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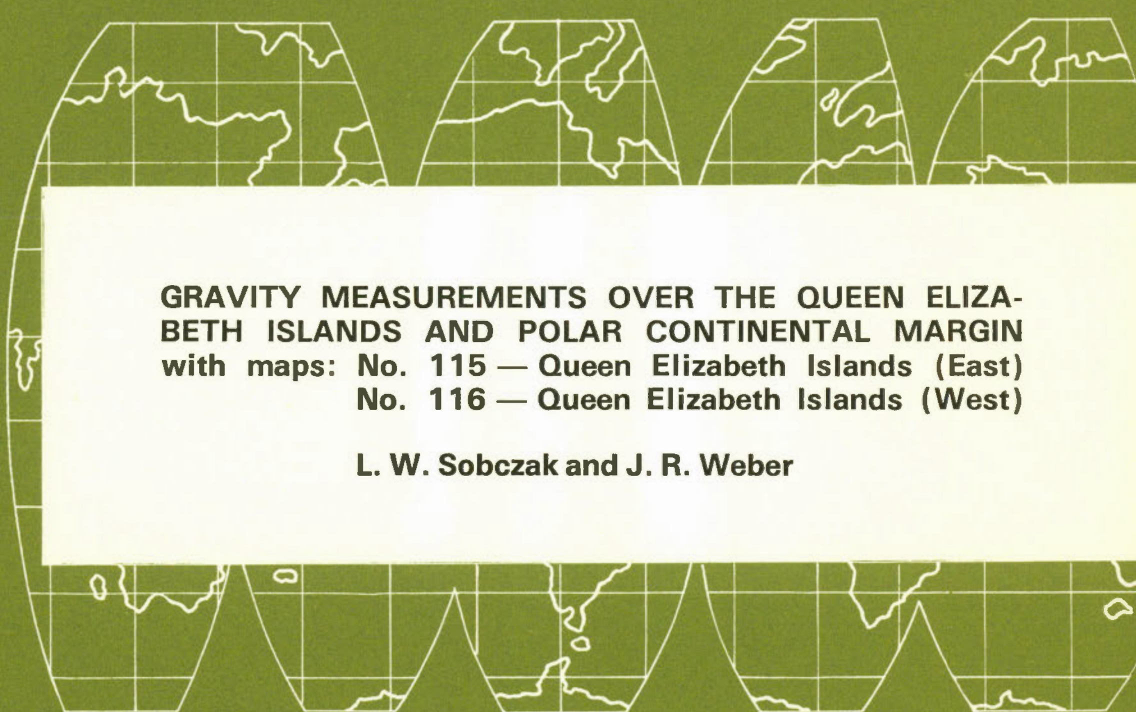

GRAVITY MEASUREMENTS OVER THE QUEEN ELIZABETH ISLANDS AND POLAR CONTINENTAL MARGIN

with maps: No. 115 — Queen Elizabeth Islands (East)
No. 116 — Queen Elizabeth Islands (West)

L. W. Sobczak and J. R. Weber

DEPARTMENT OF ENERGY, MINES AND RESOURCES

OTTAWA, CANADA 1970

GRAVITY MAP SERIES

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Frontispiece. Regional gravity surveys over the Arctic Ocean beyond 150 km from land, can best be carried out from an ocean camp on the polar ice made up of light weight portable insulated huts.

The senior author is shown measuring gravity with thermally-controlled, damped Worden and LaCoste and Romberg gravimeters some 200 km west of Prince Patrick Island.

GRAVITY MEASUREMENTS OVER THE QUEEN ELIZABETH ISLANDS AND POLAR CONTINENTAL MARGIN

L.W. Sobczak and J.R. Weber

ABSTRACT - The Dominion Observatory has made about 8,800 gravity measurements over the Queen Elizabeth Islands and Arctic Ocean between 1960-1968. Measurements were made both on land and on the sea-ice of the ocean and inter-island areas.

The Bouguer anomaly field shows that negative anomalies occur over sedimentary basins and mountainous areas, positive anomalies occur along moderately folded regions and large positive anomalies occur over the ocean. With the exception of the anomalies over the ocean and mountainous regions, the anomalies correlate well with (1) changes in lithologies of Paleozoic and Precambrian rocks, (2) evaporite and basic rocks, and (3) changes in thicknesses of clastic and carbonate sediments.

The Archipelago region west of 90°W longitude has a mean elevation of 15 m and an average Bouguer anomaly of 6 mgal and appears to be in isostatic equilibrium. This suggests that the large thickness (10 km) of clastic sediments is compensated.

RÉSUMÉ - Au cours de la période 1960-1968, l'Observatoire fédéral a effectué près de 8,800 relevés gravimétriques au-dessus des îles Reine-Élisabeth et de l'océan Arctique. Les mesures ont été effectuées sur la terre et sur les glaces océaniques et régions inter-insulaires.

