninsula a low occurs with northwesterly trend, protruding into subarea A, and overlying the area of Upper Proterozoic metasedimentary rocks. This low has been incorporated into subarea C because it lies north of the steep gravity gradient which follows the Central Borden Fault Zone, the northern boundary of subarea A.

Through the western part of Borden Peninsula, just north of the steep gradient, a northerly trending relative high occurs which, towards the north, changes to an easterly direction to follow the Navy Board High (Map I); the gravity high separates the above-mentioned low to the east from a symmetrical low to the west overlying Brodeur Peninsula and Admiralty Inlet. The high is underlain by horsts of crystalline basement rocks flanked by Upper Proterozoic metasedimentary quartzitic rocks. South of Adams Sound, however, the Upper Proterozoic rocks underlying the gravity high are predominantly volcanic flows.

A major high overlies eastern Somerset Island and Prince Regent Inlet with a parallel northeasterly trending low to the northwest occurring on northern Somerset Island. This low continues westward into northern Prince of Wales Island with a slight interruption north of the Boothia Uplift. However, the trends on northern Prince of Wales Island are easterly instead of northeasterly and in the extreme west a major low with

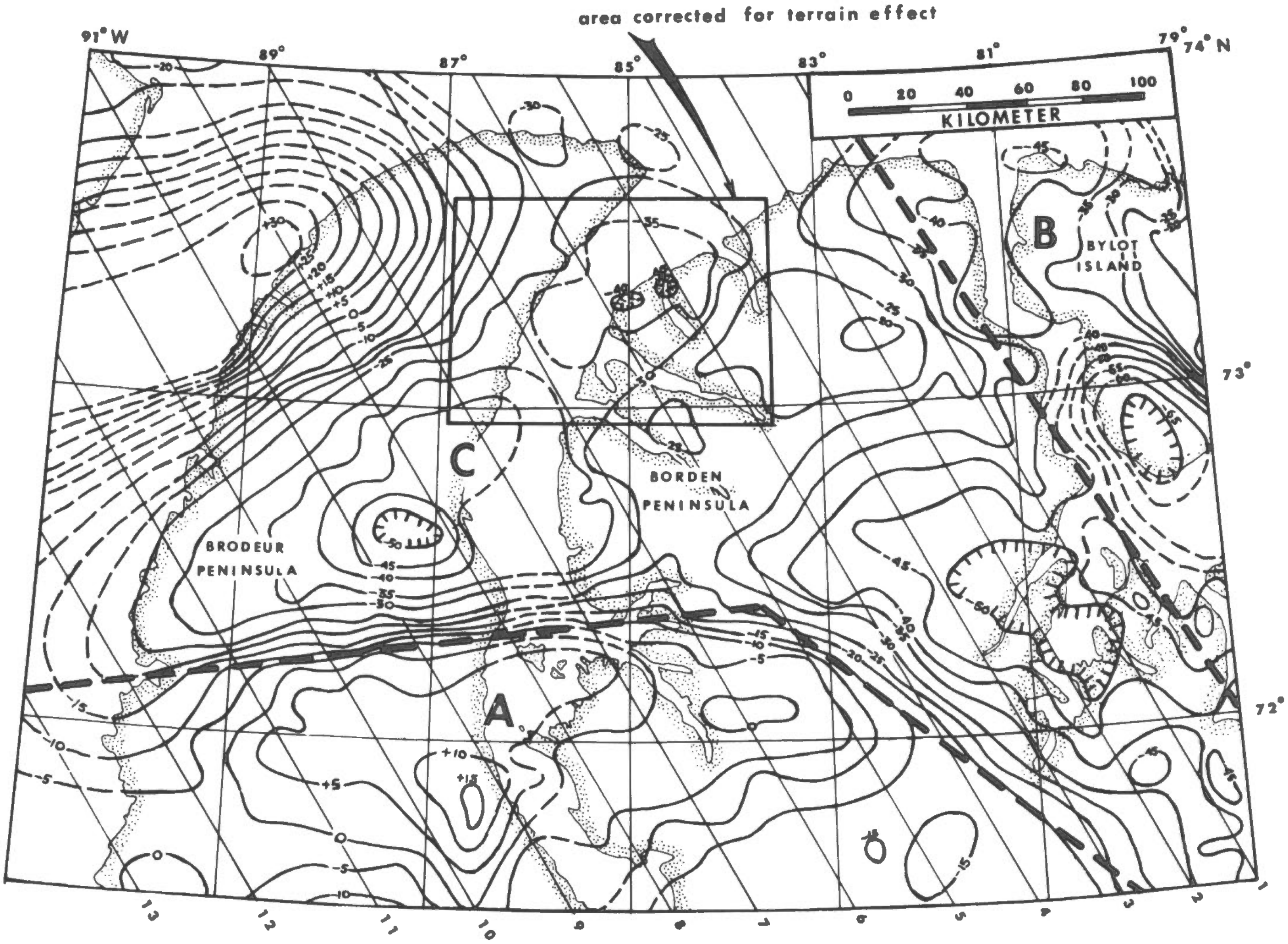

FIGURE 5. Bouguer anomaly map of the Brodeur, Borden peninsulas with contour intervals of 5 mgal. Numbered lines indicate locations of profiles in Figure 6. A,B,C indicate subareas (Map II).

closed contours occurs. North of the easterly trending low is a parallel high which occupies Russell Island and extends into Barrow Strait. The entire region of subarea C, west of Borden Peninsula, is overlain by flat-lying Paleozoic rocks.

Subarea D

The gravity field of subarea D is dominated by northerly trending belts of alternating highs and lows. The Boothia Uplift on Somerset Island is overlain by a high but at its western margin, along the east coast of Prince of Wales Island, a low occurs. Since no observations were made in Peel Sound, the existence of a gradual or steep gradient along this western margin cannot be determined. On the Bouguer anomaly map tentative, linearly interpolated contours across Peel Sound are shown.

Two belts of highs, parallel to the Boothia Uplift high, occur to the west on Prince of Wales Island; they are separated by gravity lows. The most westerly high also contains two local positive anomalies with circular contours.

Prince of Wales Island is covered by flat-lying Paleozoic sedimentary rocks. Hence the alternating gravity field cannot be explained by variations in the surface geology.

Residual Anomalies on Borden and Brodeur Peninsulas

The Bouguer anomaly map of the Borden and Brodeur peninsulas is presented in Figure 5. To separate the anomalies into regional and residual components thirteen parallel profiles across the region were smoothed. The profiles were selected at 30 km intervals approximately perpendicular to the regional trend (Figure 5 and Map III). The smoothed profiles are shown in Figure 6 and a regional anomaly map was constructed using the profile data (Figure 7). Residual anomalies were then obtained by superimposition and subtraction of the Bouguer and regional maps (Figure 8).

The residual anomalies (Figure 8 and Map IV) are similar in outline and trend to the Bouguer anomalies. The main

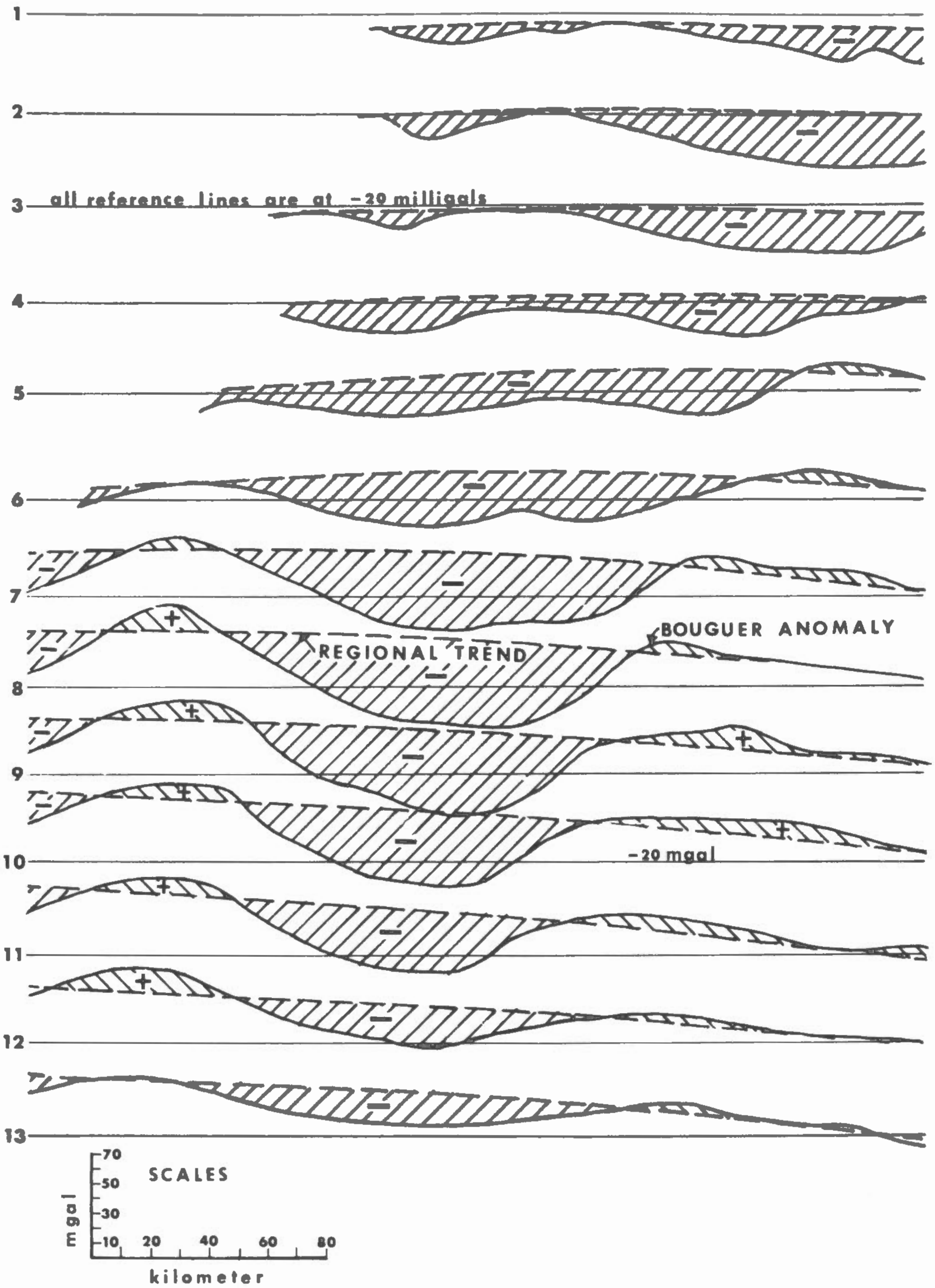

FIGURE 6. Thirteen parallel profiles across the Brodeur, Borden peninsulas. Bouguer anomalies in solid lines, regional trends in dashed lines. Locations on Map III and Figure 5.

anomalies are a low (C_1) in the west with a northeasterly trend and a low (C_2) in the east with a northwesterly trend. These lows are separated by a zone of high anomalies (C_3). To the north and east of the area local lows (C_4 and B_1) are located at the northern tip of Brodeur Peninsula and on Bylot Island.

A factor of personal judgment was introduced in smoothing the regional profiles and a measure of the success of this method is the quality of the correlation between the residual anomalies and the geology of the region. On Borden Peninsula the anomalies correlate well with the surface geology but on Brodeur Peninsula the correlation is not so obvious. Here Trettin (1965) has mapped the Paleozoic sediments and has estimated a maximum thickness of 1800 m for these beds. These rocks obscure the relationship between the gravity anomalies and the basement rocks.

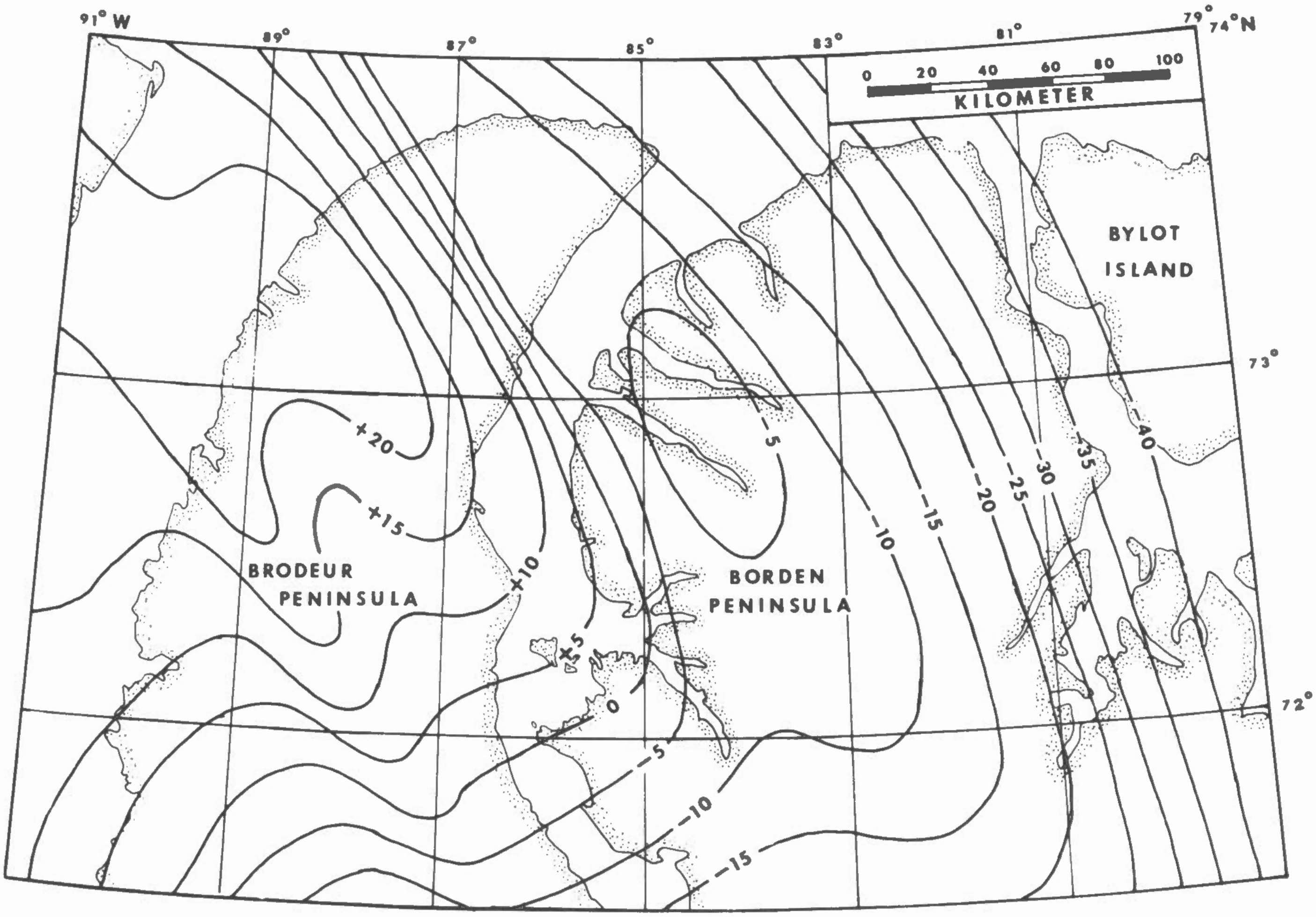

FIGURE 7. Regional anomaly map of area in Figure 5 with contours at intervals of 5 mgal.

