INTERPRETATION AND MODELLING OF GRAVITY DATA WITHIN THE MEGUMA TERRANE, CENTRAL NOVA SCOTIA

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Submitted in Partial Fulfilment of the Requirements
for the Degree of Bachelor of Science, Honours
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March 1996

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DATE April 9, 1996

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TITLE INTERPRETATION AND MODELLING OF GRAVITY DATA WITHIN THE MEGUMA TERRANE, CENTRAL NOVA SCOTIA

Degree BSc (Honours) Convocation ____________ Year ____________

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Abstract

Gravity methods can be used to identify geological features that exhibit sufficient density contrasts with the surrounding country rock. Collection and reduction of new gravity data in central Nova Scotia, combined with existing regional data, has resulted in a detailed Bouguer gravity map for the study area. This map correlates well with the local geology. Positive anomalies are associated with the Halifax Formation of the Meguma Group, and large negative anomalies are associated with the South Mountain Batholith (SMB) and the Musquodoboit Batholith (MB). A small negative anomaly situated between the SMB and MB represents the Kinsac Pluton. 2.5D and 3D computer modelling of the intrusive bodies suggest: (1) the SMB and MB join at approximately 4.5-5 km below the surface, and (2) the smaller Kinsac Pluton is connected to the MB at approximately 1-1.5 km depth. Modelling of slate belts, using density determinations from this study, indicate: (1) the Kinsac Syncline is arc-shaped overlying the intruded granite, (2) the Uniacke Syncline is approximately 2-2.5 km thick, (3) the Rawdon Syncline thickens to the north-east to a maximum depth of 5-6 km, and (4) units of the recently subdivided Halifax Formation, within the study area (Rawdon and Glen Brook Units), can be included in the model of the Rawdon Syncline. The density contrast between them, however, is insufficient to produce recognizable gravity anomalies.

Key Words: detailed, granite, Meguma, reduction, Bouguer, contrast, modelling, subsurface, synclines, 2.5D, 3D

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Partial data collection took place during employment with the Nova Scotia Department of Natural Resources. Transportation, technical, and financial support was also provided by Nova Scotia Department of Natural resources, without which this study would not have been possible. The author acknowledges the encouragement of Rick Horne (NSDNR), and the supervision of Dr. Pat Ryall. We thank the Geological Survey of Canada for the loan of the gravity meter which made this work possible.

CHAPTER 1 INTRODUCTION

1.1 Introduction

The purpose of this study is to obtain, model, and interpret gravity data to determine the geometry of the subsurface geology within the central Meguma zone, including the relationship with local granitic intrusions, in efforts to increase understanding of the geology of Central Nova Scotia.

Variations in the earth's gravitational field are produced by subsurface density changes, and changes in elevation and latitude. When a body has a different density than the surrounding rock, a density contrast is created, and hence a perturbation or anomaly in the gravitational field results. These anomalies can be mapped, contoured, and modelled using computer packages to approximate the subsurface geology.

1.2 Study Area

The study area (NTS map sheets 11D/13 and most of 11E/04; Fig. 1.1) extends from Upper Sackville to the Rawdon Hills, and is underlain by north-east-trending folds of the Cambro-Ordovician Meguma Group (Fig. 1.2; Map 1). It is bounded by two large granitic intrusions: the Musquodoboit Batholith (MB) to the south east , and the South Mountain Batholith (SMB) to the south west. Only the easternmost portion of the South Mountain Batholith, and the westernmost portion of the Musquodoboit Batholith will be addressed in this study.

