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Gravity Service of Canada

THE GRAVITY FIELD OF THE CENTRAL LABRADOR TROUGH, NORTHERN QUEBEC

with map:
No. 162 — Lac Nachicapau-Central Labrador Trough

P. Kearey and D.W. Halliday

Gravity Map Series No. 162
Ottawa, Canada 1976

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FOREWORD

The Gravity Map Series of the Earth Physics Branch is intended to provide Bouguer and/or free air gravity data to the user in map form on a timely basis. The standard and principal scale of the map series is 1:500,000 with map boundaries established according to the National Topographic System. Non-standard scales (1:250,000 and 1:1,000,000) with or without boundaries defined by NTS are used where the principal scale is inappropriate for the station density.

The maps in the series are numbered consecutively as the field work is completed. The NTS number is normally also indicated on each map. The maps are usually published with a report describing the surveys and the principal features of the gravity field. Interpretations of the data are also included from time to time. When released with a manuscript the maps are usually grouped according to the area surveyed or to provide complete coverage of a geological or geophysical feature of the earth's crust.

AVANT-PROPOS

La série de cartes gravimétriques de la Direction de la physique du globe est dressée pour fournir à l'usager, sous forme de cartes, des données sur une base opportune des anomalies de Bouguer et/ou à l'air libre. L'échelle normalisée et principale des cartes est au 1:500 000, avec des limites cartographiques établies suivant le Système topographique national. Des échelles non normalisées (1:250 000 et 1:1 000 000), avec ou sans limites définies par le STN, sont employées où l'échelle principale est impropre du fait de la densité de stations.

Les cartes sont numérotées dès l'achèvement des levés sur le terrain. Le numéro du STN est également indiqué sur chaque carte. Les cartes sont couramment publiées accompagnées d'un rapport descriptif des levés et des principaux éléments du champ de gravité. Des interprétations des données y sont incluses de temps à autre. Publiées avec un rapport, les cartes sont généralement groupées suivant les régions levées ou pour donner une représentation complète d'un élément géologique ou géophysique de la croûte terrestre.

CONTENTS

THE GRAVITY FIELD OF THE CENTRAL LABRADOR TROUGH, NORTHERN QUEBEC

P. Kearey and D.W. Halliday

ABSTRACT. The Labrador Trough is the best preserved and exposed of a series of Aphebian (lower Proterozoic) fold belts which surround the Archaean Ungava Craton of northern Quebec and mark the junction of the Superior and Churchill Structural Provinces in this region. The results of a detailed gravity survey of the central Labrador Trough are presented.

Regional gravity profiles across the Labrador Trough are characterized by a field which decreases gradually to the east over the Superior Province, reaches a minimum beneath the Trough and thence increases rapidly over the Churchill Province to attain a mean level some 15 mgal higher than observed over the Superior Province. This regional field may be interpreted in terms of a relatively elevated Conrad discontinuity beneath the Churchill Province isostatically compensated by a thickened lower crust. The model is consistent with basement reactivation of the Churchill Province following collision with the Superior Province during the Hudsonian Orogeny.

Subtraction of the regional field from the observed gravity data reveals that positive residual anomalies over the eastern part of the Labrador Trough correlate with outcrops of basic meta-igneous rocks. Their causative bodies probably dip to the east and extend to maximum depths of 9 km in the central part of the area. These interpreted depths are considerably less than previous estimates based on geological analysis. Small positive anomalies correlate with iron formation. A persistent depression in the observed gravity field over the centre of the Labrador Trough in the south coincides with thick deposits of the basal continental sedimentary unit. In the northern part of the area the causative bodies of the negative anomalies are probably elevated areas of granitic basement. These elevated basement features may be related to a ridge that controlled sedimentation during much of the Trough's history.

The geological history and present structure of the Labrador Trough may be related to a sequence of events involving the closure of a small ocean dividing the

RÉSUMÉ. Le géosynclinal du Labrador est la zone la mieux préservée et exposée d'une série de zones de plissements de l'Aphébien (Protérozoïque inférieur), qui ceinturent le craton d'Ungava, de l'Archéen, au nord du Québec, et marque la jonction des provinces structurales de Churchill et du lac Supérieur dans cette région. A ce rapport sont présentés les résultats d'un levé détaillé effectué dans le centre du géosynclinal.

Les profils gravimétriques régionaux sont caractérisés dans tout le géosynclinal du Labrador par un champ gravitationnel décroissant graduellement vers l'est dans la province du lac Supérieur, atteint un minimum sous le géosynclinal, puis augmente rapidement dans la province de Churchill où il atteint une valeur moyenne supérieure d'environ 15 milligals à celle observée dans la province du lac Supérieur. Ce champ régional peut être interprété en fonction d'une discontinuité de Conrad relativement élevée sous la province de Churchill et isostatiquement compensée par un épaississement de la croûte inférieure. Le modèle est compatible avec une réactivation de soubassement de la province de Churchill, suite à une collision avec la province du lac Supérieur au cours de l'orogénèse Hudsonien.

Une soustraction du champ régional des données gravimétriques révèle que des anomalies positives résiduelles dans la partie est du géosynclinal sont corrélatives à des affleurements de roches basiques métaignées; leurs masses causatives ont probablement un pendage vers l'est, et s'étendent à des profondeurs maximales de 9 km dans la partie centrale de la zone. L'interprétation de ces profondeurs est considérablement moindre que les estimations antérieures basées sur des analyses géologiques. Certains anomalies positives de faible importance coïncident avec des formations ferrifères. Une dépression persistante observée dans le champ gravitationnel au centre du géosynclinal dans le sud coïncide avec d'épais dépôts de l'unité sédimentaire continentale basale. Dans la partie septentrionale de la zone, les masses causatives des anomalies négatives sont probablement des zones surélevées du soubassement

Superior and Churchill Provinces in Aphebian times culminating in their collision during the Hudsonian Orogeny.

granitique. Ces structures surélevées peuvent être reliées à une crête qui aurait contrôlé la sédimentation pendant la plus grande partie de l'histoire du géosynclinal.

La formation géologique et l'actuelle structure du géosynclinal du Labrador peuvent être reliées à une succession de mouvements orogéniques comportant à l'Aphébien la fermeture d'un petit océan divisant les provinces de Churchill et du lac Supérieur et leur collison définitive au cours de l'orogénèse Hudsonien.