Le relevé des anomalies de Bouguer indique que les anomalies négatives se trouvent au-dessus des bassins sédimentaires et des régions montagneuses, les anomalies positives le long des zones modérément plissées, et les anomalies positives importantes au-dessus de l'océan. A l'exception des anomalies relevées au-dessus de l'océan et des régions montagneuses, elles correspondent parfaitement: 1) aux modifications lithologiques des roches paléozoïques et précambriennes, 2) aux roches basiques et aux évaporites, et 3) aux différences d'épaisseur des sédiments clastiques et carbonatés.

La région de l'Archipel, à l'ouest de 90° de longitude W, a une élévation moyenne de 15 m et une anomalie de Bouguer moyenne de 6 mgal et semble être en équilibre isostatique. L'équilibre laisse supposer que l'épaisse couche de sédiments clastiques (10 km) est compensée.

INTRODUCTION

In 1957 systematic gravity surveys began in the Arctic Archipelago. At that time the Dominion Observatory extended the Canadian gravity control network from Churchill, Manitoba to Eureka, Resolute Bay, Mould Bay, Isachsen and Alert using the North American gravimeter No. 137 (Bancroft, 1958). In 1958 during the International Geophysical Year during Operation Hazen, F.S. Grant established gravity control stations at Lake Hazen and at Clements Markham Inlet (Weber, 1961), while Weber and Sandstrom completed some 300 detailed gravity observations from Clements Markham Inlet across the United States Range to Lake Hazen and along Ruggles River to Chandler Fiord (Weber, Sandstrom, and Arnold, 1960; Weber, 1961). Worden gravimeters No. 10 and No. 44 were used for the control stations and for the secondary stations, respectively.

Between 1960 and 1968 nearly 8,800 gravity observations were made over the islands and inter-island waters of the Arctic Archipelago as well as over the adjoining Arctic Ocean (Figure 1). The measurements were made by personnel of the Earth Physics Branch (formerly Dominion Observatory) in co-operation with the Polar Continental Shelf Project, both of the Department of Energy, Mines and Resources. Table I lists by year of operation, the number of gravity stations established, the instruments used, the names of the observers and the areas of coverage. Most of these stations were spaced at approximately 10 km grid intervals with a greater concentration of stations over outstanding surficial features such as icecaps and gypsum domes (Spector, 1966; Spector and Hornal, 1970). The regional gravity results have already been presented for various parts of the area (Sobczak, 1963; Weber, 1963; Sobczak, Weber, Goodacre and Bisson, 1963; Berkhout and Sobczak, 1967; Picklyk, 1969). Structural interpretations of the major gravitational features have been made for the Isachsen area (Sobczak, 1963), for the continental margin region (Weber, 1963), for the western part of the Queen Elizabeth Islands and the continental margin (Sobczak, Weber and Roots). Rock densities which are essential to meaningful interpretations are discussed by Sobczak (1963), Berkhout and Sobczak (1967), Picklyk (1969), and Sobczak, Weber and Roots (1970). The geology and tectonic history which provide surface control for structural models for the area have been described by various authors and are summarized by Sobczak, Weber and Roots (in preparation).

This report presents the combined results of all the gravity surveys within the region bounded by latitude 74°N to 82°N and longitude 60°W to 141°W. The area is delineated in Figure 1. The dotted areas represent previously published regions, the cross hatched areas represent new data.

The survey procedures, the accuracy of the measurements and the Bouguer anomaly field are described. The Bouguer anomalies, which were computed using a computer oriented system (Tanner and Buck, 1964), are presented in two maps at a scale of 1:1,000,000.

REGIONAL GRAVITY SURVEYS

Survey Procedures

The operational methods by which gravity surveys are carried out in the Arctic are governed (1) by the type of navigation available, (2) by the condition of the ground (whether observations are taken on snow-covered or snow-free land, over ice-covered inter-island waters, or over the ice-covered ocean), and (3) by the season of the year. Except for summer surveys over the islands, where maps and air photos were used for navigation, the stations were positioned by Decca. The areas where Decca coverage was available are shown in Figure 2.