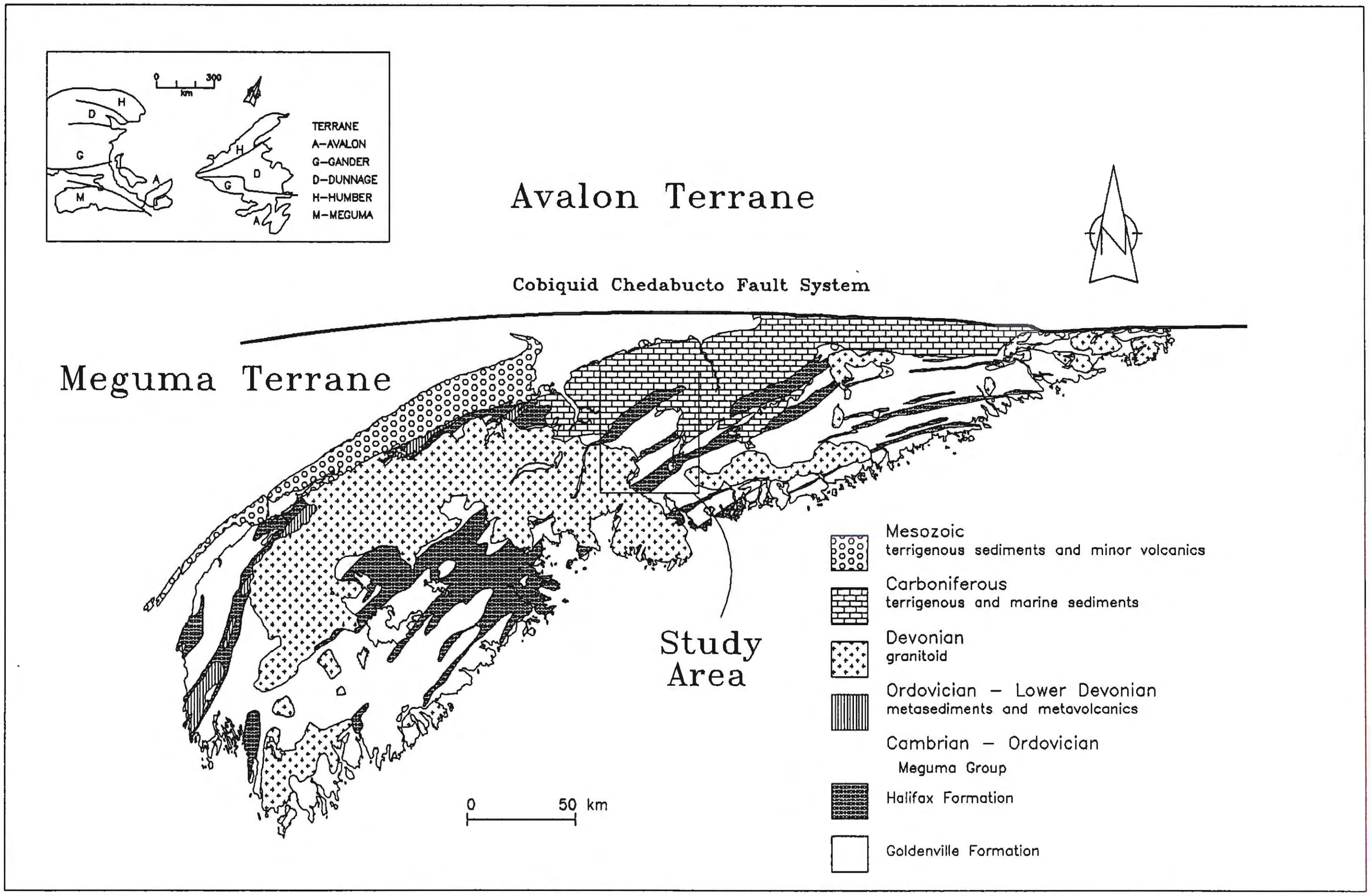

Figure 1.1 Diagram showing the location of the study area in central Nova Scotia.