INTRODUCTION

The Archean Ungava Craton of northern Quebec is surrounded by a series of Aphebian (2560-1800 m.y., Stockwell, 1973) fold belts (Dimroth et al., 1970) of which the Labrador Trough is the most easterly (Fig. 1). These belts mark the junction of the Superior and Churchill Structural Provinces in eastern Canada and are broadly composed of a meta-sedimentary unit flanking the Craton and an outer meta-igneous unit, although meta-sedimentary remnants north and west of the fold belts may indicate that the original area of deposition was considerably wider (Jackson and Taylor, 1972). The Trough fill was metamorphosed and subjected to thrusting from the northeast during the Hudsonian Orogeny (1800 m.y.). Gibb and Walcott (1971), Dewey and Burke (1973) and Kearey (1976) have suggested that the circum-Ungava fold belts represent a suture between collided continents, although Dimroth (1972) has argued strongly against this hypothesis.

Regional gravity investigations of the Cape Smith Belt and Labrador Trough (Tanner and McConnell, 1964; Tanner 1969) indicate that the Superior/Churchill Province boundary has a distinct geophysical signature expressed as a negative anomaly flanking the

Figure 1. Location map showing the principal Proterozoic fold belts of the circum-Ungava geosyncline and the area under investigation (modified after Dimroth *et al.*, 1970).

Superior Province and an adjacent positive anomaly over the Churchill Province. Tanner (1969) has related this juxtaposition of negative and positive anomalies to the gravitational effect of a dense body in the upper crust isostatically compensated by a thickened lower crust.

The following description and interpretation of the gravity field of the central Labrador Trough summarizes results that have been published elsewhere (Kearey, 1976a, 1976b). Consequently no description of the geology and history of the Labrador Trough is given although the simplified geology of the major part of the map area is presented in Fig. 2. For fuller descriptions of the interpretations and conclusions of this report the reader is referred to the previous two publications.

GRAVITY SURVEYS

The surveys on which the data used in the compilation of the gravity map were collected are listed in Table 1.

The method of survey was similar to that employed in previous surveys using helicopter transport and altimetry to determine most elevations. Station spacing was variable (2 to 8 km) in response to the geological detail. The quality of elevation controls for altimetry was superior to that of most regional surveys.

The survey was tied to 8 control stations in the National Gravity Net. Their portion of the National Gravity Net was established using LaCoste and Romberg gravity meters G9, G88 and G172.

Control elevations for altimetry were obtained from local stations in the Geodetic Triangulation Network and from benchmarks established by the Quebec Department of Natural Resources. These benchmarks are on level lines along all of the principal streams in the area. A. Yllo of the Geodetic Survey made 36 additional ties between 28 triangulation stations and to 6 benchmarks using the method of simultaneous reciprocal angles. The trigonometric heights were then adjusted by a least squares method. The pattern of repeated altimetry

TABLE 1. Summary of Gravity Surveys

Year	Number of Stations	Project	Observers	Gravity Meter+
1959	2	59-003	*Tanner Buck	W433
1961	149	61-002	*McConnell Reader Weaver	W391 W433
1964	54	64-010	*Weaver D.F. Brule Dekort Peters Richard Weaver J.	G7 G9 W391 W431 W433 W460 W546
1972	1520	72-107	*Halliday Wilson Powell Stephenson	 G172 W391 W431
1973	95	73-107	*Halliday Wilson Stephenson	G7 G9 G172 G278
Total Stations	1820		*Party Chief	