Anomaly C_2 on Borden Peninsula

On Borden Peninsula erosion has removed most of the Paleozoic rocks, and much of the Precambrian basement is exposed. A structural break, the Central Borden Fault Zone, marks the contact between gneissic rocks dated about 1745 m.y. and Upper Proterozoic metasedimentary rocks and volcanics (Map I). Near Milne Inlet crystalline rocks occur north of the fault zone and are surrounded by Upper Proterozoic sedimentary rocks, both partly covered by Paleozoic strata. The steep gravity gradient (the southern boundary of anomaly C_2, Figure 8) follows the Central Borden Fault Zone from west to east and runs south of the crystalline rocks near Milne Inlet. From here the gradient continues southeasterly, following a structural break towards the Mary River iron deposits.

In northeastern Borden Peninsula, a horst of crystalline rocks, the Navy Board High, is surrounded by Upper Proterozoic metasedimentary rocks. It is marked by relatively high residual anomalies (C_3), forming a belt curving towards the southwest (Figure 8). In the southwest a similar but narrower horst of crystalline rocks occurs, which suggests that the entire zone of high anomalies may be related to near surface or exposed gneissic rocks, forming a horst in the Upper Proterozoic sedimentary rocks. The southwestern limb of anomaly C_3 coincides with the occurrence of volcanic rocks of the Eqalulik Group (Blackadar, 1965). Their density is higher than that of the quartzitic rocks of this Group (Table 4) and they may contribute to the higher anomalies.

On Borden Peninsula, the residual anomalies are related to lateral density variations within the basement rocks. Relatively high anomalies are associated with areas of crystalline rocks, whereas gravity lows are underlain by Upper Proterozoic sedimentary rocks.

The mean densities of the Upper Proterozoic Eqalulik and Uluksan groups weighted according to estimates of stratigraphic thickness are 2.61 g/cm^3 and 2.64 g/cm^3. In the area south of Arctic Bay where the volcanic member of the Eqalulik Group predominates the mean value is 2.64 g/cm^3.

The Upper Proterozoic sequence is thus less dense than the basement gneisses of Borden Peninsula (mean 2.68 g/cm^3) and offer an explanation for anomaly C_2. A profile P_1–P_2 across the anomaly is shown in Figure 9a. Surface geology and

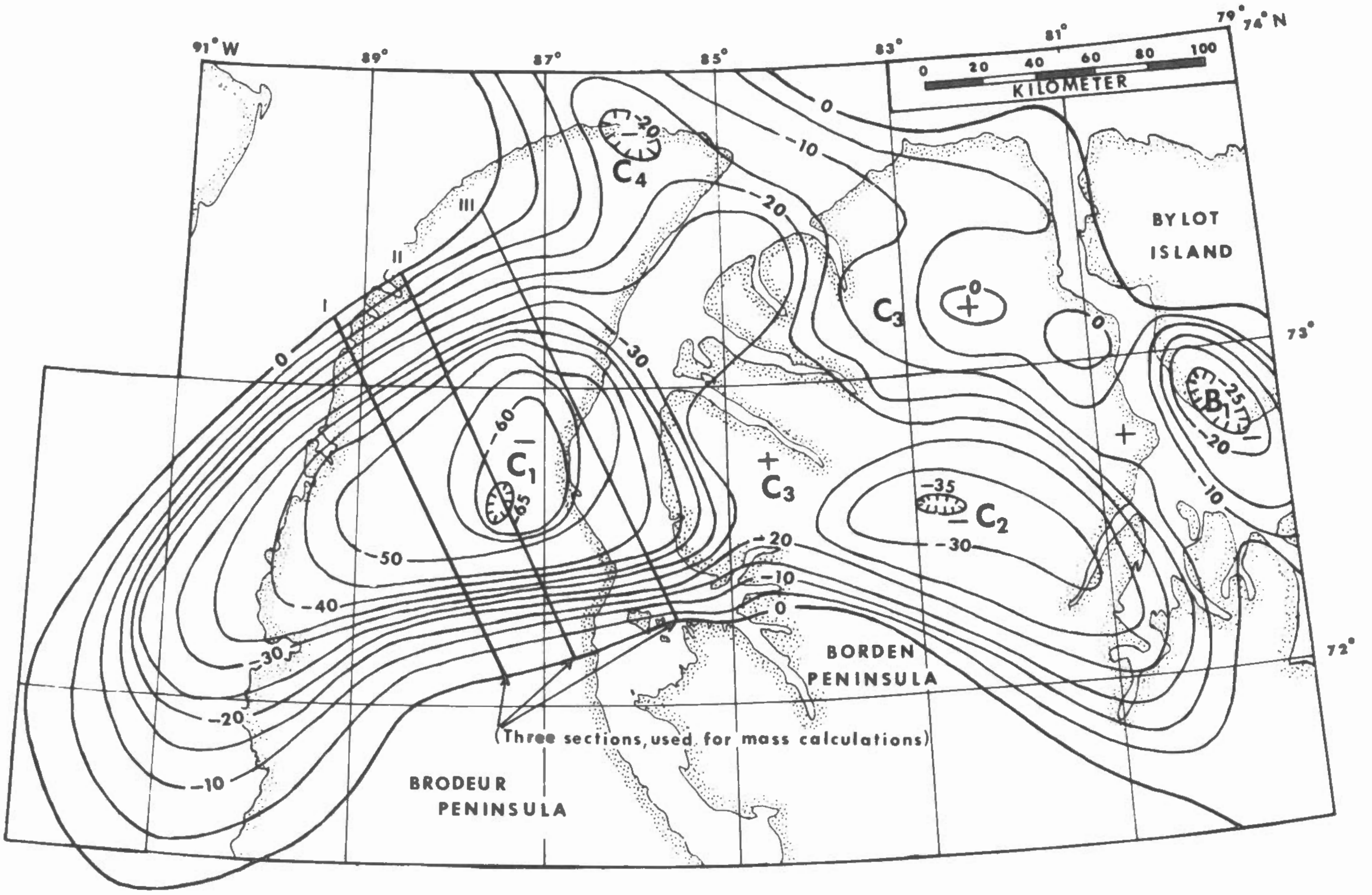

FIGURE 8. Residual anomaly map of the Brodeur, Borden peninsulas with contours at 5 mgal intervals.

topography are shown in 9c. Terrain corrections applied to two stations in the centre of the profile were only 0.6 and 0.9 mgal so that the effects of terrain are negligible.

A two-dimensional model was constructed to explain the negative anomaly (Figure 9b). The proposed final model is composed of Uluksan rocks underlain by Eqalulik rocks of similar bulk density (2.64 g/cm^3), contrasted with gneissic rocks. A model comprising these rocks alone cannot account for the observed residual anomaly of −30 mgal (Figure 9a). Therefore a core was assumed within the Uluksan rocks, composed of quartzitic rocks of the Eqalulik Group with a mean density of 2.61 g/cm^3. This assumption is supported by outcrops of such rocks along the Adams River. With this core of low-density rocks present, a gravity effect can be calculated which fits the residual anomaly well (Figure 9a).

The northern and southern contacts between Upper Proterozoic rocks and crystalline basement rocks in the model are quite steep. They represent, in the south, the Central Borden Fault Zone, and in the north, the faults bounding the Navy Board High. The contacts between the Uluksan rocks and Eqalulik rocks of the central core are relatively flat, considering the vertical exaggeration of the profile. The rocks are reported to be in faulted contact (Blackadar, 1965). To bring the rocks of the central core of quartzites to the surface, the sense of movement must be that of a normal fault, with the blocks composed of Uluksan rocks dropping downwards. Although normal faults generally are steeply dipping, the suggestion of flat contacts may indicate that these faults flatten out at depth.

The total thickness of the sedimentary rocks in the model is 7.5 km at the northern contact, 10 km at the southern contact, and about 12 km in the central part. The first two thicknesses correspond approximately to the total thickness of 8.5 km estimated by Blackadar (1965), but the thickness at the central core of quartzite is considerably greater. This thickness may be smaller if the density contrast is assumed to be larger than 0.07 and 0.04 g/cm^3.

Anomaly C_1 on Brodeur Peninsula

The steep gravity gradient along the Central Borden Fault Zone continues westward across Admiralty Inlet into Brodeur Peninsula, to form the southern boundary of anomaly C_1 (Map IV). Lithologic variations and a structural discontinuity in the basement may explain this steep gradient. Because of the overlying Paleozoic sedimentary rocks no information on the basement rocks or their densities is available, except for one outcrop of Eqalulik rocks. A possible way of testing the

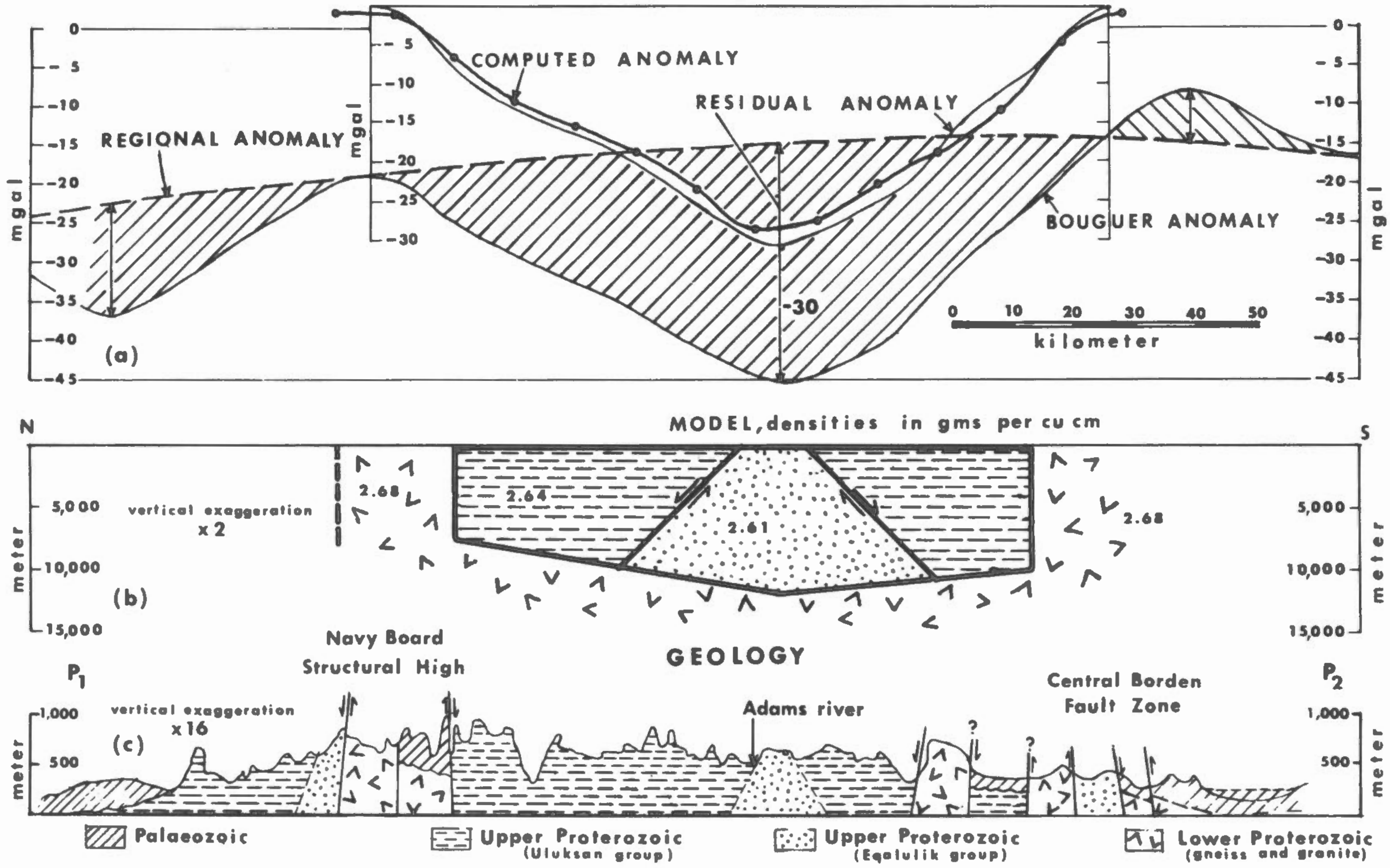

FIGURE 9. North-south section on Borden Peninsula. Location indicated on Map II. Model is based on geology, and its gravity effect is compared with the residual anomaly.

suggested basement conditions is to examine the variation in the magnetic field.