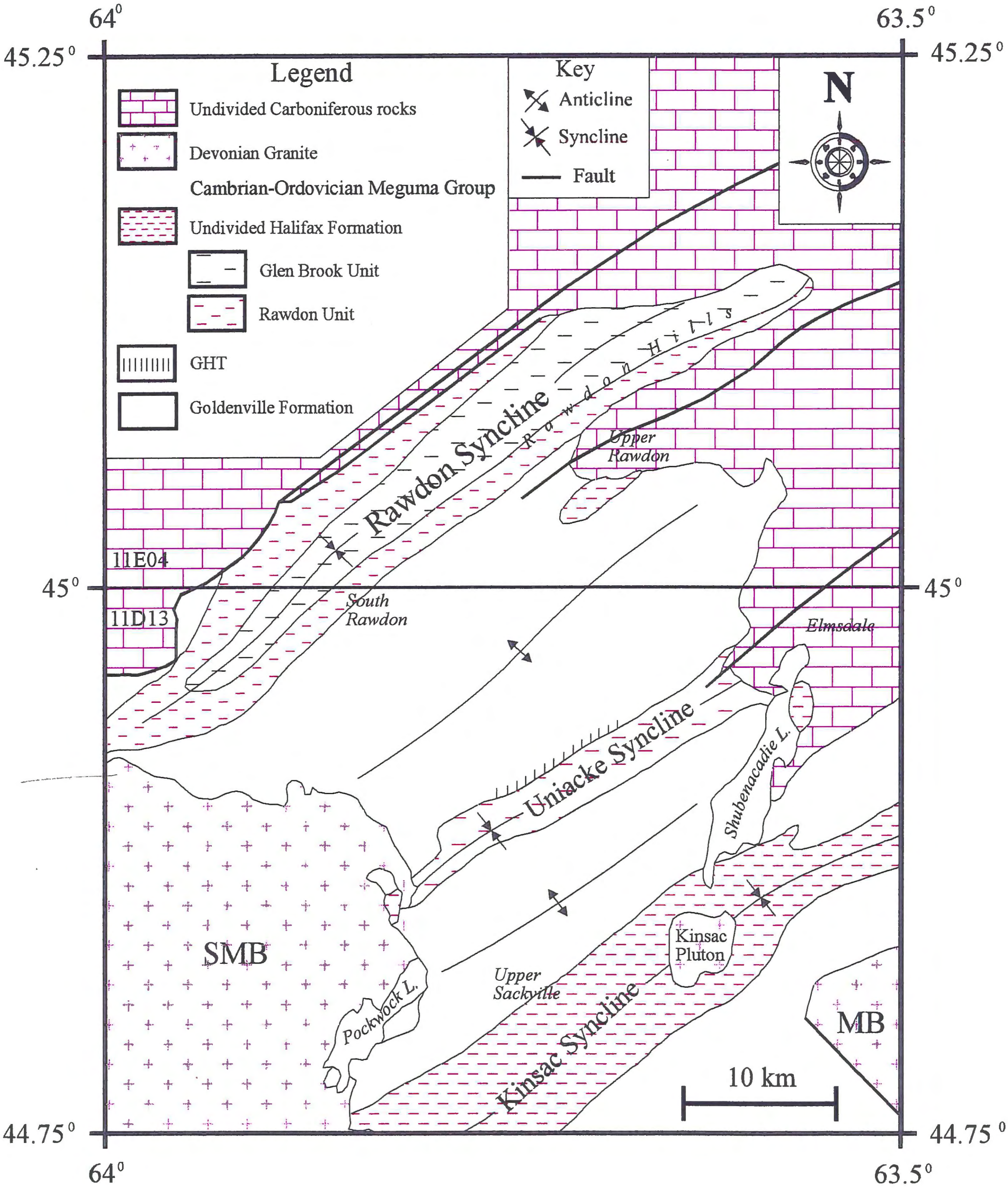

Figure 1.2 Geological Map of the Study area. SMB = South Mountain Batholith, MB = Musquodoboit Batholith. After Keppie (1979) and Horne (1993).

The Kinsac pluton, a much smaller intrusion, is located between the South Mountain and Musquodoboit Batholiths. To the north, the study area is bounded by Carboniferous sediments which unconformably overlie the Meguma Group metasedimentary rocks (Halifax and Goldenville Formations).

1.3 Hypotheses

Recent work by the Nova Scotia Department of Natural Resources has resulted in the further subdivision of the Halifax Formation into two smaller units in the study area (Fig. 1.2). One of the characteristics used to distinguish these two units is their sulphide content (Horne, 1993). The older Rawdon Unit is composed mainly of black slates and is sulphide rich. The overlying Glen Brook Unit, on the other hand, consists of grey-green banded slate which contains little or no sulphide. As sulphides are dense minerals (specific gravity range from 4-8; Klein and Hurlbut, 1985), the high sulphide content of the Rawdon Unit should increase the bulk density of the unit. This study therefore hypothesizes that the density contrast between the Rawdon and Glen Brook Units will enable gravity methods to be used to model the two units at depth.