+Gravity Meter Index: G-Lacoste-Romberg Geodetic Meter, W-Worden

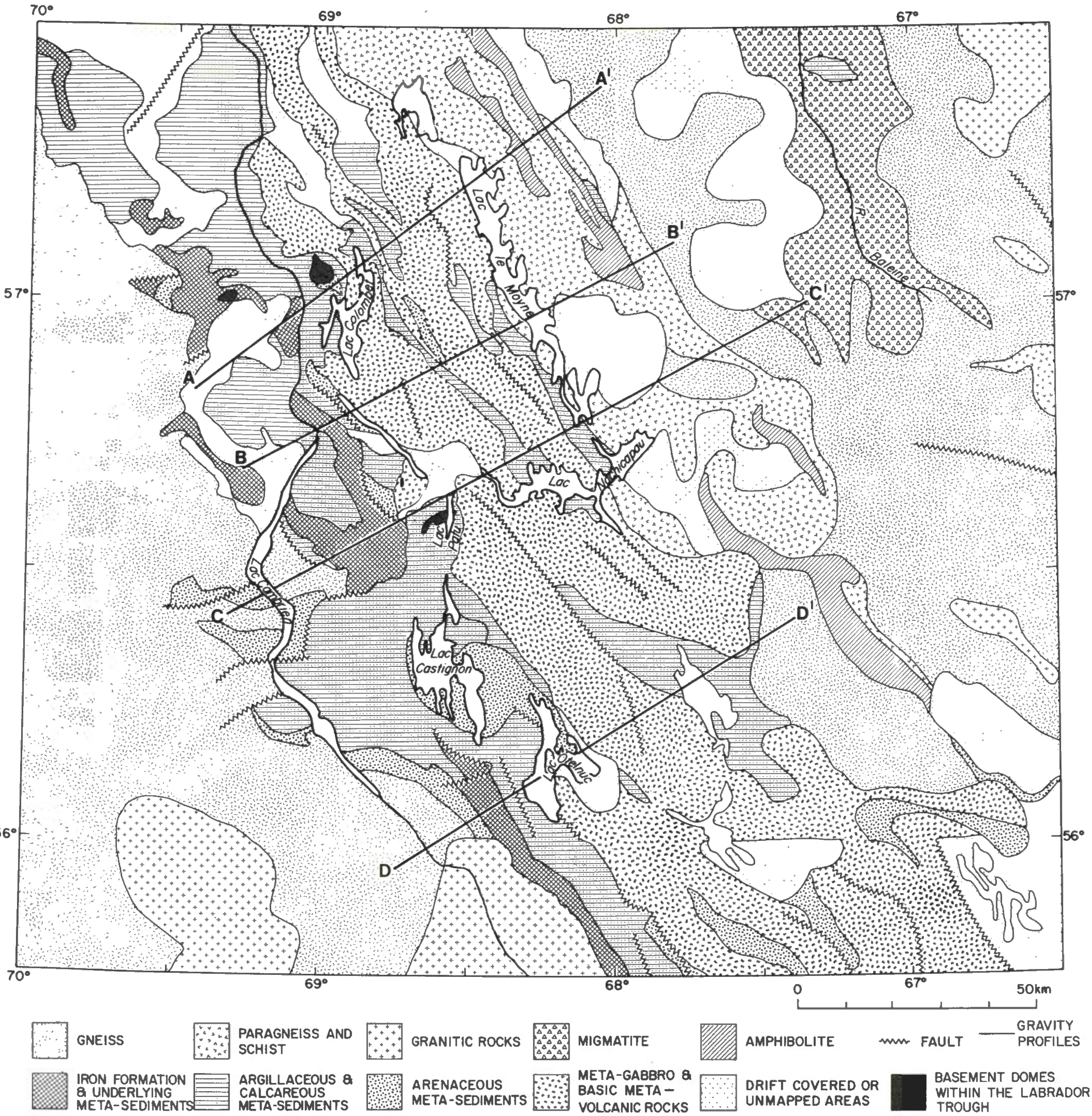

Figure 2. Geology of the central Labrador Trough. Assembled from 1 inch:1 mile geological maps and regional compilations of the Quebec Department of Natural Resources and Taylor (1969). From Kearey (1976b) with permission.

observations made possible the application of a similar adjustment to all elevations. Gravity station elevations have an accuracy of ±2 m (standard deviation).

THE GRAVITY MAP

Gravity map No. 162 (Lac Nachicapau-Central Labrador Trough) was prepared from the 1820 gravity stations illustrated at a scale of 1:500,000. The Bouguer correction density was 2.67 g/cm^3 and no correction was applied for topographic effects as the terrain correction never exceeds 1.5 mgal in the area surveyed. Errors in the Bouguer anomalies are estimated to be not more than 2.0 mgal due mainly to the absence of terrain corrections and to errors in inferred elevations. The frequency of observation of the Bouguer anomalies is presented in Fig. 3. The data were machine contoured at 5 mgal intervals using the General Purpose Contouring Package (Calcomp, 1973) which interpolates between the irregularly distributed stations to produce a regular grid. Some smoothing of the observed data takes place as a result of this process.

ROCK DENSITIES

Measurements on over 1500 rock samples collected from the central Labrador Trough by the Quebec Department of Natural Resources and the Gravity and Geodynamics Division were analyzed by Kearey (1976b). The results of these density determinations are summarized in Table 2.

For the interpretation of local anomalies within the Labrador Trough the background density was assumed to be represented by the mean density (2.74 g/cm^3) of the gneisses flanking the Trough. Relative to this background density, the basic meta-igneous rocks have a density contrast of +0.19 g/cm^3, iron formation +0.35 g/cm^3 and continental meta-sediments -0.09 g/cm^3.

REGIONAL STRUCTURE

Analysis of gravity profiles trending ENE across the region intersecting the Labrador Trough at the map area indicates that the regional gravity field (Fig. 4) is characterized by gently decreasing anomalies over the Superior Province which reach a

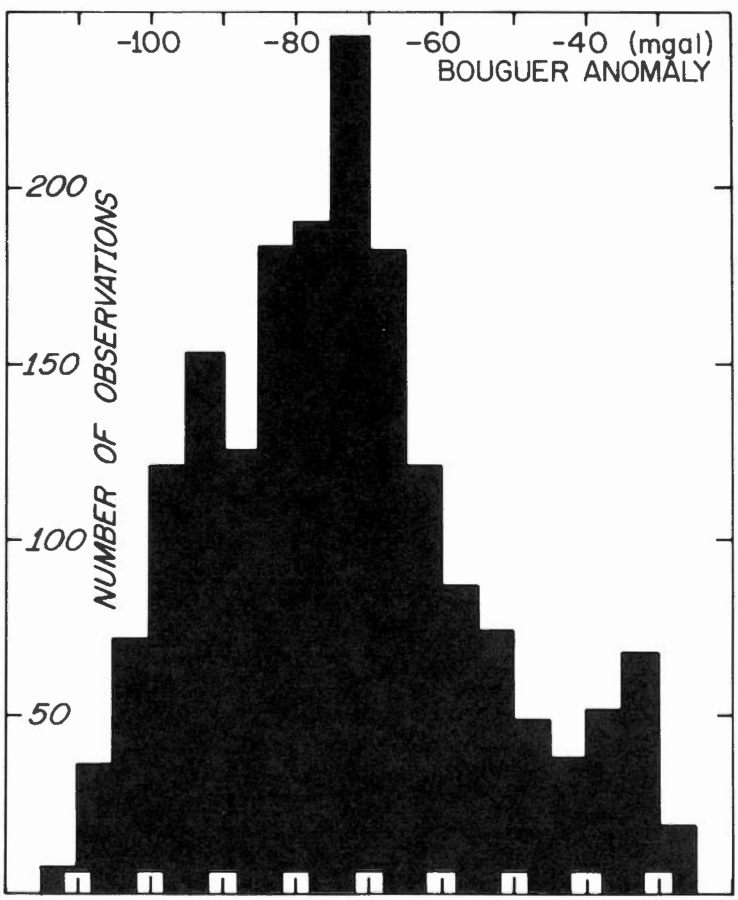

Figure 3. Relative frequency of gravity values in the area surveyed.

TABLE 2. Summary of Density Measurements on Rocks from the Central Labrador Trough*

ROCK TYPE	N	$\bar{\rho}$	s
Arenaceous meta-sediments	266	2.68	0.08
Granitic rocks	49	2.68	0.10
Argillaceous meta-sediments	262	2.72	0.11
Conglomerate and breccia	31	2.72	0.15
Gneiss	54	2.74	0.16
Calcareous meta-sediments	161	2.76	0.08
Migmatite	36	2.76	0.16
Agglomerate	10	2.76	0.12
Fault zone rocks	7	2.76	0.19
Basic meta-volcanic rocks	240	2.92	0.12
Meta-gabbro	250	2.94	0.10
Amphibolite	57	3.01	0.11
Ironstone	55	3.09	0.37
Ultrabasic rocks	4	3.15	0.50

N = number of samples

$\bar{\rho}$ = mean density in g/cm^3

s = standard deviation in g/cm^3

*from Kearey (1976b)

minimum over the eastern part of the Labrador Trough and thence increase abruptly over the Churchill Province to attain a mean level some 15 mgal higher than observed over the Superior Province (Kearey, 1976a).