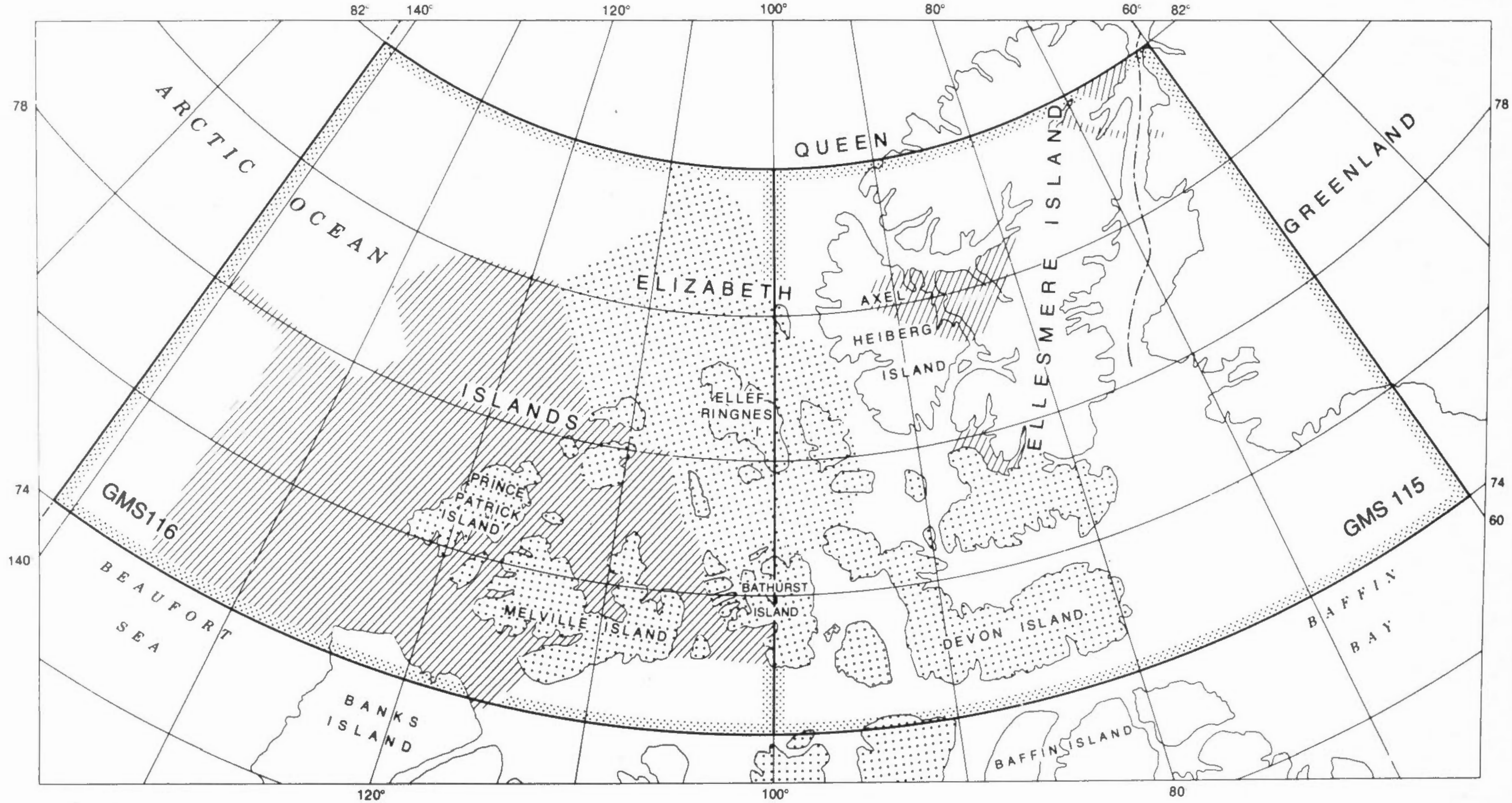

Figure 1. Location of Queen Elizabeth Islands (east and west maps). The dotted regions show the areas which have been published and the hachured regions show the additional survey areas included in this report.

TABLE I

History of Surveys in the Canadian Arctic Archipelago

Year	No. of Gravity Stations	Instrument No.	Personnel	Area of Investigation
1960	719	W 460	R.K. McConnell	Ellef and Amund Ringnes Islands
			L.W. Sobczak	Prince Gustaf Adolf Sea, Peary Channel
		W 573	R.W. Hornal	Meighen Island Ice Cap, and gypsum domes on Ellef Ringnes Island.
1961	1198	W 573	L.W. Sobczak	Arctic Ocean, Peary Channel, Ellef
		W 460	R.W. Hornal	Ringnes, Amund Ringnes, Devon,
		H 2G	J.R. Weber	Cornwall, Bathurst and Cornwallis Islands.
1962	1287	W 460	L.W. Sobczak	Melville, Prince Patrick, Brock and
		G 25A	J.L. Bisson	Mackenzie King Islands, Arctic Ocean,
		W 573	A. Spector	Prince Gustaf Adolf Sea and northern
			A.K. Goodacre	Ellesmere Island.
1963	578	G 25A	J.R. Weber	Arctic Ocean, Prince Gustaf Adolf Sea,
		W 573	L.W. Sobczak	Melville Island Ice Caps, Devon, Graham,
			A. Spector	Ellesmere and Axel Heiberg Islands.
1964	551	G 25A	L.W. Sobczak	Arctic Ocean, Byam Martin Channel.
		H 2G	J.R. Weber	
		W 573	P.J. Winter	
		G-7&G-9		
1965	1232	G 25A	L.W. Sobczak	Arctic Ocean, Ballantyne Strait,
		H 2G	B.G. Brule	Somerset and Prince of Wales Islands.
		W 573	A.W.J. Berkhout	
		G 74	A.S. Buchan	
		G 9		
1966	1190	W 573	L.W. Sobczak	Hecla and Griper Bay, Arctic Ocean,
		G 25A	B.G. Brule	northern Ellesmere and Baffin Islands.
		W 460	A.W.J. Berkhout	
			L.E. Stephens	
1967	906	W 573	J.R. Weber	Arctic Ocean, Crozier Channel,
		G 139	L.E. Stephens	Lincoln Sea, Devon and Ellesmere Islands.
		H 2G	D. Picklyk	
		G 25A		
1968	1100	G 172	L.W. Sobczak	Arctic Ocean and McClure Strait.
		G 173	P. Fernandez-Davila	
		G 25A		
		W 573	D. Todd	
Total	8761			