The Musquodoboit and South Mountain Batholiths are lithologically very similar (MacDonald and Clarke, 1985). They are also approximately the same age, 366.7 ± 4 Ma (Reynolds *et al.*,1981) for the South Mountain Batholith, and 368.7 ± 3.2 Ma (MacMicheal, 1975) for the Musquodoboit Batholith. These two aspects suggest the possibility that the two batholiths are connected at depth. Past computer modelling of regional gravity data by O'Reilly (1975), McKenzie (1976) and Douma (1978) suggest that the batholiths are connected at approximately 5 km depth. Based on previous gravity studies, similar lithological characteristics and location, it also is the hypothesis of this study that the Kinsac pluton is connected to the "granite bridge" between the South Mountain Batholith and the Musquodoboit Batholith rather than being an isolated intrusion.

1.4 Assumptions and Limitations

Several assumptions and limitations are associated with this investigation. During the modelling process, I will assume that the thickness of the units within the Meguma Group is constant. I will also assume that the bulk densities of these units do not vary laterally or vertically. Most of the gravity stations are located next to control monument (bench marks). This study presumes that the elevation and location data for these monuments is accurate since gravity surveys are dependent on these attributes.

Interpretation of gravity data is not unique, and several reasonable conclusions can be obtained from the same data. The subsurface interpretation in this study, as with most gravity studies, is constrained by knowledge of the geology and rock densities. Interpretations can be further constrained by other types of data, such as magnetics.

Due to time and transportation constraints, limited coverage was achieved. As a result several large areas between traverses contain few or no gravity stations. Detailed interpretations of these data gaps will not be possible.

1.5 Previous Geophysical Investigations

Previous gravity studies by Douma (1976), O'Reilly (1975) and McKenzie (1976) interpreted regional gravity data for Southwestern Nova Scotia.

Howells and Clarke (1995) compiled and reprocessed all the gravity data for Nova Scotia and surrounding areas obtained between 1952 and 1988. The result was the combination of 131 gravity surveys, and between 40,000 and 45,000 gravity stations. Although there is a high density of gravity stations in some areas, around Amherst for example, the majority of the province exhibits low station density. As a result, when the study area is examined closely, it is evident that existing data is sparse (Fig. 1.3). The data from this study will be combined with the data compiled by Howells and Clarke (1995).

Current work within the Meguma Group includes the processing and assessment of aeromagnetic and magnetic susceptibility data (King, 1995). The susceptibility data have been collected in the study area over the past three years as part of the central Meguma Mapping Project, Nova Scotia Department of Natural Resources. The results of these efforts has shown that there is good correlation between aeromagnetic and susceptibility data, and that susceptibility can be used to differentiate stratigraphic units within the area.