During Operation Franklin in 1955, the Geological Survey of Canada conducted aeromagnetic surveys along long-range flight lines. A complete summary and interpretation of the data has been given by Gregory, *et al.* (1961). One of these flight lines (line number 1) runs from south to north across Brodeur Peninsula (Map III). A gravity profile S_1-S_2 was constructed and compared with the magnetic anomalies along this portion of the flight line (Figure 10a and b, location Map II and Map III).

After removal of the smoothed regional anomalies three residual anomalies are revealed, a low of −20 mgal in the south, a high of +10 mgal, and a low of −45 mgal at the northern end of the profile.

The aeromagnetic observations are corrected for instrument drift and for the diurnal variation of the earth's magnetic field, based on observations in Resolute Bay (Figure 10a). Because a part of the magnetic record is missing in the neighborhood of the steep gravity gradient, the relationship between magnetic levels south and north of this hiatus cannot be established.

The magnetic anomalies which are related to gabbroic dykes or sills (Gregory, *et al,* 1961) vary with moderate-amplitude and small wavelength in the south where Upper Proterozoic quartzitic rocks and sandstone are found (anomaly A_2, Map IV). More closely spaced variations with larger amplitudes occur over the granitic gneiss north of the quartzitic rocks. To the north, the basement disappears underneath the Paleozoic cover and further north even higher amplitude variations, but with larger wavelengths, are recorded, up to the point where the record is broken (Figure 10a). North of the break these high-amplitude variations also occur, but beyond the steep gravity gradient a regional high is observed on which low-amplitude variations are superimposed. This high is similar to that in the south at the location of the quartzitic rocks. At Prince Regent Inlet, a sharp drop followed by a rise of the anomalies possibly marks the end of this regional high.

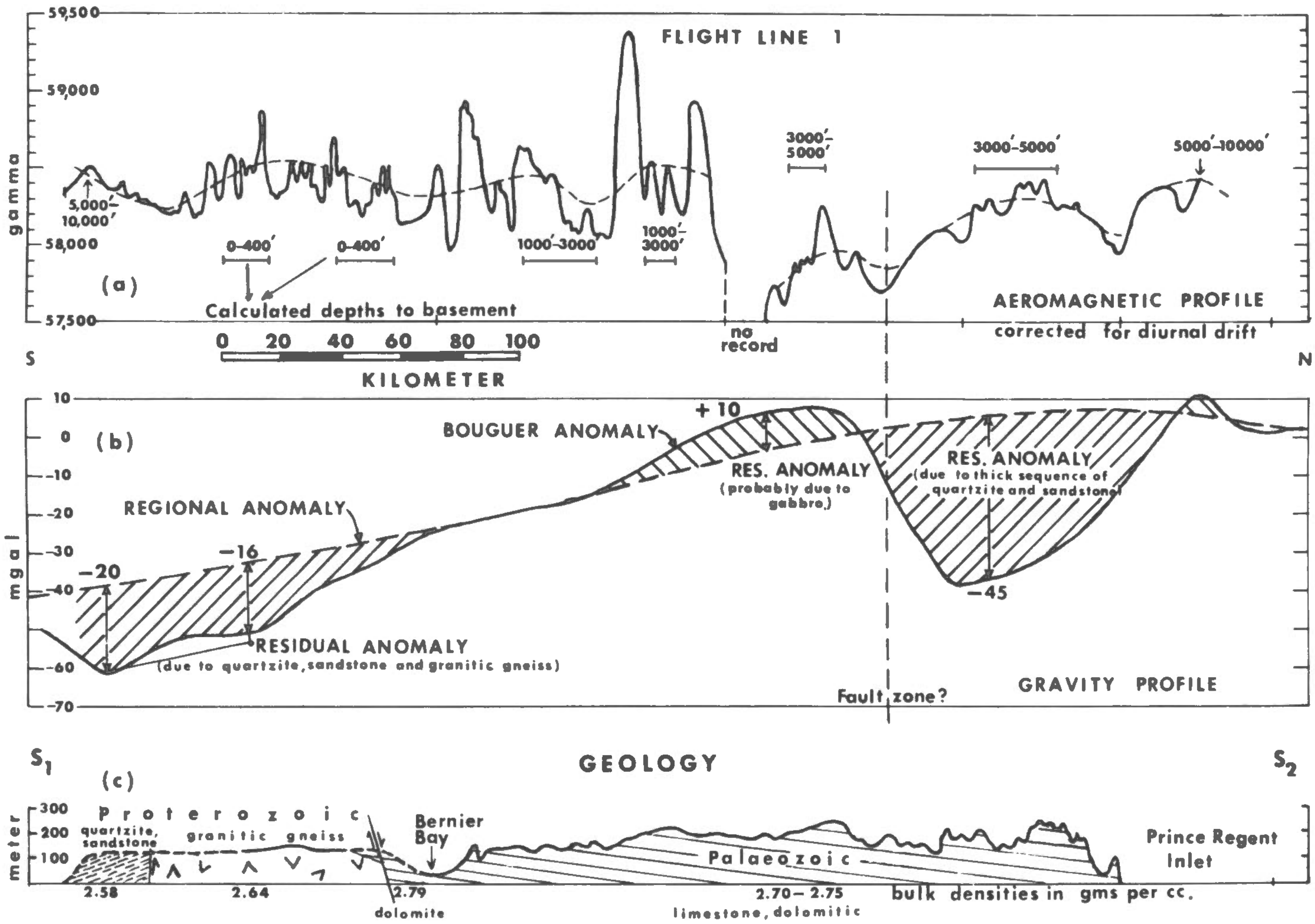

FIGURE 10. Gravity and magnetic anomalies on Brodeur Peninsula. Profile S_1-S_2 (aeromagnetic profile after Gregory, *et al.*, 1961). Location on Map II.

The magnetic record along this profile seems to provide supporting evidence for the existence of Upper Proterozic sedimentary rocks intruded by gabbroic rocks beneath the Paleozoic cover, as interpreted from gravity anomaly C_1. Gregory, *et al.* (1961, p. 7) explain this further:

> Over Archean* rocks, the dyke-like anomalies are generally more intense (of the order of 200 gammas, range 20 to 500 gammas) than similar anomalies over Proterozoic* strata (of the order of 50 gammas, range 20 to 100 gammas). Diabase dykes cut both Archean* and Proterozoic* rocks and thick sill sequences are known within the latter.

Indeed, the small-scale magnetic variations in the southern portion of profile S_1-S_2 at the location of Upper Proterozoic quartzitic rocks, are similar to those observed in the area of the proposed quartzitic rocks in the north, but are distinct from anomalies on the gneissic complex.

In the south, a residual gravity low (A_2) of −20 mgal is observed at the location of the Upper Proterozoic quartzitic rocks and sandstone. This low reaches a value of about −16 mgal north of these rocks, in a region with outcrops of gneissic rocks. The quartzitic rocks occupy a basin and have a total estimated thickness of 4950 m (Blackadar, 1965). If a density contrast of 0.10 g/cm^3 is assumed between quartzitic rocks and gneissic basement rocks, in accordance with Table 4, the gravity effect of this sequence of quartzite is −21 mgal. The estimated thickness of the sediments seems sufficient to explain the observed residual anomaly of −20 mgal.

The negative anomaly of −16 mgal north of the quartzitic rocks may be explained by the density difference of 0.04 g/cm^3 between granitic gneisses of this area and the average gneissic rocks of northern Baffin Island (2.68 g/cm^3). This contrast would have to be extended to depths of 9 to 10 km to account for the negative anomaly.

*In accordance with the nomenclature followed in this report and in agreement with Stockwell's (1964) nomenclature, the age of the rocks should be given as their metamorphic age, and hence the terms Archean and Proterozoic should be replaced in this context by Lower to Middle Proterozoic and upper Proterozoic, respectively.

Table 6

SUMMARY OF THE RESULTS OF MASS DEFICIENCY CALCULATIONS ALONG THREE PROFILES ON BRODEUR PENINSULA

(see Figure 8)

Profile	Integral I	ξ	$\omega_{\frac{1}{2}}$	d	$\tan^{-1}\left(\frac{\xi}{d}\right)$	$\overline{M}_\lambda$	Tailing-off Effect	M_λ
	(mgal km)	(km)	(km)	(km)		(g/cm $\times 10^{10}$)	(%)	(g/cm $\times 10^{10}$)
I	4650	70.5	89	44.5	1.00802	111	36	173
II	5730	75.0	94	47.0	1.01099	137	36	212
III	5520	80.5	108	54.0	0.97991	132	38	211

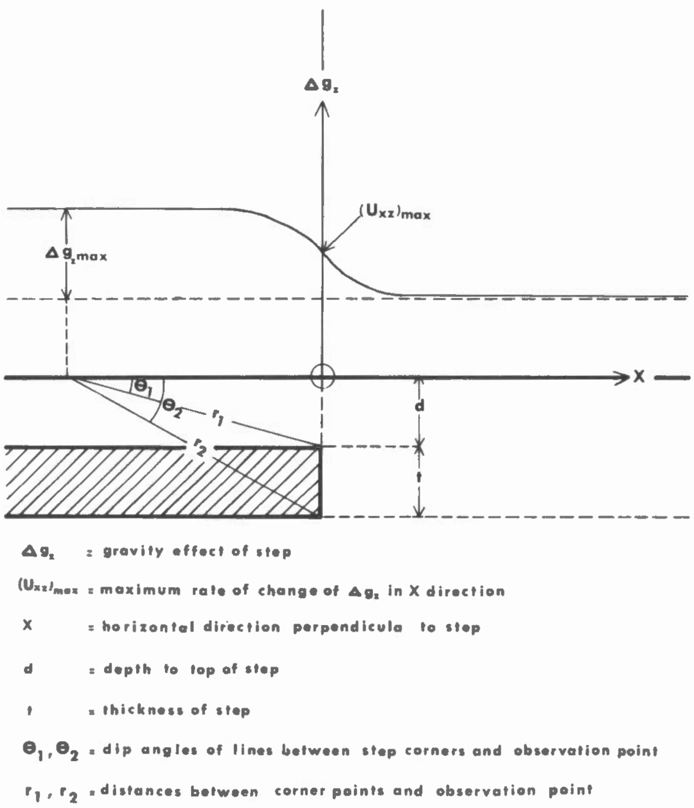

FIGURE 11. Dimensions and gravity effect of a buried step, after Nettleton (1940).

North of the contact of Paleozoic rocks with the denuded crystalline rocks, presumably 'normal' gneisses with a density of 2.68 g/cm³ underlie the sedimentary cover. These overlying sedimentary rocks consist of dolomite and dolomitic limestone with densities varying from 2.70 to 2.79 g/cm³. Calculations of the depth to the basement, from magnetic anomalies, indicate that the Paleozoic cover increases in thickness towards the north. This increase may cause a small regional gravity effect, superimposed on the regional effect of a thinning crust. The maximum increase of 2.1 km could have a gravity effect of +5 mgal if an average density for the Paleozoic rocks of 2.74 g/cm³ is assumed.

A positive residual anomaly of 10 mgal occurs in the northern portion of the profile, just south of the steep gravity gradient bounding anomaly C_1. Although the magnetic record is interrupted at this location the general magnetic response of the underlying rocks is apparent in the area of the positive gravity anomaly (Figure 10a). This high is in fact part of a northerly trending belt of local anomalies (A_1).

To obtain an estimate of the dimensions of the basin underlying anomaly C_1 mass deficiencies were calculated using the residual anomalies. Since the anomaly is elongated, calculation of the mass deficiency per unit length using the formula for the two-dimensional case is probably sufficiently accurate.

$$M_\lambda = \frac{I}{4G}\left[\tan^{-1}\left(\frac{\xi}{d}\right)\right]^{-1} \quad \text{where } I = \int_{-\xi}^{\xi} \Delta g dx$$

The total mass deficiency can easily be calculated from this by multiplying by the length of the anomaly. Three cross sections (Figure 8) were considered to obtain an average deficiency of mass per unit length. The results of calculations for these cross sections are summarized in Table 6.

The average mass deficiency per unit length is about 200×10^{10} g/cm, the average for the three profiles. Using this average, the dimensions of the body causing the mass deficiency can now be estimated. The body is assumed to consist of Upper Proterozoic quartzitic rocks and sandstone with a mean density of 2.58 g/cm³; these rocks are contrasted with the surrounding gneissic rocks, having a mean density of 2.68 g/cm³. The width of the body is estimated from the anomaly map as about 150 km.

If the thickness of the body is called T, then the cross-sectional area is

$$V = T \times 150 \times 10^{10} \text{ cm}^2$$

The average mass deficiency per unit length (200×10^{10} g/cm) is now divided by this cross-sectional area to obtain an expression for the density contrast in g/cm³, which may be taken as 0.10 g/cm³. The thickness T can be calculated from the expression

$$0.10 = \frac{200 \times 10^{10}}{150 \times T \times 10^{10}}$$

$$T = 13.3 \text{ km}$$

This value is quite close to the thickness of the model (12 km) proposed for the equivalent Upper Proterozoic rocks on Borden Peninsula (Figure 9b), but exceeds Blackadar's estimated value of 8.5 km (Blackadar, 1965). If the value of 8.5 km is correct and also exists on Brodeur Peninsula, a density contrast of 0.16 g/cm^3 is required to produce the same mass deficiency per unit length of 200×10^{10} g/cm. Such a high density contrast between the quartzitic rocks and the gneissic complex would exist if one assumes a density of 2.74 g/cm^3 for the gneissic rocks. However, it is unlikely that the measured average density of 2.68 g/cm^3 for these rocks deviates by such a large amount from the true value. Rather the total thickness of the Upper Proterozoic sedimentary rocks is probably close to 13 km.