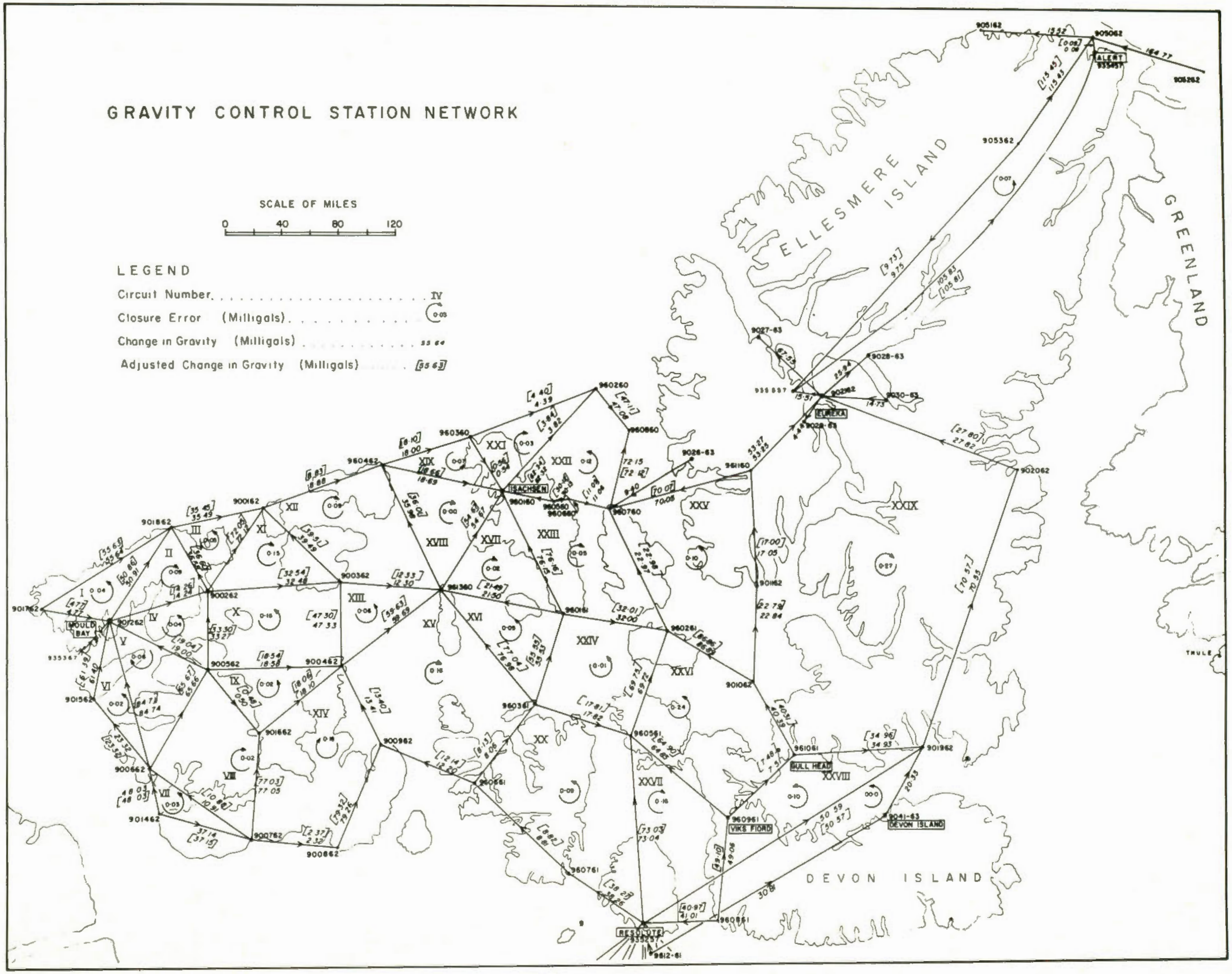

Figure 2. Location of five Decca chains showing the 75 per cent repeatability contours in metres during summer daylight propagation.

The regional gravity stations were established using helicopters for transportation (Bell 47G, 47G2, 47G2A, 47G4, 204B, 205A, and Sikorsky S55) and fixed-wing aircraft for logistic support (single engine Otters, Beechcraft, DC-3, DC-4, and Bristol Freighter).

Island and inter-island surveys. Island and inter-island surveys were usually carried out during the spring and early summer using small helicopters, such as the Bell 47G2A, for transportation. The field camps, which were located at gravity control stations about 100 km apart, consisted of four tents and four men (pilot and engineer, gravity observer and assistant). PRT-20 radios were used to communicate with the base camp of the Polar Continental Shelf Project. The field camp, which could be moved in two Otter loads, was usually moved about once a week.