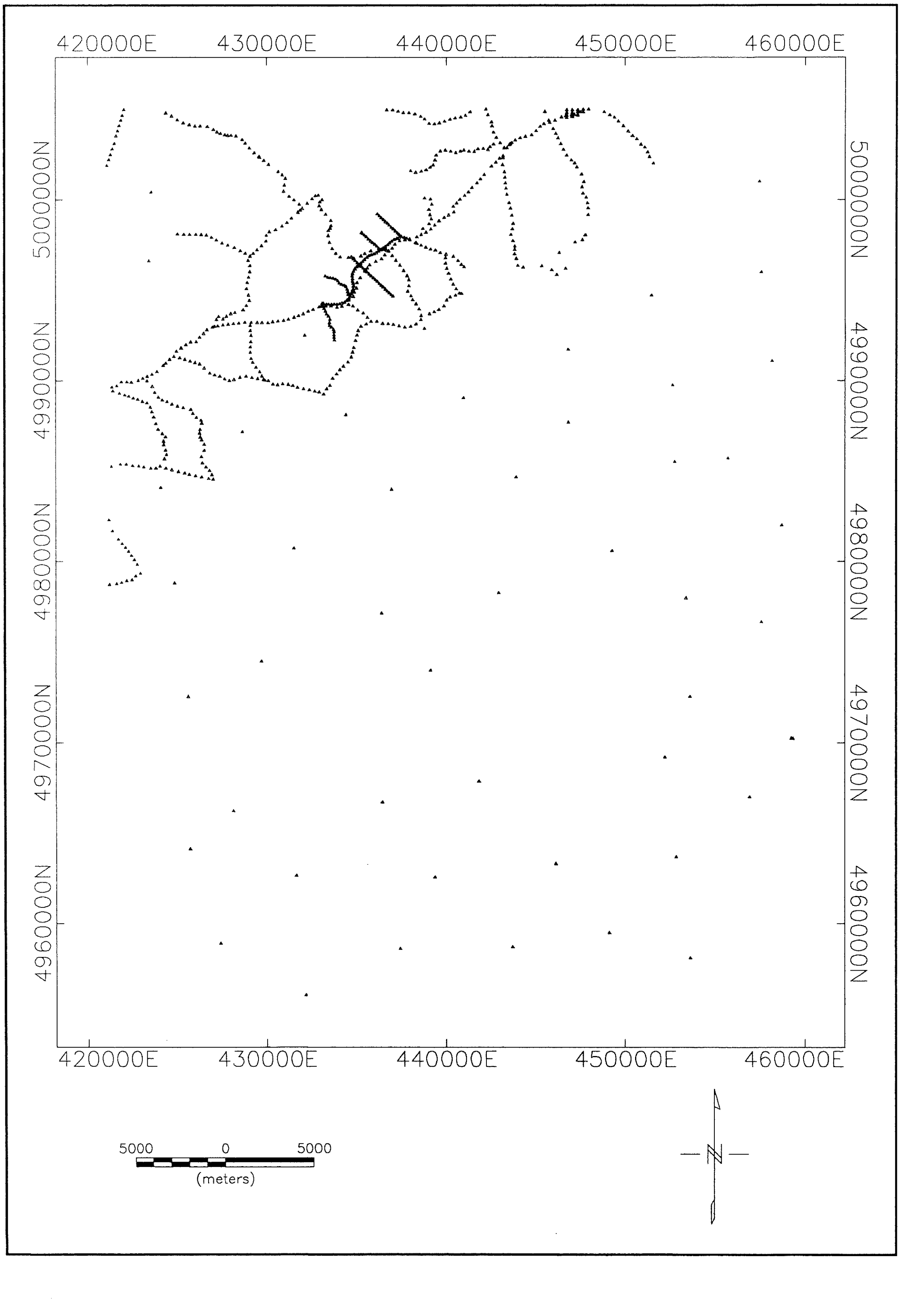

Figure 1.3 Diagram showing the sparse gravity data that existed (south of the Carboniferous rocks) within the study area prior to this study. Data from Howells and Clarke (1995).

1.6 Organization

Chapter 2 describes the geology of the map area and recent mapping by the Nova Scotia Department of Natural Resources. Chapter 3 explains some of the theory behind gravity methods and describes the gravity reduction processes. Chapter 4 will present the results in the form of a Bouguer anomaly map and Chapter 5 will contain models of the subsurface. Finally, Chapter 6 will contain conclusions and recommendations for further work.

CHAPTER 2 GEOLOGICAL SETTING

2.1 Meguma Terrane

The Meguma Terrane is an internally homogeneous geologic province with characteristics that contrast with those of the adjacent Avalon Terrane. It forms most of mainland Nova Scotia (Fig. 1.1) and is composed of the Meguma Group (a thick conformable sequence of Cambrian to Ordovician metasedimentary rock; Schenk, 1983), Late to Early Devonian metasedimentary-metavolcanic rocks, and Devonian to Carboniferous granitic bodies. Late Devonian to Tournaisian coarse terrestrial sedimentary rocks of the Horton Group unconformably overlie the Meguma Group and granite intrusions.

The Meguma Terrane was deformed during the mid-Devonian Acadian Orogeny, during which time it was accreted to North America along the Cobequid-Chedabucto Fault System (Williams and Hatcher, 1983). Deformation consisted of the development of large-scale north-east-trending folds and regional metamorphism (greenschist to amphibolite grade; Muecke *et al.*, 1988; Keppie *et al.* 1987). The younger granitic intrusions truncate the north-east-trending folds and are characterised by local contact aureoles. Rocks of Carboniferous age and younger overlay the Meguma Terrane as well as the Avalon Terrane.

2.2 Meguma Group

The Meguma Group is the main constituent of the Meguma Terrane. It represents a succession that shoals upward from submarine fans to shelf and nearshore lithologies (Schenk, 1991) and has been subdivided into the Goldenville and Halifax Formations (Woodman, 1904; Fletcher and Faribault, 1911). Recently, further stratigraphic subdivision has been assigned on a local scale to the transition zone between the Goldenville Formation (metagreywacke and metaquartzite) and the slate of the Halifax Formation (GHT; O'Brien, 1988; Zentilli *et al.*, 1986; Binney *et al.*, 1986; Graves and Zentilli, 1988; Sangster, 1992). The GHT has been recognized at various locations throughout the Meguma Group and is usually characterised by a finely laminated, manganiferous unit that may be rich in calcareous nodules, spessartine quartzite, and sulphides (Zentilli *et al.*, 1986).