A method of estimating the maximum depth to a disturbing mass has been described by Bott and Smith (1958). A special application of this method to the case of a buried step was outlined by Bancroft (1960). The gravity anomaly C_1 on northern Brodeur Peninsula is bounded to the south and to the northwest by steep gradients (Figure 5) which may be regarded as the effects of two buried steps. The expression for the gravitational attraction of such a step is given by Nettleton (1940) and is graphically represented in Figure 11. In anomaly C_1 the two assumed steps are so far apart they will exert a negligible influence on one another. Bancroft's method is applied to the easterly trending gradient which forms the southern boundary of anomaly C_1.

Two different expressions can be used:

$$d_0 = \left(\frac{1}{\pi}\right) \frac{\Delta g_z \max}{U_{xz} \max}$$

where d_0 is the maximum possible depth to the top of the anomalous body, Δg_z max the maximum gravity anomaly, and U_{xz} max the maximum rate of change of Δg_z in the x-direction; also,

$$d = t/ln(1 + t/d)$$

t being the thickness of the buried step which is found from the formula for an infinite slab of rock:

$$t = \Delta g \max / 2\pi G \Delta\rho$$

The steep gravity gradient with easterly trend, forming the southern boundary of anomaly C_1 and considered due to a buried step (Figure 8), yields the following values:

$$\Delta g_z \max = 60 \text{ mgal}$$

$$U_{xz} \max = 2 \text{ mgal/km}$$

and hence the maximum depth to the top of the anomaly (the step) is d_0 = 9.5 km. The thickness of the step (t) is found by assuming a density contrast of 0.10 g/cm^3 between quartzitic rocks of the anomalous body and the surrounding gneissic rocks (Table 4). Substituting this in the equation gives t = 14.3 km. With this value the actual depth can be found: d = 4.1 km.

The Paleozoic sedimentary rocks of Brodeur Peninsula seem to thicken towards the north, reaching a maximum value of 3000 m (Figure 10). This thickness is of the same order of magnitude as that determined as the depth to the top of the anomaly-causing body, 4.1 km, and hence the thickness of the cover. Both values 3.0 and 4.1 km are much higher than the 1.8 km, estimated from field observations (Trettin, 1965). Apparently the total section of Paleozoic sedimentary rocks has been underestimated in the field, which may not be surprising in that the strata are nearly horizontal and a good estimate is very difficult to obtain.

The calculated thickness of the step (14.3 km) is in good agreement with the result (13.3 km) based on the calculated mass deficiency per unit length. Both values exceed the estimated thickness of 8.5 km for equivalent metasedimentary strata on Borden Peninsula, 200 km to the east of the present location (Blackadar, 1965). This figure may also be underestimated. Model studies made in that section showed that the strata may be as many as 12 km thick, a thickness quite close to the thickness calculated for the step on Brodeur Peninsula.

Residual Anomalies West of Brodeur Peninsula, within Subarea C

Northeasterly trending Bouguer anomalies similar to those on Brodeur Peninsula are observed on eastern and northern Somerset Island, within subarea C (Map II). Easterly to northeasterly trending anomalies occur on northern Prince of Wales Island, and since these trends appear to be connected with those of northern Somerset Island, this region has also been included in subarea C.

Cross sections perpendicular to the northeasterly trends illustrate the existence of a series of alternating highs and lows (Figure 6). A broad low in the central part of these sections is anomaly C_1 of northern Brodeur Peninsula (Map IV). Northwest of this low, a high (C_5) is observed on the east coast of Brodeur Peninsula as well as on eastern Somerset Island, across Prince Regent Inlet. This high is flanked to the northwest by a parallel low (C_6) of northern Somerset Island. Across Peel Sound, on northern Prince of Wales Island, negative anomalies with easterly trend occur, parallel to and north of which is a belt of positive anomalies (C_7). The latter anomalies are observed on Russell Island and on two smaller islands in Barrow Strait (Map IV).

Gravity high C_5, with northeasterly trends, is bounded by a relatively steep gradient, which also forms the northwestern flank of the Brodeur low (C_1). This gradient is similar to its easterly trending counterpart through central Brodeur Peninsula. The steepness of this easterly trending gradient indicates a relatively shallow source, as previously noted, possibly a buried step due to a fault contact between Upper Proterozoic quartzitic rocks and gneisses; the top of this step may lie at a depth of 3 to 4 km.

The northeasterly trending gradient separating anomalies C_1 and C_5 may be due to a similar faulted contact between Upper Proterozoic rocks and basement gneisses beneath the Paleozoic cover of the Prince Regent Inlet region. To account for the positive residual anomaly C_5, one may assume that the density of the crystalline rocks is higher than the average on

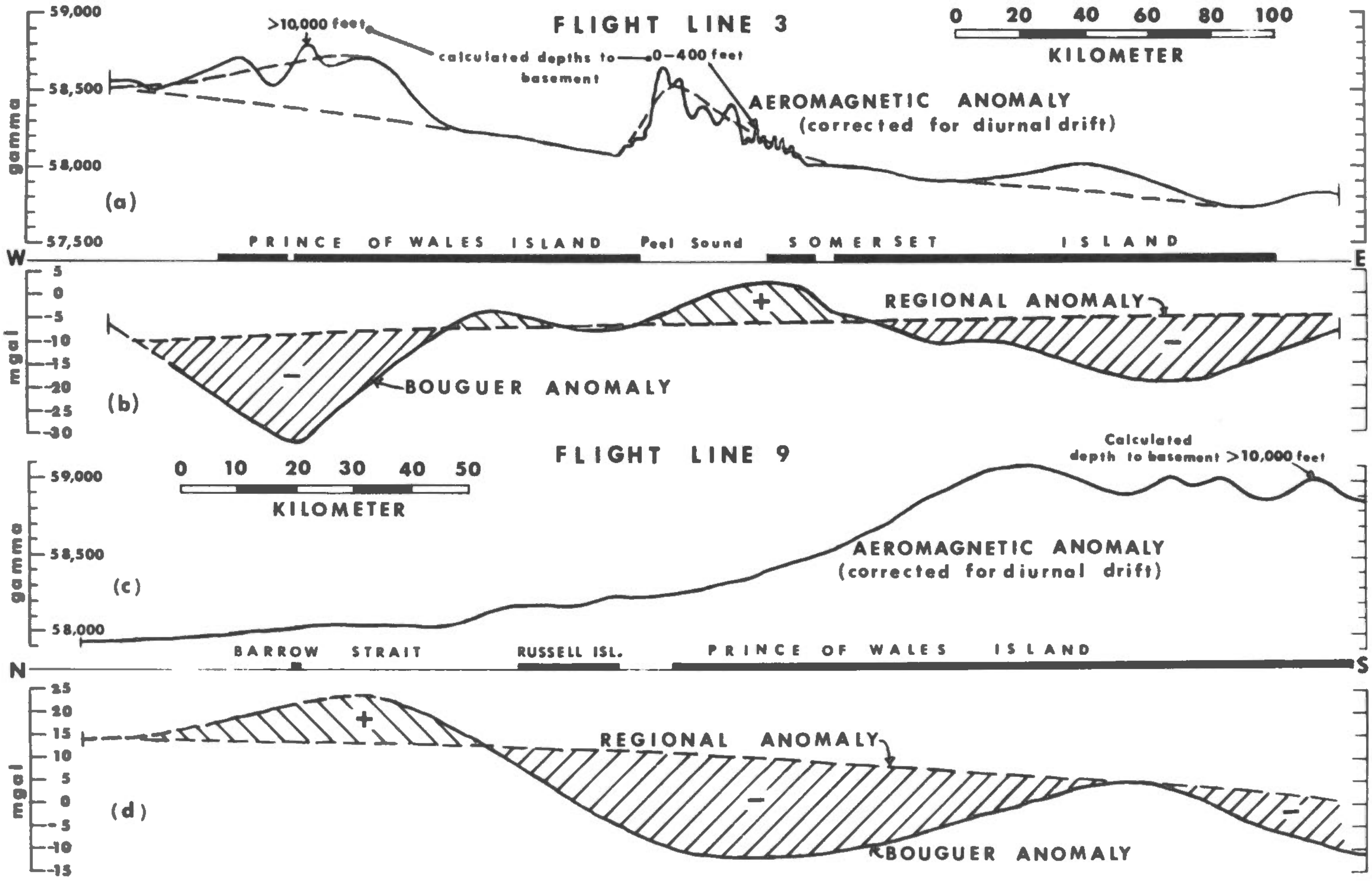

FIGURE 12. Aeromagnetic and gravity profiles along flight lines 3 and 9 (Map III) (aeromagnetic profiles after Gregory, *et al.*, 1961).

northern Baffin Island (2.68 g/cm^3). They are probably quite similar to those of the Boothia Uplift, which are much richer in mafic constituents and have a mean density of 2.76 g/cm^3.

The belt of negative anomalies (C_6) on northern Somerset Island is 50 mgal lower than adjacent high C_5. Upper Proterozoic low-density sedimentary rocks, presumably mainly quartzitic rocks, may occupy a basin on northern Somerset Island beneath the Paleozoic rocks. Outcrops of such rocks occur at Aston Bay north of the Boothia Uplift (Map I). The Aston Formation (mainly quartzitic) and possibly the Hunting Formation (dolostone and shale) are considered to be Upper Proterozoic equivalents of the Eqalulik and Uluksan groups of Borden Peninsula. Although the Hunting Formation may be partly Paleozoic (Tuke, *et al.*, 1966), the age is of minor importance in this study since lithologies determine the gravity field. The Hunting Formation does not contribute to the negative anomalies and could be included in the Paleozoic sedimentary column. The Aston Formation, however, would explain the negative anomalies if its thickness increases rapidly from the estimated 800 m at Aston Bay towards the northeast to account for a gravity low of −23 to −35 mgal of anomaly C_6. If a density of 2.58 g/cm^3 is assumed for the quartzitic rocks and of 2.76 g/cm^3 for gneisses of the Boothia Uplift region and the Prince Regent Inlet region (see Table 3), a thickness of 6.5 km is required to explain the difference between anomalies C_6 and C_5. This thickness is half the thickness estimated for the equivalent sedimentary rocks on Borden Peninsula.

This proposed basin on northern Somerset Island, occupied by Upper Proterozoic quartzitic rocks, may be connected with the basin of equivalent rocks on Brodeur Peninsula associated with gravity low C_1. Figure 8 reveals the presence of a low (C_4) north of Brodeur Peninsula in Lancaster Sound, perhaps indicating deposits of quartzitic rocks connecting basins underlying C_1 and C_8 (see Map IV).

The idea that interconnected basins of Upper Proterozoic sedimentary rocks existed throughout Arctic Canada was first suggested by Blackadar (1957); the presence of anomaly C_4 may support this hypothesis. The Boothia Uplift has provided the quartzitic sediments at Aston Bay (Tuke, *et al.*, 1966), and may further have supplied part of the clastic rocks of the proposed basin associated with anomaly C_6. It is not likely that all sedimentary rocks of this basin are derived from the Boothia Uplift, which is 80 km away. A second area of origin is proposed at the site of the positive anomaly C_5 in the Prince Regent Inlet region. The proposed basement uplift would have

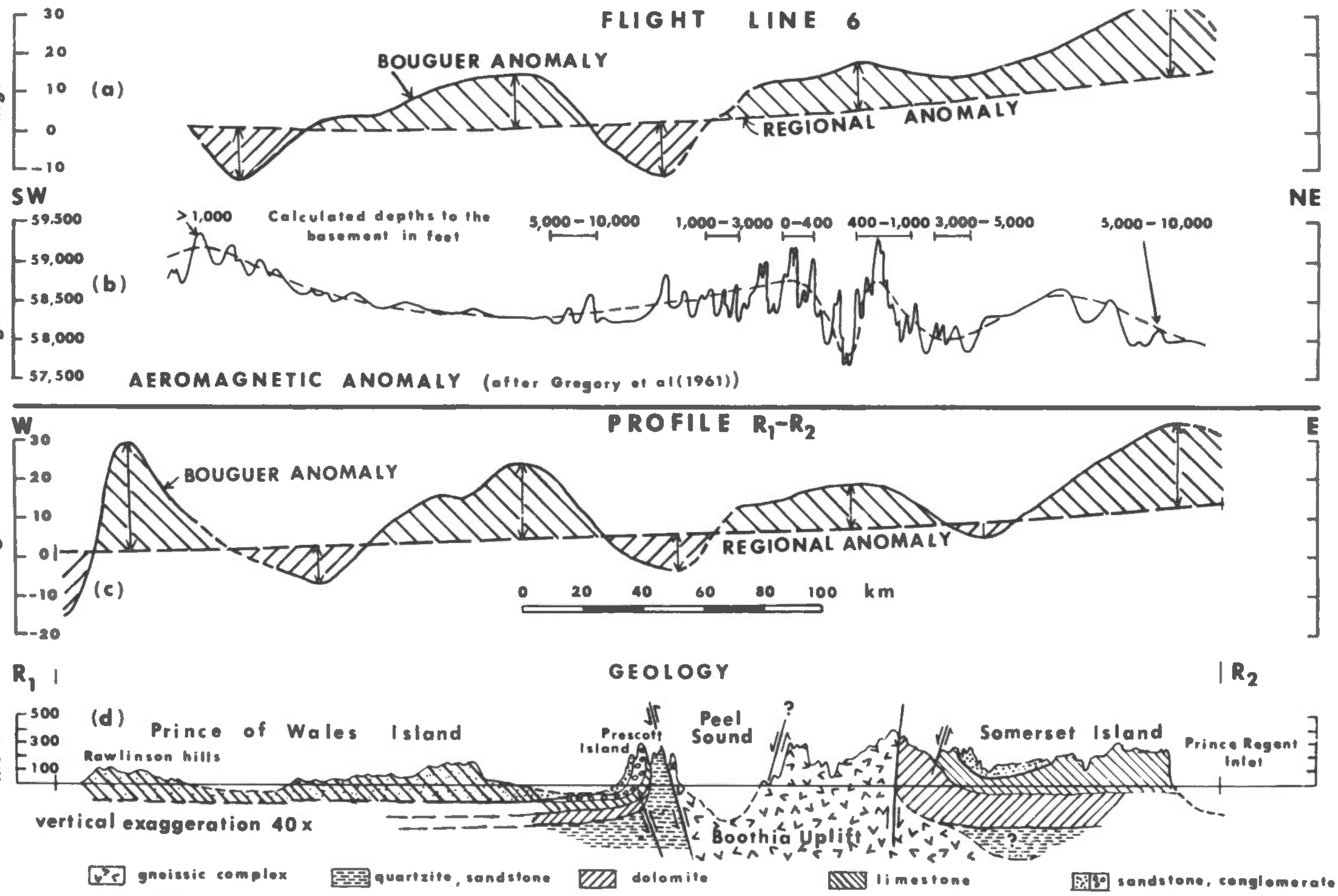

FIGURE 13. Gravity and magnetic anomalies and geology along flight line 6 and profile R_1-R_2. Locations indicated on Map II and Map III.