The preferred interpretation of the regional gravity field is a modification of Tanner's (1969) model of the Labrador Trough. The model (Fig. 4) relates the positive gravity field of the Churchill Province to the presence of an underlying elevated Conrad discontinuity. The negative anomaly beneath the Labrador Trough is caused by a crust thickened from 35 to 41 km which isostatically compensates for this positive mass and by a small downwarp of the Moho beneath the Superior Province. North-south trending linear anomalies superimposed upon the positive gravity field of the Churchill Province are related to undulations on the surface of the elevated Conrad discontinuity. Control of the surface geology by deeper structures is indicated by the alignment of the major units of the Churchill Province into broad bands parallel to the strike of the Labrador Trough (Taylor, 1969, 1970). The processes responsible for the present structure are discussed in a later section.

Other possible interpretations of the regional gravity field are a dense layer in the upper crust compensated by a root of similar dimensions as the above model, or by the Churchill Province crust being formed of a series of dense, north-south trending, vertical sided blocks of varying density in approximate isostatic equilibrium (Gibb *et al.*, 1976). The former is not supported by surface density measurements. The latter is probably a reasonable alternative model and reflects a situation similar to that attaining in the Peruvian Andes whose structure has been controlled by the relative vertical movements of blocks about 50 km in width which trend parallel to the Peru-Chile Trench (Myers, 1975). A similar model has been proposed to explain gravity anomalies over the Grenville Front by Thomas and Tanner (1975).

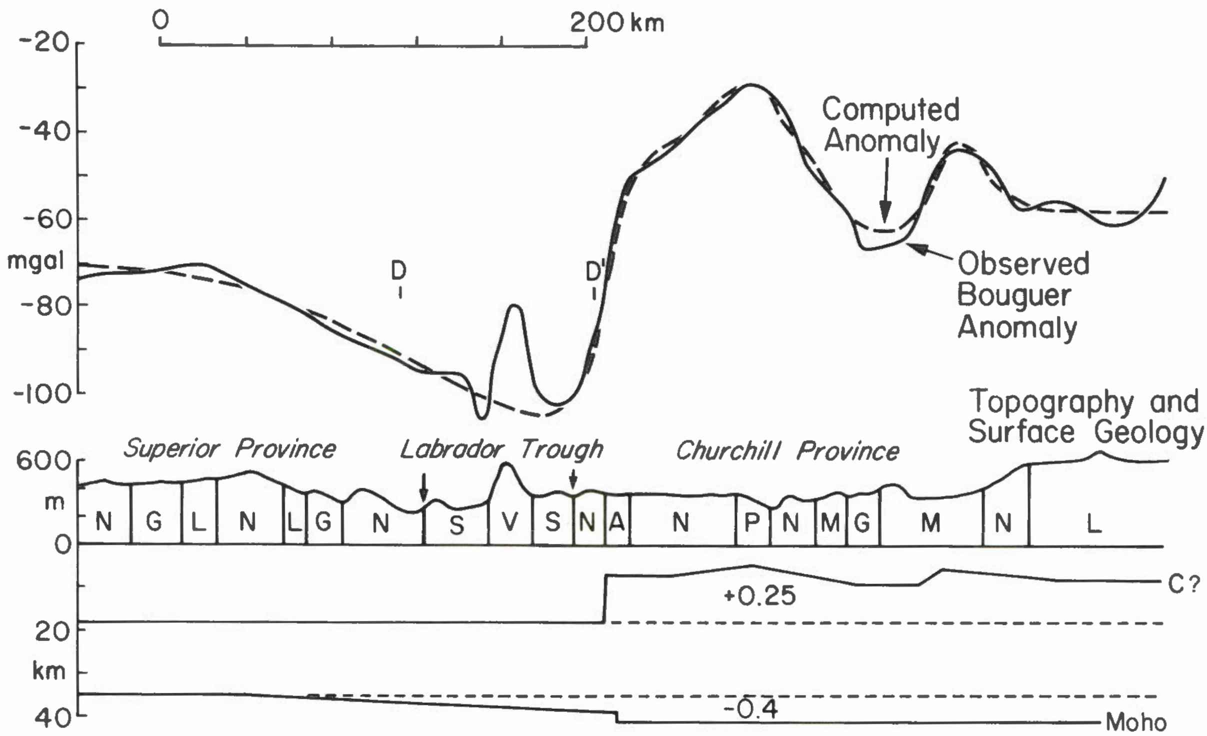

Figure 4. Regional crustal structure across the Labrador Trough along the profile shown in Fig. 1. The computed anomaly represents the type of regional field used in the separation of residual anomalies from the observed Bouguer anomalies and is the actual regional field used on profile D-D' (Fig. 7) whose location is indicated. C-Conrad discontinuity, N-granitic gneiss, G-granite, L-granulitic gneiss, P-paragneiss, V-meta-gabbro and basic meta-volcanic rocks. Arrows mark the boundaries of the Labrador Trough. Density contrasts in g/cm^3. From Kearey (1976b) with permission.

LOCAL STRUCTURES WITHIN THE LABRADOR TROUGH

A simplified Bouguer anomaly map of the area is presented in Fig. 5. Local anomalies caused by structures within the Labrador Trough were isolated by subtraction of a regional field of the form illustrated in Fig. 4. Although this regional field clearly isolates the positive anomalies attributed to bodies of basic meta-igneous rocks, it is not sufficiently well known to isolate accurately the much lower amplitude anomalies associated with iron formation and meta-sediments. Two interpreted profiles from Kearey (1976b) are presented in Figs. 6 and 7.