2.3 Geology of the Study area

2.3.1 *Introduction*

The study area (Fig. 1.1 and 1.2) is dominated by Meguma Group metasedimentary rocks. The northern portion of the study area is characterised by Carboniferous rocks, whereas, the SMB and MB are exposed in the south-west and south-east corners of the map area, respectively. The Kinsac Pluton is situated between the two larger intrusions.

2.3.2 *Goldenville Formation*

Within the study area, the Goldenville Formation consists of mainly thickly bedded metasandstone with minor interbedded metasiltstone and slate (Fig. 2.1; Fox, 1994; Ryan, 1994). Broad anticlines within the study area are associated with the Goldenville Formation.

2.3.3 *Transition Zone*

Strata of Mn-rich slate, metasiltstone, and fine grained metasandstone containing abundant spessartine garnet have been interpreted as the GHT within the study area (Fig. 2.1; Ryan, 1993). The location of the GHT within the study area is shown in Figure 1.2.

2.3.4 *Halifax Formation*

Within the study area the Halifax Formation is mainly confined to three north-east-trending synclines, the Kinsac Syncline, Uniacke Syncline, and the Rawdon Syncline. The Halifax Formation within the inclined and plunging Rawdon Syncline has been subdivided into the Rawdon and Glen Brook units (Fig. 1.2 and 2.1; Horne, 1993). The thin (~ 800 m) Rawdon Unit is composed of sulphide rich, bituminous black slate and is overlain by pale green to grey banded slate of the Glen Brook Unit. Thickness of the Glen Brook Unit is unknown. The rocks along the northern limb of the Rawdon

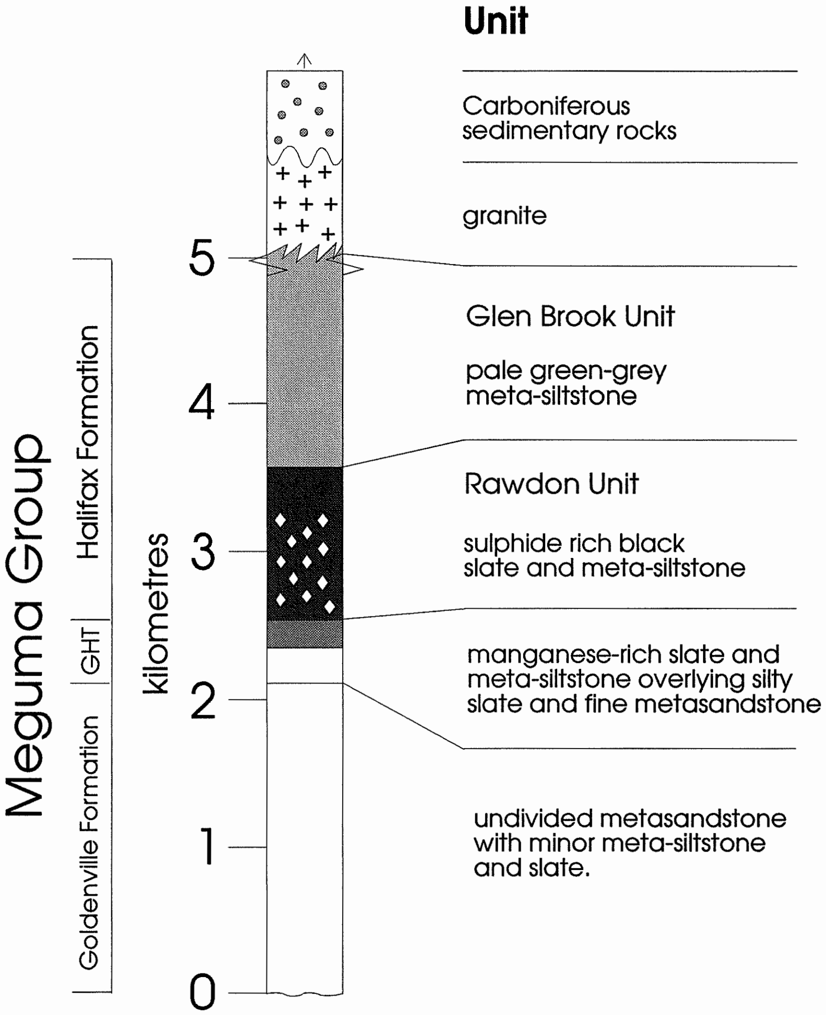

Figure 2.1 Stratigraphic column for the study area with description of units (after Haysom *et al.*, *in press*)