For land surveys over bare ground, maps and air photo mosaics were used for positioning whereas over snow-covered ground and over inter-island waters Decca was used for navigation and positioning. Inter-island surveys require knowledge of the water depth at each gravity station. If the survey was in an area of good Decca coverage where the Canadian Hydrographic Service had previously sounded the water depth, gravity stations were established at the locations previously occupied by the hydrographers. In areas of poorer Decca coverage and in areas that had not been previously sounded, depth soundings were made by either the gravity observer or by a hydrographer who accompanied the gravity observer. The latter case required a larger helicopter and a correspondingly larger camp and the survey was carried out in the same way as the ocean surveys described below. On a good working day two to three gravity traverses with 12 observations each could be completed.

Off-shore ocean surveys. The gravity surveys over the continental shelf and beyond were integrated with the hydrographic surveys of the Polar Continental Shelf Project. Sikorsky S-55 helicopters were used until recently when the turbine-powered Bell 204B's and 205A's helicopters, equipped with long range tanks replaced them.

The surveys close to shore were carried out from bases on land, usually from Decca transmitter stations or from the main base of operations. The surveys over the outer part of the continental shelf required the establishment of an ocean camp some 100 to 200 km off-shore. The camp and the fuel for the helicopters were moved by ski-equipped, single-engine Otter aircraft, DC-3 and Bristol Freighter on balloon tires. The camp was usually located on a smooth floe of old polar ice. Ocean camps were established in 1961, 1962, 1967 and 1968 but no suitable locations were found in 1964, 1965, and 1966, and the survey had to be carried out from a land base.

In recent years the ocean camp was manned by a party of 12 (two pilots, two engineers, four hydrographers, two gravity observers, one cook, and one assistant) and comprised three 16 by 20 foot Parcoll huts (see frontispiece) which served as sleeping quarters, office, and mess. An additional tent housed the diesel generator which supplied the electric power for the camp. The office hut contained the radio transceiver, the Decca type 80A receiver and the radio beacon.

The regional gravity-hydrographic ocean surveys were carried out by a gravity and hydrographic observer sharing one large helicopter. Gravity readings and depth soundings could be completed in about three to four minutes after the helicopter landed at a station. Under normal working conditions, and using the turbine-powered helicopters, about 20 sets of observations could be taken in a five-hour traverse.

Measurements

The degree of reliability of the Bouguer anomaly values is dependent on (a) the quality of the control station gravity value, (b) the accuracy of the gravity interval measurement between the control station and the point of observation, (c) the accuracy of the elevation and water depth measurements, (d) the positional accuracy, (e) the knowledge of the terrain effect, and (f) the speed and direction of the ice drift for ocean stations.

Control station values. The network established by base-looping (Nettleton, 1940) was found to have, before adjustment, closure errors not exceeding 0.27 mgal (Figure 3). A booklet giving base station descriptions and their adjusted gravity values has been prepared (Winter and Perrier, 1968) and is available on request. All gravity values are based upon a value of 982.86297 cm/sec^2 adopted for the gravity base station in Resolute Bay.

Regional station values. Gravity measurements on land and on solidly frozen sea ice between the Arctic Islands were mostly carried out with temperature-controlled, damped Worden gravimeters. The r.m.s. error of all the gravity interval measurements between control stations and detail stations is about ±0.04 mgal. Gravity observations on moving ice, particularly over the continental shelf, where the accelerations due to the wave motion of the ice may amount to several milligals, were made with damped LaCoste and Romberg gravimeters some with electronic beam position indicators. The period of the ocean waves lies in the 5 to 100 seconds range (Hunkins, 1962). The sum of all the vertical accelerations due to the wave motion is zero if averaged over a sufficiently long period of time. To save helicopter fuel the time allotted to carry out a gravity observation and a depth sounding during traverse is limited to about three minutes. The averaging process is therefore incomplete and results in an estimated r.m.s. error of the gravity measurements ranging from ±0.1 to ±0.3 mgal depending on the nature of the wave motion.

Another consideration is the frequency with which gravity ties from a drifting ocean camp to control stations on land can be made. If handled carefully, as on shipborne operations, the drift of the LaCoste and Romberg meter rarely exceeds 0.5 mgal per month; but if transported by helicopter, vibration induced drift may occur which is irreversible and which has been observed to amount to as many as 4 mgal over a few minutes. When operating from an ocean camp it is therefore important (1) to use carrying cases which are equipped with mechanical isolators which protect the instruments from vibrations (Hamilton and Brule, 1967), (2) to monitor gravity at the ocean camp with a separate gravimeter which is never moved during the whole operation, and (3) to carry out land ties as frequently as possible. Vibration-induced drift on ocean surveys may have occurred occasionally during the surveys but it is unlikely to have exceeded one milligal without being detected.