Residual positive anomalies over the eastern part of the Labrador Trough correlate closely with basic meta-igneous rocks. The anomalies extend farther to the east than the surface expression of these rocks, suggesting that their causative bodies dip, or are covered, in this direction (Figs. 6 and 7). In the central part of the area, where the positive anomalies attain amplitudes of up to 50 mgal, the meta-igneous rocks may reach a depth of 9 km but are thinner to the north and south. The computed depths are considerably less than the estimate of 15 km based on geological analysis (Dimroth, 1970).

Small positive anomalies of up to 15 mgal are associated with iron formation in the western part of the Labrador Trough, which occurs as thrust wedges or in the cores of synclinoria (Fig. 7). Depth estimates are complicated by the iron formation's having a wide range in density related to the varying heavy mineral content, but using the determined mean density of 3.09 g/cm^3 indicates that the iron formation may reach depths of up to 1 km.

A persistent depression in the observed gravity field over the centre of the Labrador Trough in the south corresponds to outcrops of the basal Chakonipau Formation, a continental sedimentary sequence mainly composed of arkosic sandstones. Although the argillaceous and calcareous members of the Trough sediments have only a low density contrast with the upper crust, the Chakonipau Formation produces a density contrast of -0.09 g/cm^3. The Formation is thickly developed in the southern part of the area and beneath Lac Otelnuc may reach a depth of up to 2.6 km (Fig. 7). This depth estimate

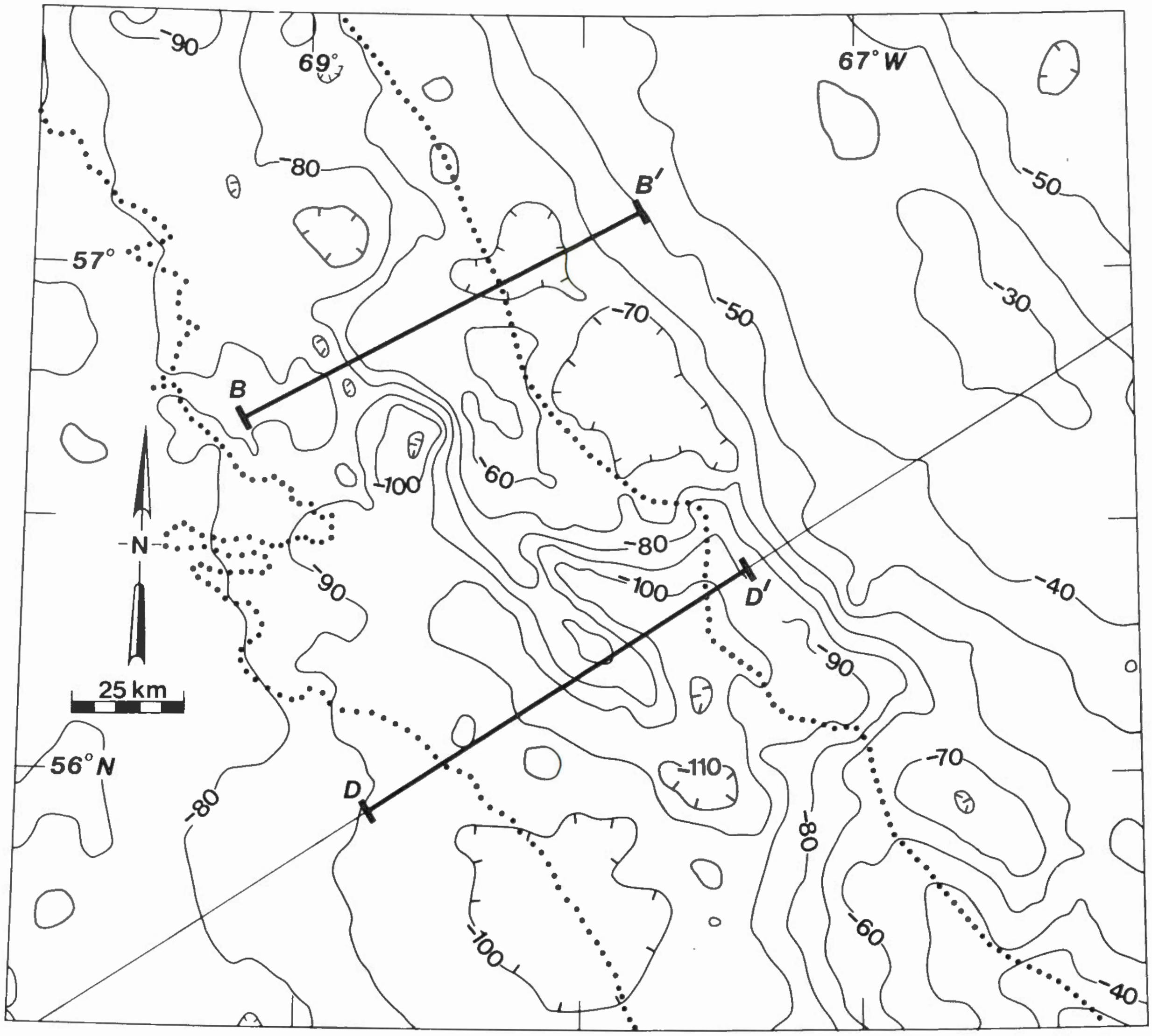

Figure 5. Simplified Bouguer anomalies of the area surveyed. Contour interval 10 mgal. Dotted lines mark the boundaries of the Labrador Trough. The locations of profiles B-B' show the location of the profile illustrated in Fig. 4 in the region of the map area.

is only approximate, however, and is controlled by the regional level selected, as the low density contrast of the meta-sediments causes a sensitive dependence of computed depth on anomaly amplitude. This estimate is similar to those based on geological mapping (Dimroth *et al.*, 1970). An alternative, more likely, explanation of the gravity depression in the northern part of the region is the presence of elevated granitic basement (Fig. 6) as Hashimoto (1964), Fahrig (1965) and Dressler (1973) have mapped inliers of Archaean granitic basement at the location of the gravity depression.