Syncline are steeply faulted against Carboniferous sedimentary rocks. Regionally, the Rawdon and Glen Brook Units correlate well with the Cunard and Feltzen members at Mahone Bay.

The smaller Uniacke syncline contains sulphide rich black slate of the Rawdon Unit. The Halifax Formation within the Kinsac Syncline has not yet been subdivided into the Rawdon and Glen Brook Units.

2.3.5 *South Mountain Batholith*

The South Mountain Batholith (SMB) is the largest of the Devonian granitoid intrusions within the Meguma zone and was emplaced after the folding and regional metamorphism of the Acadian orogeny. The South Mountain Batholith occupies an area close to 10,000 km^2 (Fig. 1.1; MacDonald and Clarke, 1985) and is a composite of 13 plutons which, on the basis of lithological and textural similarities, have been grouped into six main rock types: (1) leucogranite, (2) fine-grained leucomonzogranite, (3) coarse grained leucomonzogranite, (4) muscovite-biotite monzogranite, (5) biotite monzogranite, and (6) biotite granodiorite (MacDonald *et al.*, 1992).

Interpretation of regional gravity data by Garland (1953) and Douma (1978) suggested that the SMB is approximately mushroom shaped, with a large slab-like form 5-10 km thick and a main column reaching depths of 20-25 km near the New Ross pluton.

2.3.6 *Musquodoboit Batholith*

The Musquodoboit Batholith (MB) is a large Devonian-Carboniferous aged granitoid intrusion that covers an area of approximately 800 km^2 in Central Nova Scotia (Fig. 1.1). Like the larger SMB, the MB is a massive, post-tectonic intrusion injected into Meguma Group country rock. Monzogranites dominate approximately 80-90% of the intrusion with two other small porphyritic bodies and minor aplite and aplite-pegmatite dykes located throughout the batholith (MacDonald and Clarke, 1985).

2.3.7 *Kinsac Pluton*

The Kinsac Pluton is a small, 5-6 km^2 , approximately circular (in outcrop), Devonian aged (369-379 Ma) granitic intrusion with composition similar to that of the SMB and MB (Coolen, 1974). It is located between the larger batholiths and is bounded on all sides by the Halifax Formation within the Kinsac Syncline (Fig. 1.2).

Stoping and assimilation are not believed to be the methods of intrusion. Sharp contacts, lack of sedimentary inclusions, chemical data, and warping of country rock around the pluton suggest that implacement was mainly achieved by forceful injection (Coolen, 1974).

Very little is known about the subsurface structure of the Kinsac Pluton. Common differentiation from a melt of similar composition, approximately same time of emplacement, and geographic location, are all lines of evidence that suggest that it is a small unroofed section of the larger MB to the east (Coolen, 1974).

2.3.8 *Carboniferous rocks*

Carboniferous age units within the study area consist of the Scotch Village Formation (sandstone, siltstone and conglomerate), the Windsor Group (sandstone and carbonates), and the Horton Group (sandstone and conglomerate). The Carrols Corner Formation (anhydrite and gypsum) overlays the base of the Windsor Group (Macumber Formation) sedimentary rocks in the north-western section of the map area, but do not outcrop. These units are grouped as "undivided Carboniferous rocks" in Figure 1.2.

CHAPTER 3 METHODS

3.1 Gravity Theory

Information pertaining to gravity theory within this section was taken from both Dobrin and Savit (1988) and Kearey and Brooks (1991).

The basic idea behind a gravity survey is that rock units in the subsurface that have different densities than their surroundings (causative bodies) create variations in the local gravitational field. These variations are known as gravity anomalies. There are many geological circumstances that can produce gravity anomalies. For example, large negative gravity anomalies can be produced by granitic plutons and sedimentary basins. Small scale negative anomalies are common for salt domes and small local anomalies are common for buried valley fills.