existed as a positive land mass during and prior to Upper Proterozoic time, and thus may have provided clastics to the adjacent areas, C_1 and C_6. Its core of gneissic rocks is now flanked by these sedimentary rocks, deposited along steep margins of the uplift, thus producing a steep gravity gradient. Early Paleozoic sedimentary rocks of this area are almost horizontal, indicating that, unlike the Boothia Uplift region, no movements occurred in Paleozoic time.

The suggestion that Upper Proterozoic quartzitic rocks are the cause of anomaly C_6 on northern Somerset Island may also apply in other areas. Perhaps deposition of clastics occurred throughout northern Somerset Island and extended across Peel Sound into northern Prince of Wales Island, although the gravity anomalies are here less negative. The metaquartzitic rocks must have caused the abrupt termination of northerly gravity trends associated with the Boothia Uplift and adjacent structures of subarea D. On northwestern Prince of Wales Island the Upper Proterozoic quartzitic rocks thicken again and occupy a basin with the associated anomaly D_5. This anomaly is of the same magnitude as anomaly C_6, on northern Somerset Island, and presumably both basins have similar thicknesses of Upper Proterozoic rocks. These strata may join Upper Proterozoic sedimentary rocks outcropping on Victoria Island, 450 km west.

A gravity high (C_7) on Russell Island may, like anomaly C_5, be due to an ancient basement uplift with an easterly to northeasterly trend. The uplifted block could have supplied sediments to the areas south of it. These easterly to northeasterly trending anomalies (C_6 and C_7) represent an interruption of the northerly trends associated with the Boothia Uplift region, and which continue on Cornwallis and Bathurst islands north of Barrow Strait (Sobczak, *et al.*, 1963). These structures are undoubtedly extensions of the Boothia Uplift structure or of those adjacent to it. Therefore the easterly trending anomalies must represent a superimposed system which may have led to wrench faulting along the northern margin of Barrow Strait (Gregory, *et al.*, 1961).

Aeromagnetic anomalies seem, to some extent, to support the suggestion of abundant deposits of Upper Proterozoic quartzitic rocks. A regional magnetic high, on which low-amplitude variations are superimposed, is associated with the areas of Upper Proterozoic rocks on Brodeur Peninsula, the same areas which are marked by gravity lows C_1 and A_2 (see Figure 10a and b).

Flight line 3, across northern Prince of Wales and Somerset islands (Map III), indicates similar variations at the locations of gravity lows D_5 and C_6 (Figure 12a and b). The high-amplitude variations of this profile across Peel Sound are attributed

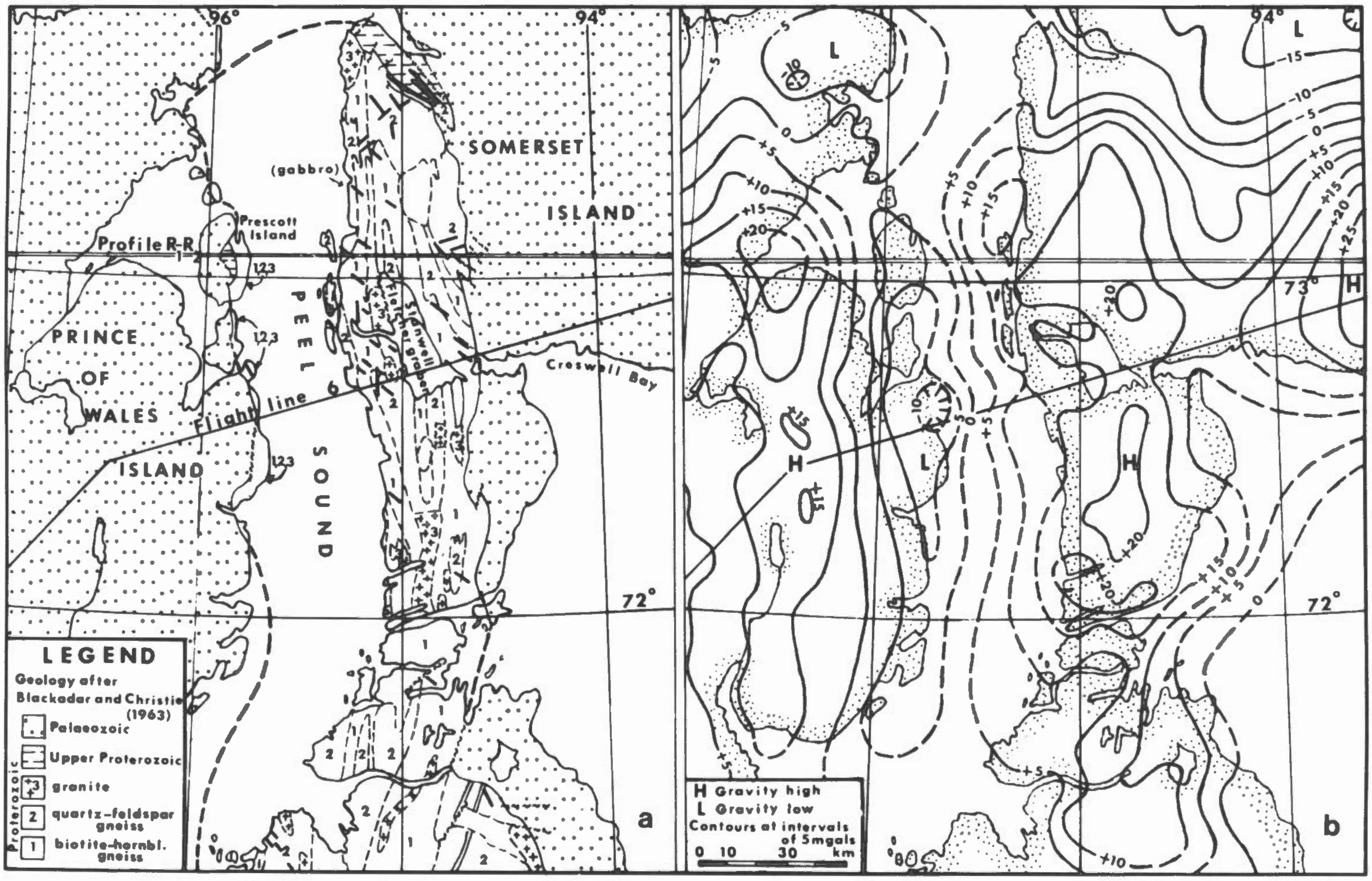

FIGURE 14. (a) Geology of the Boothia Uplift region. (b) Bouguer anomalies in the Boothia Uplift region.

to gabbroic intrusions in the gneissic complex of the Boothia Uplift. Low-amplitude variations near Aston Bay east of the uplift are caused by gabbroic sills in the Aston Formation. Farther east the magnetic field is relatively flat but at the site of the proposed basin of Upper Proterozoic rocks (C_6) a regional high exists. The absence of smaller variations superimposed on this high may indicate no intrusions here. Intrusions apparently do occur in similar rocks on northern Prince of Wales Island, at anomaly D_5 (Figure 12a).

Flight line 9 crosses anomalies C_7 and D_5 from north to south (Maps III and IV) and shows a regional magnetic increase over gravity low D_5 (Figure 12c and d). Low-amplitude variations, probably due to gabbroic intrusions, appear again in the southern portion of the profile.

Residual Anomalies on Somerset and Prince of Wales Islands, within Subarea D

The Bouguer anomalies of subarea D are dominated by northerly trending belts of alternating highs and lows, similar to the system of such belts with northeasterly trend in subarea C (see Map II). The northerly trending anomalies D_1, D_2, D_3, D_4, D_6, D_7 and D_8 (Map IV) are best shown in an east-west profile through the central region (Figure 13c). The variation of the gravity field is roughly periodic with an average wavelength of 120 km and an amplitude of about 15 mgal. The magnitudes of the residual anomalies, ranging from 10 to 20 mgal are taken with respect to a smooth regional shown in Figure 13e as a dashed line. This regional anomaly gradually increases from +3 mgal in the west to about +12 mgal in the east.

Correlation of the Gravity Anomalies and Geology

Crystalline rocks of the Boothia Uplift occupy western Somerset Island, Peel Sound, and the extreme eastern coast of Prince of Wales Island including Prescott Island and some smaller islands off its east coast (Figure 14a). In the eastern part of the Uplift, on Somerset Island, Bouguer anomalies of +20 mgal and higher were observed (Figure 14b), but these positive anomalies decrease towards Peel Sound. Across Peel Sound, at the western margin of the uplift, Bouguer anomalies are much lower, with a minimum just under −10 mgal (Figure 14a and b). No observations could be made in Peel Sound, and therefore the interpolated linear decrease in the gravity field from east to west may not be correct.

Adjacent to the crystalline rocks of the Boothia Uplift, Paleozoic sedimentary strata occur (Figure 14a). Evidently these sedimentary rocks in contrast to the crystalline basement rocks, cannot account for the observed periodic gravity field. Estimates from magnetic data indicate that as much as 3000 m of these Paleozoic rocks may be expected (Gregory, *et al.*, 1961). If the previously calculated density contrast of 0.03 g/cm^3 between crystalline rocks and Paleozoic rocks is assumed, the gravity effect of such a section of Paleozoic rocks would be −3.8 mgal. In other words, unless very low-density rocks such as evaporities are within the sedimentary column, the Paleozoic formations do not contribute significantly to the gravity field. Minor deposits of gypsum found on northern Somerset Island cannot justify an assumption of large evaporite occurrences in the Paleozoic rocks of the sedimentary basins.

The difference between anomalies east and west of Peel Sound, on the Boothia Uplift, is not due to terrain. Calculations of the terrain effect were made for five stations along the coasts and were found to be small, ranging from 0.5 to 1.5 mgal. The rapid change of anomalies from one side of the water to the other is therefore assumed to be related to geological phenomena.

Interpretations of the Gravity Field on and adjacent to the Boothia Uplift

If the sedimentary basins do not contribute significantly to the observed gravity field, other possible causes include variations in the crystalline basement rocks themselves or variations in a basement, formed by alternating crystalline gneisses and Upper Proterozoic metasedimentary rocks.

Variations within the surface basement rocks apparently do occur. The geological map of the Boothia Uplift region, by Blackadar and Christie (Figure 14a), shows distinct units of mafic and felsic gneiss, although it should be noted that the contacts were mainly assumed and only a limited amount of control was available. All gradations between mafic gneiss (unit 1) and felsic gneiss (unit 2) seem possible. The distinction between the two mappable units was based merely on the quartz-feldspar contents of the samples; if this was estimated as larger than 50 per cent, the rock was classified as unit 2. However, since the rocks of the Boothia Uplift reflect a complex history, with at least three periods of folding distinguished before Upper Proterozoic time (Dineley, 1966), it seems likely that these regular map units represent an oversimplification of the actual situation.

Density determinations confirm that a distinction between the two units based on estimation of mineral contents of the hand specimens may be inaccurate. In the present study, samples which were classified as mafic gneiss had a density falling in the range of felsic gneisses. The felsic gneiss (unit 2) has a mean density of 2.68 g/cm^3, whereas mafic gneiss (unit 1) has a mean density of 2.85 g/cm^3 (Table 4).

The Bouguer map (Figure 14b) shows a gravity high in the eastern part of the Boothia Uplift and a low in the west (anomalies D_1 and D_2, respectively; Map IV). If variations in the basement rocks cause this change from high to low, it may be expected that low-density felsic gneisses prevail in the west and that mafic gneisses are more abundant in the east. Inspection of the geological map confirms that mafic gneiss occurs along the eastern margin of the uplift, except in the northern part (Figure 14b). However, mafic gneiss exists also in the westermost part of Somerset Island, and on Somerset Island as a whole, felsic and mafic gneisses apparently occupy about equal areas. As a test, the areas occupied by felsic gneiss, mafic gneiss and granite were measured with a planimeter from the geological map. The result showed a ration of 43: 45: 6 for the three rock types, respectively, confirming that mafic and felsic gneiss occupy about equal areas.