DISCUSSION

The geological history and present structure of the Labrador Trough appear to be consistent with a sequence of events involving the gradual closure of a small ocean basin which separated the Superior and Churchill crustal plates in early Aphebian times (Fig. 8A) (Kearey, 1976), according to the model of Dewey and Bird (1970). The closure was effected by subduction of oceanic lithosphere in an easterly direction beneath the Churchill plate at a trench situated along its western margin. The earliest con-

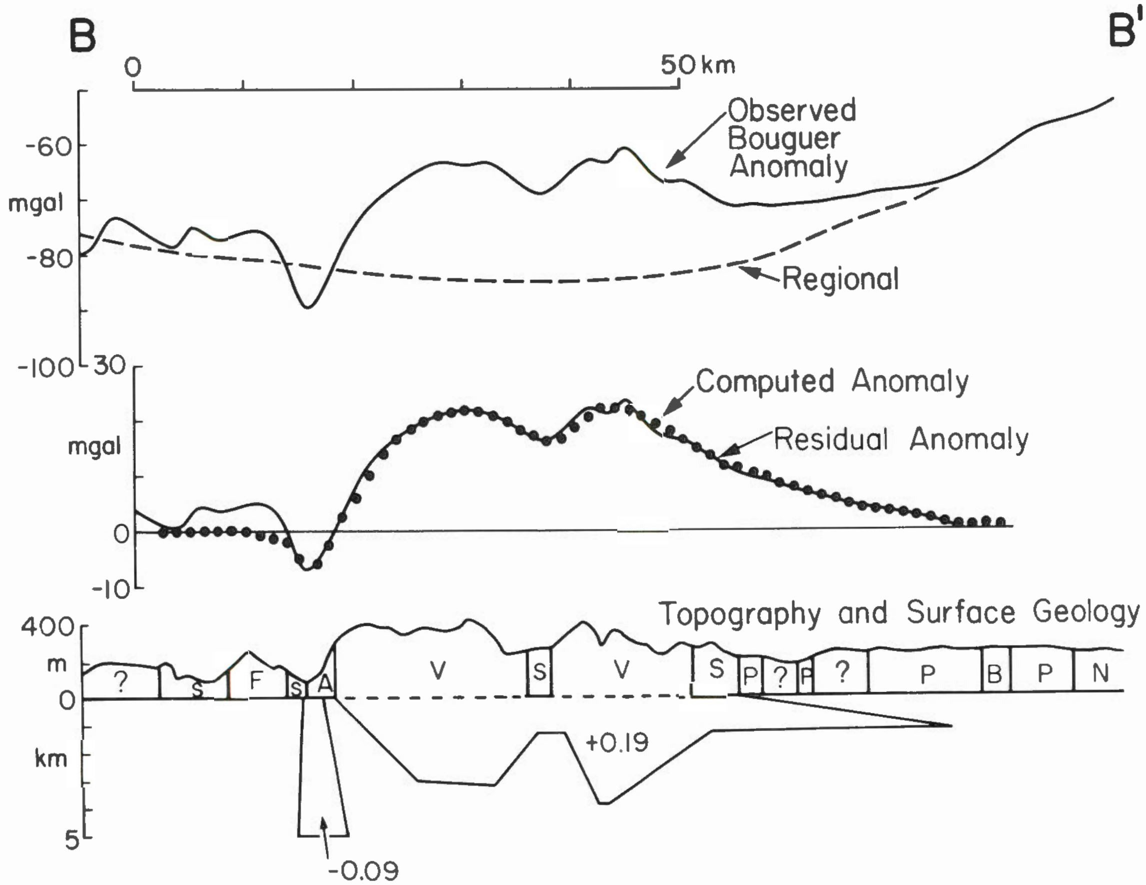

Figure 6. Interpretation of profile B-B' (location shown in Fig. 5). Surface geology: S-argillaceous and calcareous meta-sediments, A-arenaceous meta-sediments, F-iron formation, V-meta-gabbro and basic meta-volcanic rocks, N-gneiss, P-paragneiss and schist, M-migmatite, B-amphibolite, ?-unmapped or drift covered area. Density contrasts in g/cm^3. From Kearey (1976b) with permission.

tinental deposits grade upwards into an orthoquartzite-carbonate shelf sequence. Subsequent increased subsidence as the oceanic lithosphere descended was accompanied by the rise of a central ridge and the deposition of flyschoid sediments derived from older deposits into a fore-arc basin: the inliers of granitic basement in the centre of the Trough are probably related to this ridge and since they are Archaean in age indicate that some deep-seated process, probably related to thermal effects of the descending oceanic lithosphere, must have been responsible for their elevation. Finally large volumes of basic igneous rocks with tholeiitic affinities were extruded and intruded from fissures located at the eastern edge of the Trough after descent of the oceanic lithosphere to depths in excess of 100 km (Fig. 8B). After three such cycles of sedimentation and volcanism the Superior and Churchill cratons collided during the Hudsonian Orogeny (Fig. 8C). During collision the Churchill plate rose and thrust the Trough fill towards the Ungava Craton. The computed easterly dips of the basic meta-igneous rocks are consistent with these movements which were directed from the northeast. On collision, underthrusting of the Superior beneath the Churchill plate was prohibited by the buoyancy of continental lithosphere, but reactivation of the Churchill plate (Dewey and Burke, 1973) resulted from thickening of the crust by ductile flow in the upper mantle in response to the additional loading. This thickening and thermal contributions from the sinking oceanic lithosphere caused partial melting in the lower crust which divided the crust into a refractory lower part and an upper part richer in potassium and the lithophile elements. The boundary between the two layers was marked by a zone of migmatites defining the Conrad discontinuity. The positive gravity field of the Churchill Province is attributed to this elevated boundary; moreover, one of the positive gravity anomalies superimposed on this field corresponds to a broad belt of migmatites flanked by