Elevation and water depth measurements. On land station elevations were determined barometrically. In the Queen Elizabeth Islands, where most of the terrain is relatively flat, the error in the elevation determination is estimated to be ±3 m corresponding to an uncertainty in the Bouguer anomaly of ±0.6 mgal (Sobczak, 1963). Over the polar ice on the ocean, uncertainties in station elevation are caused by the varying thickness of the snow cover. The uncertainties are estimated at ±0.6 m corresponding to an uncertainty in the Bouguer anomaly of ±0.16 mgal.

A variety of acoustic transducers, such as Edo sounders 9004 and 9006, were used for depth sounding over inter-island waters and over the continental shelf to depths of about 1,000 m. The technique of sounding through the ice has been described by Eaton (1963). The soundings have a reading error of about ± 2 m.

Until and including 1967, deep water soundings beyond the continental shelf were carried out with seismic reflection instruments having a reading accuracy of about ±1 m for a known water velocity. Small charges (1/4 to 1 lb) of geogel were used to provide seismic energy. In 1968 all soundings were carried out with echo

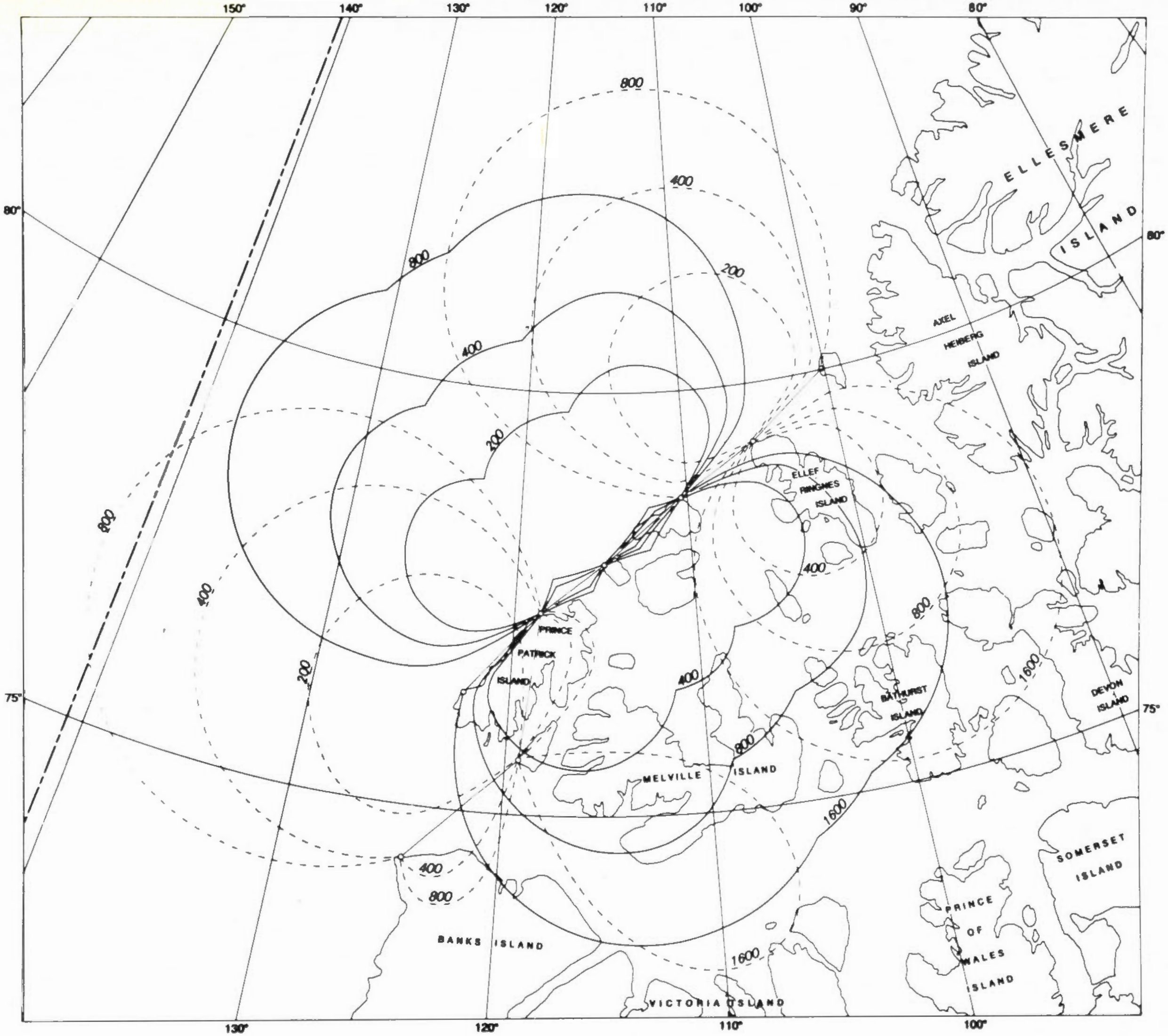

Figure 3. Gravity control station network.

sounders. However, these sounders had electro-mechanical devices incorporated for measuring time intervals which for deep soundings, may have introduced errors of as many as $\pm$60 m or about $\pm$4.1 mgal in the Bouguer anomaly. In 1969 modern high precision acoustic transducers were introduced which measure travel times to an accuracy of $\pm$ millisec corresponding to a travel distance of $\pm$0.7 m. Acoustic travel times are converted to water depths using Matthews' tables (1939). Although over the continental shelf (depth 600 m) the depth-velocity relationship of the tables are in agreement with observed water velocities (Collin, 1960) there are no reliable checks on the accuracy of the tables for depths exceeding 3,000 m and Matthews' tables may be in error by up to 2 per cent of the depth. This points to an urgent need for more precise water-velocity determinations in Arctic waters.