The same three rock types are reported in equal amounts along the east coast of Prince of Wales Island (Blackadar and Christie, 1963). Rocks between Prince of Wales and Somerset Islands lie below Peel Sound. They may be predominantly felsic gneisses if trends of such rocks continue from their occurrence on Boothia Peninsula northward into the Sound (Figure 14a). If this is the case, these felsic gneisses may be contrasted with a combination of the three rock types on Somerset Island. The mean density of Somerset Island rocks may be calculated by assigning weighting factors to the previously determined densities of the rock types according to their areas; this gives a density of 2.76 g/cm^3. If the density of the rocks below Peel Sound is taken as 2.68 g/cm^3 the density contrast of 0.08 g/cm^3 must be extended to a depth of 10 km to account for the change of 30 mgal. If the Boothia Uplift were occupied by exclusively mafic gneiss in the east and by felsic gneiss in the west (with a density contrast of 0.17 g/cm^3), this depth would be only 4.3 km.

Apparently if variations within the crystalline basement rocks cause the alternating gravity field of subarea D, distinct zones of felsic gneiss alternating with zones of mafic gneiss or a combination of both rocks must extend to considerable depths (4 to 10 km). However, the variations within the basement do not appear to be regular enough to explain the gravity field and since structural relief of at least 500 m is observed at the western margin of the uplift (Kerr and Christie, 1965), a more acceptable solution is presented. It is proposed that Upper Proterozoic quartzitic rocks occur adjacent to the Boothia Uplift, and that these cause the negative anomalies.

A steeper gravity gradient may exist along the west coast of Peel Sound, a suggestion supported by the presence here of a steep magnetic gradient (Figure 12a). If so, it may be assumed that the low-density Upper Proterozoic rocks are faulted against the gneissic basement. Evidence of such a faulted contact is found on Prescott Island, where a small area of quartzitic rocks similar to the Upper Proterozoic Aston Formation occurs (Map I). The negative anomalies observed on the western part of the uplift can now be explained by overthrusting of the basement rocks onto these Upper Proterozoic rocks. These Upper Proterozoic clastic sediments may have been deposited east of the present margin of the uplift and may have been thrust westward into thick accumulations during early Paleozoic time. Figure 13d schematically indicates the possible result of this.

If a density contrast of 0.18 g/cm^3 is taken between the quartzitic rocks and the gneissic rocks according to the density results, a thickness of about 4 km of quartzite would be required to explain the change of anomalies from east to west. The observed structural relief of 500 m (to sea level) apparently is only one eighth of the actual structural relief which must exist at the site of the lowest anomalies.

Along the east side of the Boothia Uplift similar Upper Proterozoic rocks may occur, extending from the outcrop area at Aston Bay southward beneath the Paleozoic rocks to Creswell Bay (Figure 14a). They may have been partly eroded, thus explaining the smaller decrease of anomalies towards the east of the uplift, as compared with the decrease westward.

Clearly low-density Upper Proterozoic quartzites play an important role in the gravity field of the area. The anomalies lead to the proposal that major basins are occupied by these rocks and are marked by gravity lows (C_1, C_2, C_6, A_2 and D_5; Map IV). The same proposal is made here to account for the anomalies along both sides of the Boothia Uplift. Extensive erosion must have occurred during Upper Proterozoic time, with several positive land masses supplying clastic detritus to the depositional basins surrounding them.

Aeromagnetic anomalies along flight line 6, across the Boothia Uplift (Map III) together with the gravity anomalies are presented in Figure 13a and b. High-frequency magnetic variations occur over the Boothia Uplift, with a distinct low over the Stanwell Fletcher graben (Figure 14a). East of the uplift a sharp drop in the magnetic anomaly marks the termination of the uplift and low-frequency variations, typical for regions of Upper Proterozoic quartzitic rocks, are found. These variations are superimposed on a regional magnetic high, which decreases towards the east coast of Somerset Island. If this high is caused by the quartzitic rocks it may indicate that they onlap onto the basement ridge responsible for anomaly C_5. West of the Boothia Uplift variations of magnetic anomalies are also low-frequency, presumably caused by gabbroic intrusions into the Upper Proterozoic quartzitic rocks there.

In subarea D, the magnetic anomalies again lend support to the interpretation that gneissic rocks are flanked by quartzitic sedimentary rocks, as they are consistent with the magnetic observations over such outcrops at anomaly A_2. Low-gravity anomalies and magnetic highs, with low-frequency variations superimposed on them, seem to be associated with these Upper Proterozoic quartzitic rocks. In contrast, high-gravity anomalies and low-magnetic anomalies with large amplitude, high-frequency variations seem to be related to the crystalline basement.

To obtain an estimate of the susceptibility of these Upper Proterozoic quartzitic rocks, Poisson's theorem is applied. For the simplified case of a two-dimensional body which is vertically polarized, it states:

$$H_t = \frac{I}{G\,\Delta\rho}\,\frac{\partial g}{\partial z}$$

H_t is the total magnetic field, I is the intensity of magnetization tentatively assumed to be due to induction, G is the universal constant of gravity, and $\Delta\rho$ is the density contrast. The direction of magnetization is approximately vertical (z) in these high latitudes; hence $\partial g/\partial z$ is the vertical gradient of gravity.

For several regional magnetic highs along the flight lines the total field was plotted against the vertical gravity gradient. This gradient was determined at regularly spaced points along the profile, following a method outlined by Evjen (1936). The fitted straight lines resulting from these plots indicate that with a density contrast of 0.18 g/cm^3 between quartzitic rocks and gneiss the susceptibility of the quartzitic sandstone may be 0.0044 cgs units higher than that of the gneiss. Such a high susceptibility could be due to a high magnetite or maghemite content of the quartzose rocks. Grant and West (1965) point out that grain size and shape of the ferromagnetic minerals also have an influence on the effective magnetization. However, the calculations are based on the assumption that magnetization is solely due to induction, in the direction of the earth's magnetic field. If it is assumed that natural remanent magnetism (NRM) exists in these rocks, the magnetization due to induction may be smaller than the total magnetization (I); hence the value for the susceptibility will also be smaller. The calculated value for the susceptibility, which is much higher than for most sedimentary rocks, probably indicates that NRM indeed exists.

Interpretation of the Northerly Trending Anomalies on Prince of Wales Island

The northerly trending belts of highs (D_3 and the belt formed by C_6-D_7; Map IV) separated by lows (D_2 and D_4) are parallel to and similar to the Boothia Uplift high (D_1) and must have a similar origin. One belt (D_3) lies just east of central Prince of Wales Island and the other occupies the extreme west (Map IV). The latter positive belt trends northerly to northwesterly and ends in the north in a basin-shaped negative anomaly D_5; it further differs from D_1 and D_3 in that it incorporates two well defined local anomalies D_6 and D_7.

The system of northerly trending anomalies evidently must have a structural origin, as has the Boothia Uplift high. Arguments have been given for and against the possibility that lateral density variations within the basement cause the alternating gravity anomalies. If these variations do occur, they must be structurally controlled, and probably existed since the basement was formed. It is suggested that the two northerly trending highs parallel to the Boothia Uplift are caused by an ancient uplift possibly during Proterozoic time. The Boothia Uplift itself formed part of this system of elevated blocks but it became active again in Paleozoic time, while the two parallel uplifts seem to have remained quiet and were buried beneath a

Paleozoic cover. The gravity lows separating the highs, as previously suggested, may be caused by Upper Proterozoic metasedimentary rocks adjacent to these highs. Material for these deposits may have been supplied by either one or both of the adjoining uplifts, probably deeply eroded in Upper Proterozoic time.

The westermost low (D_8) along M'Clintock Channel is separated from the adjacent anomalies D_6 and D_7 by steep gradients. These may be partly due to these two local anomalies, but part of these gradients may indicate faulting between Upper Proterozoic rocks and gneisses. These metasedimentary quartzitic rocks, much as their equivalents on northwestern Prince of Wales Island (associated with D_5), may be connected with the Upper Proterozoic rocks outcropping on Victoria Island to the west (see Figure 1).

Aeromagnetic flight lines 6 and 9 (Map III) reveal anomalies which conform with the present interpretation. Flight line 6 (Figure 13b) indicates a magnetic high with moderate variations over gravity low D_4 (13a). Depth calculations suggest that the Paleozoic cover is only 300 m thick in this region, as compared with an estimated 1500 to 3000 m towards the Boothia Uplift. Across gravity high D_3 the magnetic field is relatively flat, although one would expect high-amplitude variations as on the Boothia Uplift. The increased thickness of Paleozoic rocks may blanket them.

Records along flight line 9 commence in Barrow Strait, north of Prince of Wales Island (Map III). A major increase in the magnetic anomaly is observed towards the south at the location of gravity low D_5 on northern Prince of Wales Island (see Figure 12c and d). This increase cannot be explained by thinning of the Paleozoic cover, because depth estimates are similar (3000 m) north as well as south of the increase. The conclusion must be that it is caused by Upper Proterozoic quartzitic rocks, which are outlined by gravity low D_5 (Map IV). Flight line 9 also overlies the northern tip of gravity high D_3 and terminates in the belt of negative anomalies D_4. Small amplitude variations with moderate frequencies are superimposed on a constant regional anomaly across this belt D_4 as well as across D_3. Differences of high-frequency variations of the magnetic field across the quartzitic rocks and the gneissic complex, as observed on Brodeur Peninsula (Figure 10a) may be obscured by the cover of Paleozoic rocks.

The Origin of the Northerly and Northeasterly Trending Structures of the Boothia Uplift and Adjacent Areas

What is the origin of the proposed series of northerly and northeasterly trending fault blocks of the area of study? They may perhaps be compared with similar features on the North American continent or in other parts of the world.

Systematic surveying of the gravity field over the Canadian Shield by the Gravity Division of the Dominion Observatory, Ottawa, has defined two major highs with which the Boothia Uplift and adjacent highs may be compared. The Kapuskasing high with northeasterly trend, located in northeastern Ontario, has recently been interpreted by Innes, *et al.* (1967). They suggest that the Kapuskasing high, which may connect to the midcontinental high of North America, is a manifestation of crustal rifting during late Precambrian time, as is the midcontinental high. The Kapuskasing high is thought to be caused by a rise of the lower layer of the crust. The Nelson River high, in northern Manitoba near the boundary of the Churchill and Superior (geological) provinces, is the topic of discussion by Gibb (1968) and Innes and Gibb (in press). Innes and Gibb point out that geological and geophysical similarities exist between the Kapuskasing and Nelson River belts. High-grade metamorphic rocks of the granulite facies, associated with gabbroic intrusives, occur along both belts. In both areas, the northeasterly trend of the fault-bounded zones cuts across the generally easterly trend of the surrounding Shield rocks. Intrusive rocks such as periodotite and alkaline intrusives, rising from deep-seated sources, are present.

In agreement with observations made on African rift systems (Bailey, 1964), Innes and Gibb suggest that both belts may occur along Archean orogenic zones. These zones may have been the preferred locations of renewed uplift, possibly in Proterozoic time, resulting in block faulting (the Kapuskasing belt) or leading to a new orogeny (the Nelson River belt).

The northerly-trending belt of the Boothia Uplift has features similar to the preceding examples from the Shield. The metamorphic grade of the crystalline basement is generally of the upper amphibolite facies, but in places as on Arcedeckne Island (Map III), garnet and pyroxene are abundant, indicating a higher metamorphic grade (granulite facies). Gabbro intrusions and ultramafic masses are common (Blackadar and Christie, 1963). Also, the northerly gravity trend interrupts the general (Archean) easterly trend, as observed on Baffin Island (Map II).

These similarities suggest that one large-scale system of such elongated belts with associated gravity highs originated in Archean time, and comprised zones of crustal warping and rifting, which later, in Proterozoic time, were sites of renewed crustal unrest. The Archean orogenic zones may have formed a conjugate set of belts with northerly and northeasterly trends (the northerly ones being not as common, perhaps). Crustal unrest of the Boothia Uplift and adjacent blocks in Proterozoic time resulted in a series of faulted blocks parallel to the trends of the ancient orogenic zone. The northeasterly trending high, east of the Boothia Uplift region (Map II), within subarea C, reflects a fault block parallelling the northeasterly-trending orogenic zone, similar to the Kapuskasing and Nelson River highs.

The conjugate pair of orogenic belts, as described, could have been formed by regional compression of the crust in Archean time. The results of this ancient event may still be reflected in the area of study by the two differently trending systems of gravity highs.

Residual Anomalies of Local Extent

Several local anomalies have already been mentioned in the description of the anomaly field. In this section, three areas of local anomalies will be discussed.

Local Residual Anomalies on Western Prince of Wales Island

The westermost positive belt of the series of gravity anomalies on Prince of Wales Island incorporates two local, approximately circular, anomalies (D_6 and D_7; see Map IV). The shape of the contours and the steep gradients bounding the anomalies suggest that they are due to relatively near-surface sources. From the observations on the Boothia Uplift it may be assumed that gabbroic intrusions and ultramafic masses are also associated with the proposed buried basement uplift on which the two local highs occur. The size of the local highs with diameters of 40 and 60 km, suggests that large ultramafic masses have been intruded into the basement ridge, and possibly into the overlying Paleozoic sedimentary rocks. Mafic intrusions in Lower Paleozoic rocks of Somerset Island are reported (Blackadar and Christie, 1963). About 50 km east of these local anomalies the thickness of the Paleozoic cover has been estimated at 300 m or more (Figure 13b). A hundred km north of this point a thickness of 3000 m or more was estimated (Figure 12c). The thickness of the Paleozoic cover apparently may vary over relatively short distances, and the basement may actually lie quite close to surface in the areas of local highs D_6 and D_7. An indication of intrusive activity in these areas may be the marked change of topographic relief at the sites of the anomalies. The extremely flat topography of the western part of Prince of Wales Island (elevations below 30 m) is broken by the Rawlinson Hills near anomaly D_6 (elevations of 80 m), and by Mount Cowie near anomaly D_7 (Figure 15). These elevated areas may reflect intrusive doming of the sedimentary strata. Dips of the beds cannot be determined, however, because of an extensive cover of glacial drift.