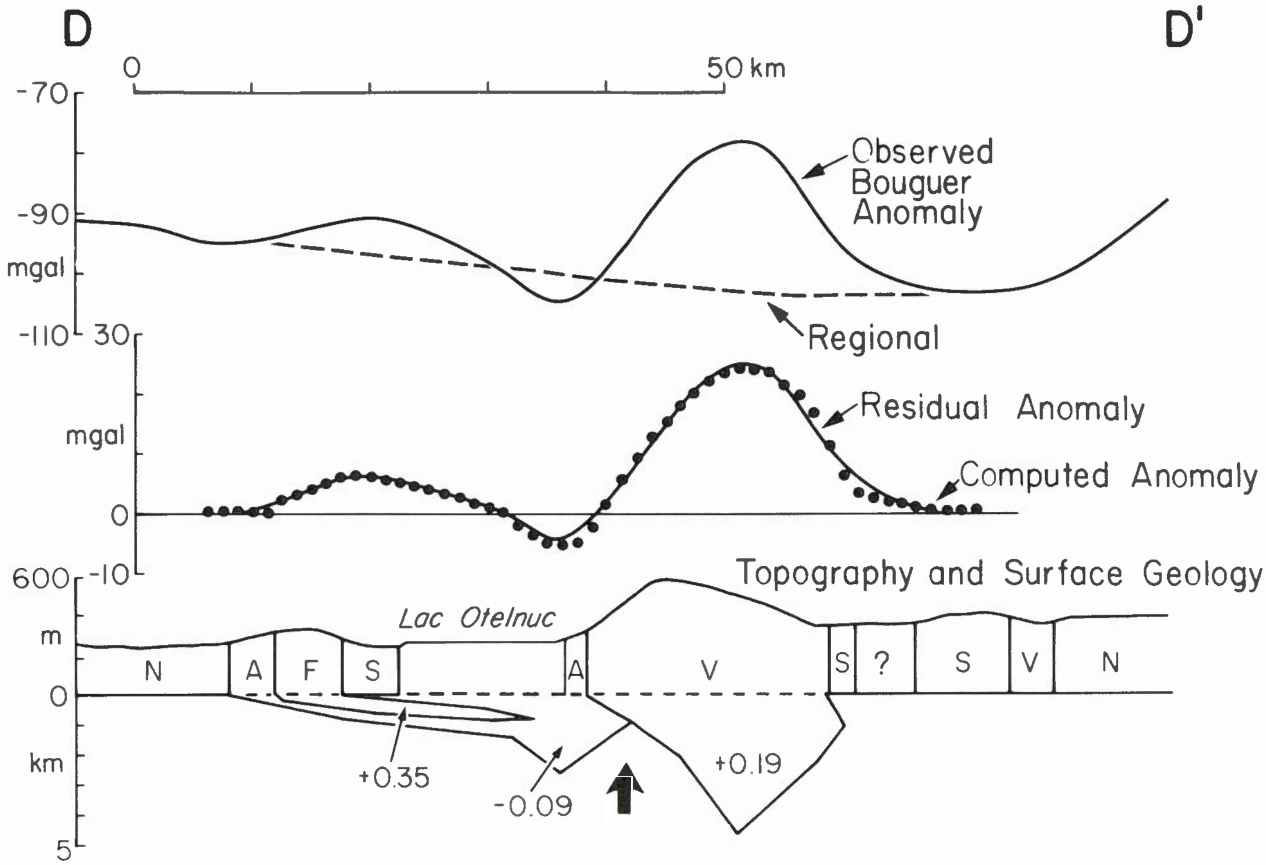

Figure 7. Interpretation of profile D-D' (location shown in Fig. 5). See Fig. 6 caption for explanation of symbols. The arrow marks the location of a basement rise which may be related to the ridge in the centre of the Labrador Trough referred to in the text. From Kearey (1976b) with permission.

granite (Fig. 4) which strikes parallel to the Labrador Trough (Taylor, 1969). Regional negative gravity anomalies over the Trough are related to a thickened crust compensating for the elevated Conrad discontinuity and also to down-warping of the Superior plate on collision.

It should be noted that although this basement reactivation model provides a reasonable explanation for the present structure of the Superior/Churchill Province boundary at the Labrador Trough, it is possible that the present gravity signature of the Churchill Province was established before collision by the relative vertical movements of large, linear crustal blocks similar to those observed in the Peruvian Andes (Myers, 1975) discussed in an earlier section. Continental collision, however, results in drastic modifications of the collided margins, e.g. the Himalayas, and it seems unlikely that the pre-collision régime could have survived such an event intact. Consequently the basement reactivation model is preferred.

There is currently a growing body of opinion that plate tectonic processes similar to those postulated for the Phanerozoic were active in the Precambrian and that structural province boundaries in the Canadian Shield are a consequence of continental plate collisions. This hypothesis has been invoked to explain the structure across the Labrador Trough deduced from gravity studies. However, if this process were responsible for all the members of the circum-Ungava fold belts, portions of the Churchill Province must have moved in at least three directions at approximately the same time to explain thrusting into the Ungava Craton at the Belcher Island Fold Belt, Cape Smith Belt and Labrador Trough (Fig. 1). The timing and nature of the coalescence of the Churchill Province into its present, extensive, cratonic condition and the location of sutures within the Province to the northeast and northwest of the Ungava Craton remain significant unknowns in the history of the Canadian Shield.