Determination of position. Most of the stations were positioned by a Decca 6f Lambda survey system used in hyperbolic mode. A description of the Decca navigational and survey system has been published by the International Hydrographic Bureau (1956). Figure 2 shows the position of the Decca chain, which was moved five times along the coastline of the Queen Elizabeth Islands over a nine-year period.

It also shows the 75 per cent repeatability accuracy (contours in metres) of the decca chain during summer daylight as published by the manufacturers. This is an indication of the internal accuracy of the system. Because the ocean is a more homogeneous conductor with fewer seasonal changes in conductivity than the island and inter-island areas, a Decca fix on the ocean is about twice as accurate as a Decca fix at equal distance from the baseline on the landward side. In order to gain an estimate of the absolute accuracy of the Decca positions on the ocean side of the baseline, comparisons with careful astronomical observations were made at 20 different points on the ocean. At each station several hours of sun observations were taken which were reduced by a method developed by Lillestrand, Grosch, and Vannelli (1967). The mean departure between Decca and astronomical positions was less than 1,000 m (Anderson and Mahaffy, 1969). It is estimated that the absolute position accuracy of stations located at the extremity of the Decca range vary from 1,600 m for ocean stations to 3,200 m for stations on the landward side of the baseline. If these were latitude errors this would correspond to Bouguer anomaly errors of 0.5 and 1.0 mgal, respectively.

Terrain effect. Over most of the Queen Elizabeth Islands the topography is flat resulting in small terrain effects which were neglected. In Devon and Ellesmere Islands where the topography is more rugged, the terrain effect may contribute up to 10 mgal error to some of the Bouguer anomalies (Picklyk, 1969). Terrain effects were not calculated because detailed topographic maps are not available.

Effect of station drift. Gravity observations taken from the drifting polar ice are affected by the Coriolis force. Gravity changes proportionally to the drift rate; it increases when the drift is westerly and decreases when the drift is easterly (Eötvös effect). This effect is given by $\Delta G = -4.05\, \upsilon \cos\phi \sin\varphi$ (Heiskanen and Vening Meinesz, 1958) where ΔG is the change in gravity in mgal, υ is the drift speed km/hr., ϕ is the geographical latitude, and φ is the drift direction. For instance, the gravity change for a station drifting at 78° latitude at 0.2 km/hr in an easterly direction will be -0.17 mgal. During the survey season (March and April) it is estimated that the average speed of the ice drift for stations beyond the land-locked ice on the continental shelf will range between 0.05 and 0.35 km/hr. Usually the drift rate is unknown when observations are made and consequently no Coriolis corrections were applied.

THE BOUGUER ANOMALY FIELD

Geological Setting

Figure 4 shows the Arctic Archipelago divided into five structural provinces (after Thorsteinsson and Tozer, 1960). The Precambrian Shield is exposed to the south and to the east of the region. To the north and to the west it underlies a relatively thin belt of late Precambrian and Paleozoic rocks known as the Arctic Lowlands. Farther to the north and to the west the Paleozoic marine formations thicken considerably and become, over most of the region, miogeosynclinal in character. These formations, known as the Franklinian Geosyncline, experienced major orogenic disturbances between late Devonian and middle Pennsylvanian time which produced the Parry Island, the Cornwallis, and the Ellesmere Island fold belts which lie parallel to the geosynclinal axis. To the north and to the west the Precambrian formations are overlain unconformably by the Sverdrup Basin, a very thick sequence of shallow water deposits ranging in age from Permo-Carboniferous to early Tertiary. These rocks, which form a closed basin, were deformed in late Cretaceous and Tertiary times resulting in a great variety of structures. The north trending Cornwallis fold belt and Cornwall anticline and the Prince Patrick uplift are discussed below. To the northwest the Sverdrup Basin is bounded by the Arctic Coastal Plain, a narrow belt of unconsolidated sands and gravels which extends to the inner part of the continental shelf.

Description of the Anomalies

Enclosed in the pocket of this publication is a Bouguer anomaly map of the Queen Elizabeth Islands which is made up of two map sheets, an east half and a west half. Figure 4 is a generalized map of the same area.