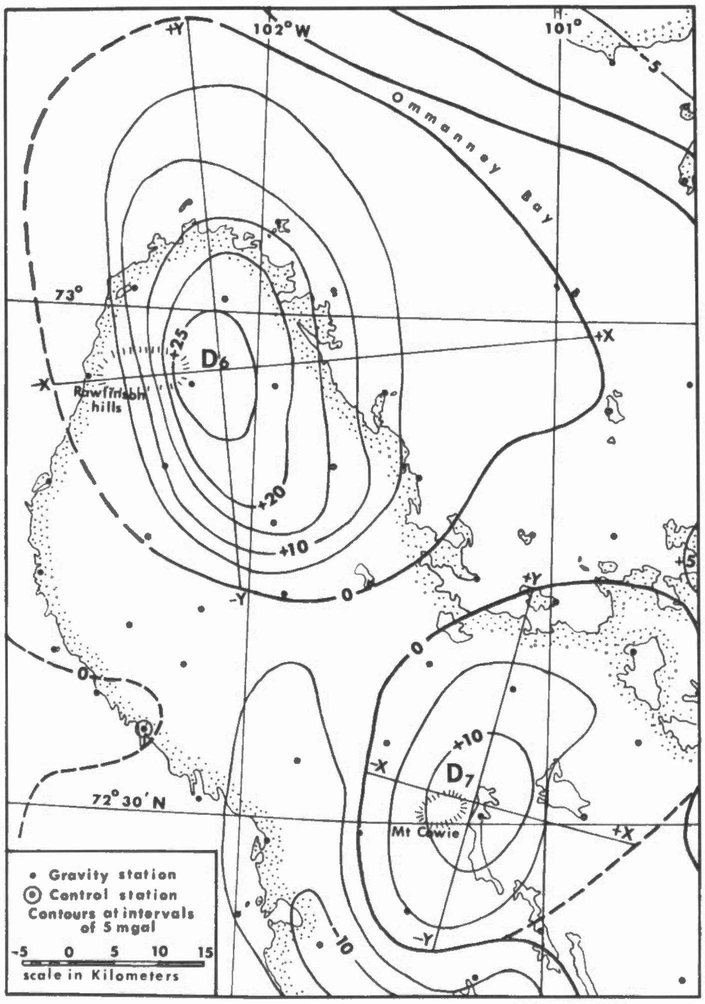

FIGURE 15. Residual anomaly map of western Prince of Wales Island.

The two local anomalies were separated from the regional background anomaly as for anomaly C_1. The regional was estimated to include the positive gravity effect of the buried basement ridge, on which the local anomalies are superimposed. Thus, a regional map can be produced, and from this a residual anomaly map (Figure 15). By extending the zero contours to a closed form to facilitate calculations, both anomalies D_6 and D_7 were delimited.

The excess of mass associated with the anomalies was estimated. Because of the circular shape of the anomalies, it is not permissible, in this case, to obtain the mass per unit length by integration in a cross-sectional profile. However, the apparent total mass excess can be computed from the expression

$$I = \int_{-x}^{+x} \int_{-y}^{+y} \Delta g(x,y) dx dy = 2\pi G \overline{M}$$

where $\overline{M}$ is the apparent total mass excess causing the anomaly $\Delta g(x,y)$. The directions x and y in a horizontal plane are arbitrarily chosen for each anomaly, and the intersections of these directions with the zero contours designate the limits of integration ($-x$ to $+x$ and $-y$ to $+y$; Figure 15).

The tailing-off factor may be determined by assuming the anomalous masses to be spherical bodies, and is used to relate the apparent mass excess to the true mass excess. The result of a derivation of this factor is found in Grant and West (1965, p. 270), which is

$$\overline{M}/M = 2/\pi \tan^{-1}\left(\frac{xy}{z\sqrt{x^2 + y^2}}\right) \tag{1}$$

If cylindrical coordinates are used, this derivation is somewhat easier and the result is then

$$\overline{M}/M = \left(1 - \frac{z}{\sqrt{R^2 + z^2}}\right) \tag{2}$$

in which z is the depth to the centre of mass, which may be calculated using the formula for a sphere: $z = 0.65\ \omega_{1/2}$; $\omega_{1/2}$ being the half-maximum width of the anomaly. x and y are measured on the residual anomaly map, as is R, the radius of the circle which approximately encloses the anomaly.

The double integral (I) may be obtained by finding the volume under the anomaly with a planimeter or by Simpson's rule if a rectangular grid is used. The results of the determination of I, x, y, R and z, and of the calculation of $\overline{M}$ and M and the tailing-off factor are summarized in Table 7. The numbers (1) and (2) indicate that the true mass excess was calculated from the apparent mass excess using Equations (1) and (2) (above), respectively.

Table 7

SUMMARY OF MASS EXCESS CALCULATIONS FOR RESIDUAL ANOMALIES D_6 AND D_7 ON WESTERN PRINCE OF WALES ISLAND

Anomaly	I	X	Y	R	z	Apparent Mass Excess $\overline{M}$	True Mass Excess M	Tailing-off Effect
	(mgal km)	(km)	(km)	(km)	(km)	($g \times 10^{15}$)	($g \times 10^{15}$)	(%)
						(1) 477	710	33
D_6	21300	30	32	32	12			
						(2) 477	742	36
						mean:	726	
						(1) 114	210	46
D_7	4790	15	20	18	10			
						(2) 114	234	51
						mean:	222	

The calculations show that anomalies D_6 and D_7 represent gravity effects of masses which differ by a factor of about three (726 and 222 $\times 10^{15}$ g, respectively; Table 7).

The depths to the centre of mass of both anomalous bodies (z), calculated at 12 and 10 km, are based on the assumption of perfectly spherical bodies. They are only approximate values and serve to calculate the tailing-off effect. The depths of the tops of the two bodies may be estimated by applying the rules for limiting depths to the top of anomalous bodies derived by Bott and Smith (1958), which state

$$d = (48\sqrt{5}/125)\, \Delta g_{max} / (d\, \Delta g(x)/dx)_{max} \qquad (3)$$

$$d = (3/2)\, \Delta g(x)/(d\, \Delta g(x)/dx), \text{ for any } x \qquad (4)$$

where Δg_{max} is the maximum gravity effect, and $(d\, \Delta g(x)/dx)_{max}$ is the maximum value of the function $d\, \Delta g(x)/dx$, the horizontal gradient of gravity. The limitation of these rules is that the density contrast of the anomalous body with its surroundings must be entirely positive or entirely negative. This condition is met if it is assumed that ultramafic masses intrude the crystalline basement.

For anomaly D_6 it was found that:

$$\Delta g_{max} = 28 \text{ mgal}$$

$$(d\, \Delta g(x)/dx)_{max} = 4.45 \text{ mgal/km, at } \Delta g(x) = 15.5 \text{ mgal}$$

This information, substituted in Equation (3), gives a maximum depth to the top of the body of 5.4 km, and in Equation (4) at the location of maximum horizontal gradient: 5.2 km.

These values are estimates of the maximum depth to the top of the body, and an estimate of the actual depth may be made using the formula for a buried step if it is applied to the steepest gradient of anomaly D_6 (Figure 15). This calculation yields a value for the maximum depth to the top $d_0 = 2.0$ km. The calculated thickness of the step (t) depends on the density contrast which then determines the actual depth. For a density contrast of 0.17 g/cm^3 between gabbroic rocks (2.93 g/cm^3) and gneisses (2.76 g/cm^3), the thickness is $t = 3.9$ km and the actual depth d_0 is 0.6 km. These values are $t = 1.2$ km and $d_0 = 1.4$ km if the density contrast is taken as 0.54 g/cm^3 between ultramafic rocks (3.30 g/cm^3) and gneisses.

The value of about 5 km calculated with Bott and Smith's rules for three-dimensional gravitating bodies is probably too high. The maximum depth of 2.0 km and an actual depth of 1.4 km, calculated for a two-dimensional buried step of ultramafic rocks, fit better into the range of estimates for the thickness of the Paleozoic cover (i.e., from 0.3 to 3 km).

Similar calculations were made for anomaly D_7, which yield for the values of its maximum gravity effect and maximum horizontal gradient:

$$\Delta g_{max} = 13 \text{ mgal}$$

$$(d\, \Delta g(x)/dx)_{max} = 0.76 \text{ mgal/km at } \Delta g(x) = 7.6 \text{ mgal}$$

Applying the rules for the maximum depth to the top yields values of 14.7 km (Equation (3)) and 15 km (Equation (4)), obviously much too high for an actual depth. If, as for anomaly D_6, a buried step is assumed, a maximum depth to the top of the step of 5.4 km is calculated. The thickness of the step is 1.8 km and the actual depth to the top is 4.6 km, if a gabbroic mass is assumed to intrude the basement. For an ultramafic body the thickness is 0.6 km and the actual depth is 5.2 km. These calculations indicate that the smaller mass associated with anomaly D_7 lies at a greater depth (3 to 4 km deeper) than the mass of anomaly D_6.

The volumes occupied by the masses underlying both anomalies may be calculated from the results of mass excess calculations (Table 7) by assuming ultramafic rocks with a density contrast of 0.54 g/cm^3 with the surrounding gneisses. The results are: a volume of 13.4 $\times 10^{17}$ cm^3 for anomaly D_6, and a volume of 4.1 $\times 10^{17}$ cm^3 for anomaly D_7. If it is further assumed that the anomalous bodies in reality approach vertical cylinders, with heights equal to the thickness (t) calculated for buried steps, a diameter of 38 km for mass D_6 and 30 km for mass D_7 results.

Local Anomaly B_1 of Southwestern Bylot Island

A conspicuous local anomaly occurs in the southwestern corner of Bylot Island and presumably extends into the adjacent water of Eclipse Sound (Map IV). The anomaly is added to a gravity field which gradually increases from west to east. To separate anomaly B_1 from the regional, a profile (Q_1-Q_2) was drawn from central Borden Peninsula through the area of the anomaly and through the remainder of Bylot Island (Figure 16, Map II).

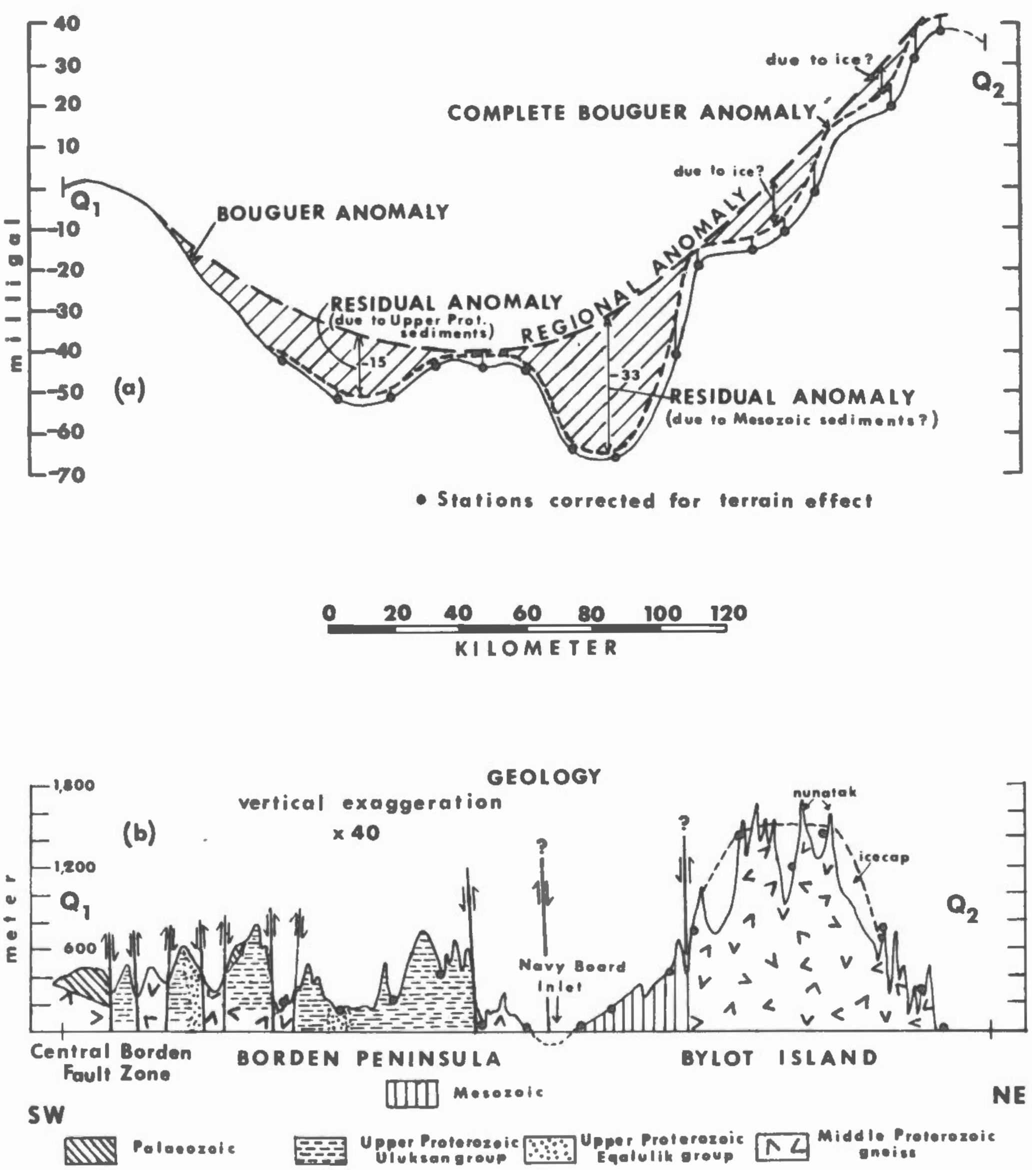

FIGURE 16. Profile Q_1-Q_2 through Bylot Island (location on Map II). Terrain corrections applied to 16 stations along the profile.