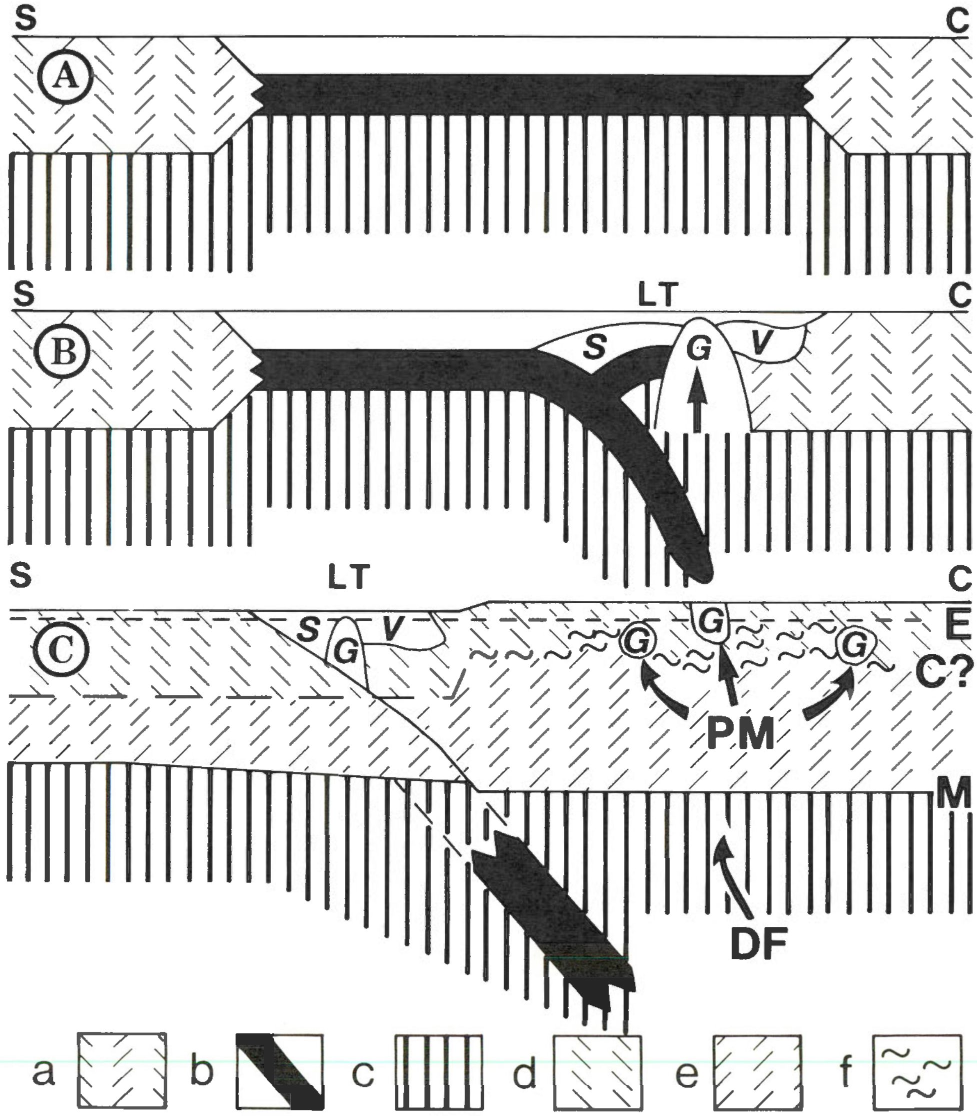

Figure 8. Diagrammatic illustration of the proposed tectonic history of the Labrador Trough. 8A - late Archaean and early Aphebian, 8B - lower Aphebian (2560 m.y. - pre 1800 m.y.), 8C - Hudsonian Orogeny (1800 m.y.) and after.

a-continental crust, b-oceanic crust, c-subcrustal lithosphere, d-potassic upper crust, e-refractory lower crust, f-migmatite, S-Superior Province, LT-Labrador Trough, C-Churchill Province, s-sediments, v-basic igneous rocks, G-granitic rocks, PM-partial melting, DF-ductile flow, M-Moho, C-Conrad discontinuity, E-present erosional level.

(8C, modified by the gravity interpretation, after Dewey and Burke (1973). From Kearey (1976b) with permission.)

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REFERENCES

Calcomp, 1973. GPCP, a general purpose contouring program. Users manual. California Computer Products Inc., Anaheim, California.

Dewey, J.F. and J.M. Bird, 1970. Mountain belts and the new global tectonics. J. Geophys. Res., 75, 2625-2647.

Dewey, J.F. and K.C.A. Burke, 1973. Tibeten, Variscan and Precambrian basement reactivation: products of continental collision. J. Geol., 81, 683-693.

Dimroth, E., 1970. Evolution of the Labrador Geosyncline. Bull. Geol. Soc. Am., 81, 2717-2742.

Dimroth, E., 1972. The Labrador Geosyncline revisited. Am. J. Sci., 272, 487-506.

Dimroth, E., W.R.A. Baragar, R. Bergeron and G.D. Jackson, 1970. The filling of the circum-Ungava Geosyncline. In Basins and Geosynclines of the Canadian Shield, ed. Baer, A.J. Geol. Surv. Can. Paper 70-40, 45-142.

Dressler, B., 1973. Geology of the Patu Lake Area, New Quebec Territory. Quebec Dept. Nat. Res., Prel. Rep. No. 603, 22 pp. with map 1742.

Fahrig, W.F., 1965. Lac Herodier Map Area. Geol. Surv. Can. Map 1146A.

Gibb, R.A., P. Kearey, J.G. Tanner and M.D. Thomas, 1976. Gravity anomalies and ancient plate boundaries in the Canadian Shield. Abst. Section 1, 25th Int. Geol. Cong., Sydney, Australia.

Gibb, R.A. and R.I. Walcott, 1971. A Precambrian suture in the Canadian Shield. Earth planet. Sci. Lett., 10, 417-422.

Hashimoto, T., 1974. Geology of Jogues Lake Area, New Quebec Territory. Quebec Dept. Nat. Res., Prel. Rep. No. 524, 6 pp. with map 1549.

Jackson, G.D. and F.C. Taylor, 1972. Correlation of major Aphebian rock units in the northeastern Canadian Shield. Can. J. Earth Sci., 9, 1650-1669.

Kearey, P., 1976a. A regional structural model of the Labrador Trough, northern Quebec, from gravity studies and its relevance to continent collision in the Precambrian. Earth planet. Sci. Lett., 28, 371-378.

Kearey, P., 1976b. A gravity survey of the Central Labrador Trough, northern Quebec. Can. J. Earth Sci., (in press).

Myers, J.S., 1975. Vertical crustal movements of the Andes in Peru. Nature, 254, 672-674.

Stockwell, C.H., 1973. Revised Precambrian time-scale for the Canadian Shield. Geol. Surv. Can. Paper 72-52.

Tanner, J.G., 1969. A geophysical interpretation of structural boundaries in the eastern Canadian Shield. Unpub. Ph.D. thesis, Univ. of Durham, U.K.

Tanner, J.G. and R.K. McConnell, 1964. The gravity anomaly field in the Ungava region of northern Quebec. Grav. Map Ser. Dom. Obs., 5, 6.

Taylor, F.C., 1969. Reconnaissance geology of a part of the Precambrian Shield, northeastern Quebec and northern Labrador. Geol. Surv. Can. Paper 68-43.

Taylor, F.C., 1970. Reconnaissance geology of a part of the Precambrian Shield, northeastern Quebec and northern Labrador, Part II. Geol. Surv. Can. Paper 70-24.

Thomas, M.D. and J.G. Tanner, 1975. Cryptic suture in the eastern Grenville Province. Nature, 256, 392-394.