The Bouguer anomalies have a range of more than 330 mgal, varying from less than -70 mgal south of Eureka on Ellesmere Island to more than 260 mgal over the ocean of the Canada Basin where the water depth is in excess of 3, 500 m. Examination of the map reveals the following characteristics: positive anomalies along moderately folded regions, negative anomalies over basin and mountainous areas and large positive anomalies over the ocean. A steep gravity gradient (3. 2 mgal/km) occurs along the continental slope. The Archipelago region which is topographically very flat (the mean elevation of 4, 000 stations is 15 m) is also gravitationally very flat. With the exception of the anomalous areas over the fringe regions such as the southeastern parts of Devon and Ellesmere Islands, where the anomalies are in excess of 100 mgal with steep gradients of up to 4 mgal/km (Picklyk, 1969), most of the Bouguer anomalies generally vary between $\pm$20 mgal. The mean value of the regional Bouguer anomalies for the Archipelago region west of 90° longitude is 6. 0 mgal.

Discussion of the Anomalies

The gravity anomalies in the Queen Elizabeth Islands will be discussed more fully in a forthcoming publication. Only the major anomalies are discussed here.

The Bouguer anomaly field shows that the whole area of the Archipelago is close to isostatic equilibrium and that most of the smaller anomalies are related to the near surface geology.

Positive anomalies varying from 0 to +60 mgal are usually present over the folded areas even though some of these folds traverse basin regions e.g., (1) the north trending anomalies along the Cornwallis Fold Belt and the Cornwall Anticline, (2) the easterly trending anomalies along the northern side of the Parry Island Fold Belt which also corresponds to the southern lip of the Sverdrup Basin, and (3) the northeast trending anomalies along the Arctic Coastal Plain which are underlain by the northwestern flank of the Sverdrup Basin and the Prince Patrick Uplift. Possible

Figure 4. Generalized Bouguer anomaly map of the Queen Elizabeth Islands (contours at intervals of 10 mgal) superimposed on the geology.

explanations for some of these anomalies are as follows.

The Cornwallis Island High (maximum anomaly 23.9 mgal) along the Cornwallis Fold Belt may be explained by the combined effect of dense carbonate rocks within the sediments, variation in the lithology of the shield rocks and intrusions of basic rocks. A drill hole at Resolute Bay on the eastern flank of the high and another at the Caledonian River on the western flank indicate a 1.3 km thickening of clastic rocks which could cause an 11-mgal variation. Part of the carbonate rocks which crop out at Resolute Bay may have been removed causing a decrease in the anomaly. Alternating bands of mafic and felsic gneiss in the crystalline basement as indicated to the south over the Boothia Uplift could also account for a 30-mgal variation (Berkhout and Sobczak, 1967). The local positive anomalies over the eastern part of Bathurst Island and Little Cornwallis Island are related to basic rock intrusions and mineralized areas.

The Isachsen High (maximum anomaly +60 mgal) along the northern limb of the Sverdrup Basin is underlain by an arch in the basement and lenticular masses of basic rocks. Seismic evidence indicates a very broad arch, about 150 km wide rising about 7 km along the south flank above the base of the Sverdrup Basin and about 2 km on the north flank. This arch alone can easily account for a gravity contribution of 50 mgal. Lenses of basic rock of variable thickness may also contribute significantly to the anomaly.

If we exclude regions that have been folded, basin areas are normally characterized by negative anomalies such as those over the Sverdrup Basin (around Eureka, Graham Island, southern part of Ellef Ringnes Island, sea south of Ellef Ringnes Island and Hecla and Griper Bay), Melville basin (southern Melville Island) and Jones-Lancaster Basin (south-western Devon Island). Such areas are underlain by large thicknesses of clastic sediments; for example Sander and Overton (1965) found more than 10 km of low-velocity material south of Ellef Ringnes Island. These low density sediments should depress the Bouguer anomaly field by 80 mgal, however, there is no evidence for this, and it may therefore be concluded that compensation at depth has taken place. A similar situation exists in other basins when the anomalies are only slightly negative suggesting at least partial compensation.

The high value of the Bouguer anomaly field over the ocean deep merely reflects the water depth. The ocean area is better represented by the free-air anomaly field where it clearly shows the anomalous regions (Sobczak, et al., in preparation). A series of large elliptical anomalies lies parallel to the continental shelf of the Archipelago. The axes of these anomalies lie along the continental break and the anomalies are believed to be an expression of the transition zone between continental and oceanic crust (Weber, 1963). They are not readily recognizable on the Bouguer anomaly map because they are masked by the effect of the increasing water depth over the continental slope, but they stand out very clearly on the free-air anomaly map.

SUMMARY

Over the Archipelago the Bouguer anomalies correlate well with geological features; gravity highs are related to folded areas and gravity lows to basin areas. The negative anomalies over the basin areas are, however, insufficient to account for the thick sedimentary layers and it is concluded that isostatic compensation has taken place below the basins. Interpretation of the gravity field over the ocean and to a certain extent over mountainous areas is difficult without free-air anomaly maps. An 80 to 100 mgal transition zone anomaly exists along the outer edge of the continental shelf. It stands out clearly on the free-air anomaly map (Sobczak, et al. (in preparation). The Archipelago region west of 90°W longitude with a mean topographical elevation of 15 m and an average Bouguer anomaly of 6 mgal appears to be in isostatic equilibrium.

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