Before the regional was estimated, stations along or close to the profile were tested for possible effects of terrain because the rugged terrain on Bylot Island (Figure 16b) might influence the gravity observations. Computations were made for 16 stations. The resulting corrected anomaly (the complete Bouguer anomaly) is represented by a dashed line (Figure 16a), and shows that only minor corrections were applied, the largest amounting to 4.2 mgal.

The regional was then estimated by drawing a smooth curve through the corrected Bouguer anomalies, which resulted in the delineation of two negative anomalies along the profile. The low in the southwestern portion is low C_2 (Map IV), the other being B_1 of the present discussion. They are separated by a high, probably related to high C_3 associated with the Navy Board Structural High. This high was assumed to represent the gravity effect of normal rocks, i.e., rocks of the crystalline basement with a mean density of 2.68 g/cm^3, which occur here as the southeastern limb of the Navy Board High (Map I, and Figure 16b). The Bouguer anomalies of about −35 mgal observed in this area of basement rocks were therefore assumed to represent the regional anomaly, and the regional of the profile was drawn through this level of −35 mgal (Figure 16a). Anomaly C_2 has a magnitude of −15 mgal, and anomaly B_1 is −33 mgal with respect to this regional.

As already noted, anomaly C_2 is probably due to Upper Proterozoic quartzitic rocks in fault contact with the gneissic complexes of the Central Borden Fault Zone and of the Navy Board High (Figure 16b).

Residual anomaly B_1 (−33 mgal) is delimited by ellipsoidal contours with steep gradients (Map IV), which may indicate a near-surface source. Mesozoic sedimentary rocks have been reported in this area by geologists of the Geological Survey of Canada (Map I). This suggests that perhaps a local basin, probably tectonically formed, filled with low-density clastic

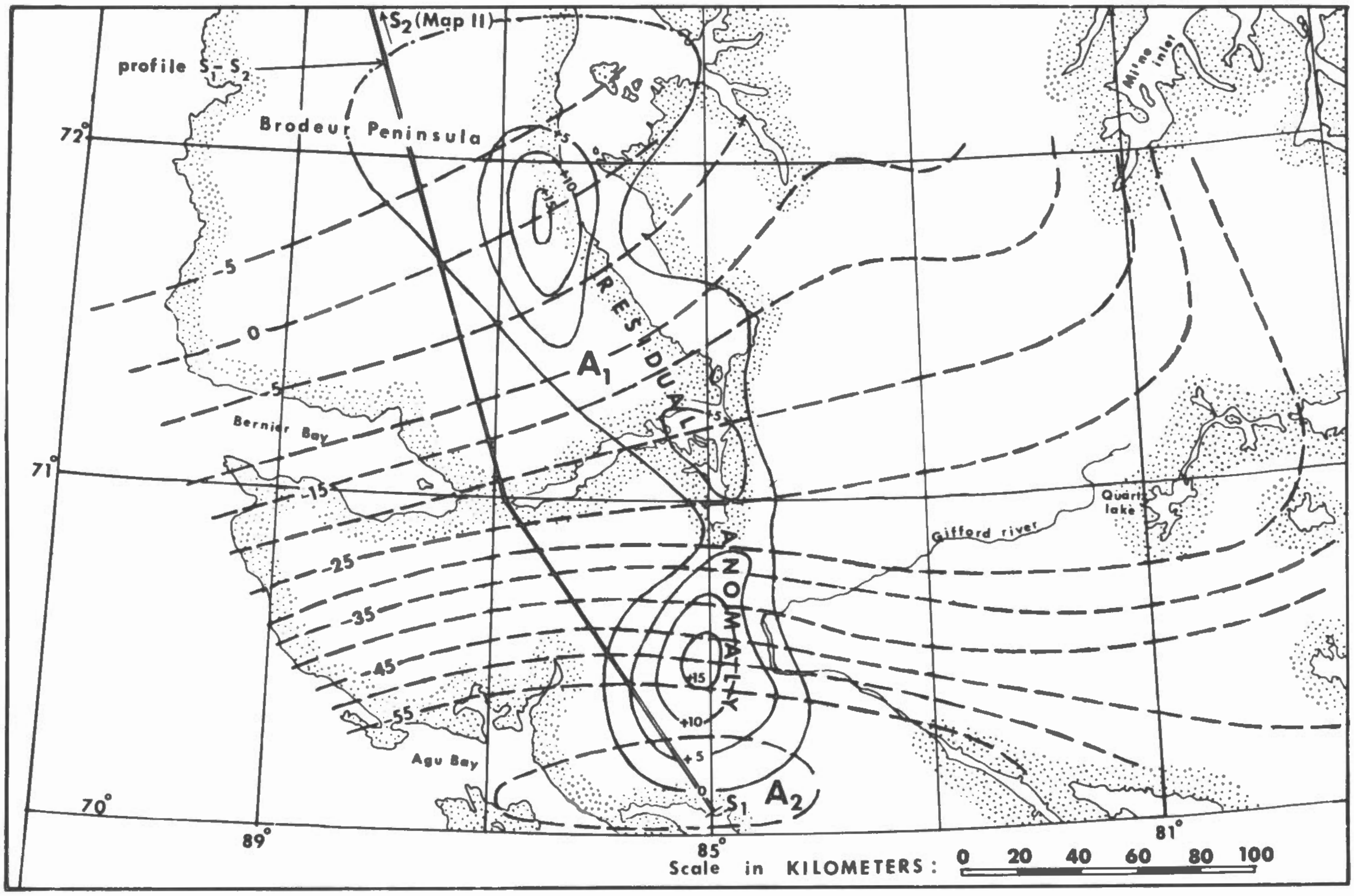

FIGURE 17. Map of residual anomaly 'ridge' on southern Brodeur Peninsula. Regional trend in dashed contours. All contour intervals are 5 mgal.

rocks of Mesozoic age, causes the negative gravity anomaly. The basin may be a graben associated with the adjacent Navy Board horst to the west; the latter seems to have developed in Precambrian time (Trettin, 1965).

If the Mesozoic sedimentary rocks have a density of 2.56 g/cm^3, similar to that of clastic rocks of that age in the Sverdrup basin to the north (Sobszak, 1963), a density contrast of 0.12 g/cm^3 with the gneisses of northern Baffin Island (2.68 g/cm^3) exists. From the formula for an infinite slab of rock, the thickness of these Mesozoic rocks is calculated at about 6 km. The presence of the high mountains of Bylot Island to the east of this basin may explain how such a thick sequence could have accumulated. An alternative solution involves postulation of low-density granitic intrusions within the basement beneath the Mesozoic sedimentary rocks, which, if present, must be fairly thin.

A few smaller negative anomalies occur along the profile (Figure 16a) in the mountains of Bylot Island, east of low B_1. They are probably due to icecaps covering the crystalline rocks. The extremely low density of ice must have caused a considerable error in the Bouguer correction term, in which a slab of rock with a density of 2.67 g/cm^3 is assumed. Anomalies of −7 and −11 mgal with respect to the proposed regional are present (Figure 16a). A more detailed survey may define these anomalies more precisely. If a density contrast of 1.77 g/cm^3 between the gneissic rocks (2.68 g/cm^3) and ice is assumed (ice having a density of 0.91 g/cm^3 (Spector, 1966)), the thicknesses of these icecaps are calculated to be 93 and 147 m, respectively.

An Anomaly Ridge on, and South of, Brodeur Peninsula

A local residual anomaly (A_1) northeast of Agu Bay on northern Baffin Island is readily seen on the Bouguer anomaly map (Map II). Deflections of the regional contours, in fact, occur along a continuous and narrow zone extending from this area northward to the southern end of Admiralty Inlet and from there towards the northeast, into Brodeur Peninsula (see Figure 17, and Map IV).

This zone of anomalies was separated from the regional by smoothing the contours of the Bouguer map (Figure 17). By determining the differences between these smoothed contours and the Bouguer anomalies at points of intersecting contours, a residual anomaly map was produced. Figure 17 shows that a long and narrow zone of residual anomalies exists. Northeast of Agu Bay the residual anomalies are as high as +15 mgal, but they decrease towards the north to +5 mgal, while on Brodeur Peninsula a high of +15 mgal is again reached. This high of +15 mgal has already been discussed and it was proposed that because high-amplitude magnetic variations are observed as well, gabbroic rocks must occur beneath the Paleozoic cover.

The remainder of the ridge of positive anomalies may be explained by similar rocks of gabbroic composition intruding the basement and, because of the zonal occurrence, probably tectonically controlled. At the southern termination of Admiralty Inlet along which the anomaly ridge extends, Paleozoic rocks have been removed by erosion and Precambrian crystalline rocks outcrop (Map I). The geology of this area was adapted from a map by Trettin (1965). Crystalline rocks also lie along the extension of the anomaly ridge from Admiralty Inlet towards the south and extend to the area east of Agu Bay occupied by Upper Proterozic quartzitic rocks. The fact that the residual anomaly ridge terminates where these quartzitic rocks outcrop strongly suggests that the anomaly is associated with Precambrian crystalline rocks.

Unfortunately, although the area was mapped by the Geological Survey of Canada (Blackadar, 1958), not much is known about these rocks. The preliminary map of this region (Fury and Hecla Strait, Map 3-1958) indicates that much of the basement in the area of the positive anomaly ridge is covered by glacial drift. Crystalline rocks of granitic composition (mainly granitic gneiss) outcrop here and there, and it may perhaps be assumed that much of the basement in this area is comprised of these rocks.

While these granitic rocks on a regional scale cause a gravity low (Figure 10b), heavier intrusive rocks may be associated with them at the site of the positive residual anomaly. Gabbroic sills and dykes are abundant to the south within the crystalline basement and in the Upper Proterozoic quartzitic rocks, but whether or not they are associated with anomaly A_1 is not known.

It may be, on the other hand, that the positive anomaly belt is due to a complex of mafic metavolcanic rocks within the granitoid massif, similar to the basement rocks in the area of the Mary River iron deposits about 200 km to the east (Gross, 1966).

Summary and Conclusions

This gravity study forms part of a series of scientific investigations by the Canadian Government and other institutions into the upper crust of the southwestern sector of the Canadian Arctic Archipelago. Without doubt many refinements of the observations, and consequently of the interpretations, will be made. Additional geophysical work, together with more detailed studies of the gravity field, will provide better data for quantitative interpretation. Further geological field work will be necessary to provide a basis for sound interpretation, especially for the Precambrian crystalline basement rocks of northern Baffin Island.

The large area investigated, and the limited amount of information available, have precluded any detailed studies, but several important generalizations are possible. The map of Bouguer anomalies was subdivided into four areas marked by distinctly different trends. Interpretations of these subareas will now be summarized.

1. The area of study incorporates four separate systems with different regional trends of Bouguer anomalies. Two of these (subareas C and D) may be caused by rift systems, founded on two related ancient orogenic zones. These may have counterparts on the main Canadian Shield.

2. Major negative anomalies occur throughout the area. They are associated with thick accumulations of Upper Proterozoic metasedimentary rocks (quartzitic) on Borden Peninsula (anomaly C_2) and at Agu Bay (A_2). The extension of anomaly C_2 to the west suggests that similar quartzitic rocks occupy a basin beneath the Paleozoic cover of Brodeur Peninsula (anomaly C_1). Other gravity lows (C_2, C_6, D_2, D_4, D_5 and D_8) on Somerset and Prince of Wales islands are thought to mark the sites of equivalent Upper Proterozoic clastic rocks; where information is available, magnetic highs are associated with these gravity lows. The gravity field apparently maps numerous basins of Upper Proterozoic sedimentary rocks and the trends suggest that most of these basins are interconnected (see Map IV).

3. The two systems of northerly and northeasterly trending anomalies (subareas C and D) may be caused by a series of fault blocks with northerly and northeasterly trends. The Boothia Uplift is one of three northerly trending blocks, with an associated gravity high, separated from the adjacent blocks by troughs filled with Upper Proterozoic quartzitic rocks marked by gravity lows. This situation may repeat itself for alternating belts of gravity highs and lows on Prince of Wales Island. The Boothia Uplift presumably continues north of Barrow Strait, but is offset to the west (Gregory, *et al.*, 1961). This may not be true; instead the northerly structures north of Barrow Strait may form the extension of the proposed basement ridge D_3, through Prince of Wales Island, parallel to the Boothia Uplift.

4. The Boothia Uplift appears to have developed asymmetrically. The west side is probably thrust over Upper Proterozoic quartzitic rocks, causing a gravity low at this margin which continues some distance westward to a basin of quartzitic rocks. The east side of the uplift is quite different. It has no negative gravity anomalies, no evidence of thrust faults, but instead has tension faults, and finally it lacks conglomerate deposits where these do occur on the west side.

5. Large masses of ultramafic rocks probably intrude the uplifted basement ridge of western Prince of Wales Island. Calculations suggest that they may lie at a depth between 1.5 and 5 km.

6. A long, narrow zone of gabbroic or mafic metavolcanic rocks may lie within the granitoid basement on and south of Brodeur Peninsula (anomaly A_1).

7. A local negative anomaly (B_1) on southwestern Bylot Island is probably caused by Mesozoic rocks accumulated in a structural basin adjacent to the Navy Board horst.

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