A gravity survey involves the passive measurement of a natural potential field at different locations. Gravity data are used to infer the subsurface configuration, and the best result is assumed to be the most reasonable one that agrees with all other sources of information. Gravity data contain contributions from everything in the nearby subsurface. For example, if an area was underlain by three different bodies, each with densities different from the country rock, a gravity measurement taken at the surface would contain contributions from each of them (Fig. 3.1).

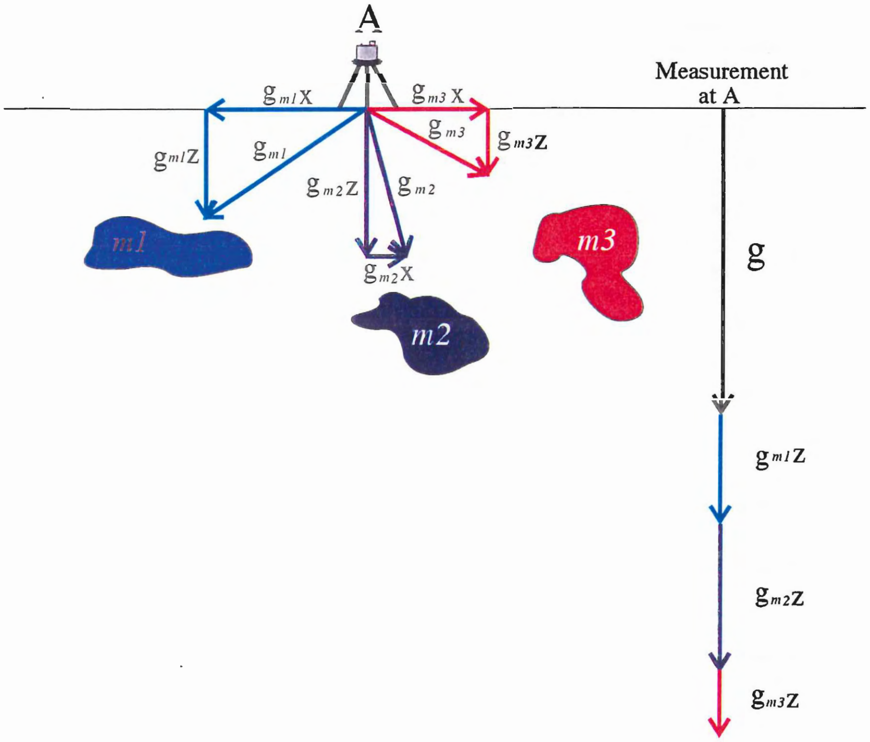

Figure 3.1 Diagram showing the gravitational contributions from different masses, $m_1 > m_2 > m_3$.

When studying gravity, an acceleration of 1 cm/s^2 is referred to as a Gal, and the average gravitational acceleration at the surface of the earth is 980 Gal. In a gravity survey it is actually the change in gravity from one location to the next that is measured (relative gravity). This amount is always less than 1 Gal, therefore the milliGal is used (mGal=$\frac{1}{1000}$ Gal).

3.2 Survey Design and Data Collection

Four factors generally control the location and number of gravity stations during a survey: (1) accessibility, (2) gravity station pattern required to cover the geologic features of interest, (3) availability of precise xyz coordinates for gravity stations and (4) time.

Control monuments or bench marks make useful gravity stations because precise elevation and location coordinates exist for them. Prior to this study complete control monument data for the study area was obtained from the Nova Scotia Department of Natural Resources. The data showed that there was a good distribution of control monuments throughout the study area making them all potential gravity stations (Map 1). The control monuments are mostly located along major roads making them quite accessible.

Data for this study was collected from mid-August 1995 to late-October 1995, and a total of 276 gravity stations was obtained (Fig 3.2). To optimise the time available for data collection, stations were chosen at control monuments (Fig. 3.3) that were located along easily accessible roads that run approximately orthogonal to the north-east-trending geology. The Beaverbank Road, for example, contains many gravity stations and run perpendicular to the trending geology (Map 1). Unfortunately not all the gravity stations are located at control monuments. When it was felt necessary, gravity stations were sometimes established on roads that did not have control monuments. In such cases the xyz coordinates had to be approximated. Thus, the precision of the

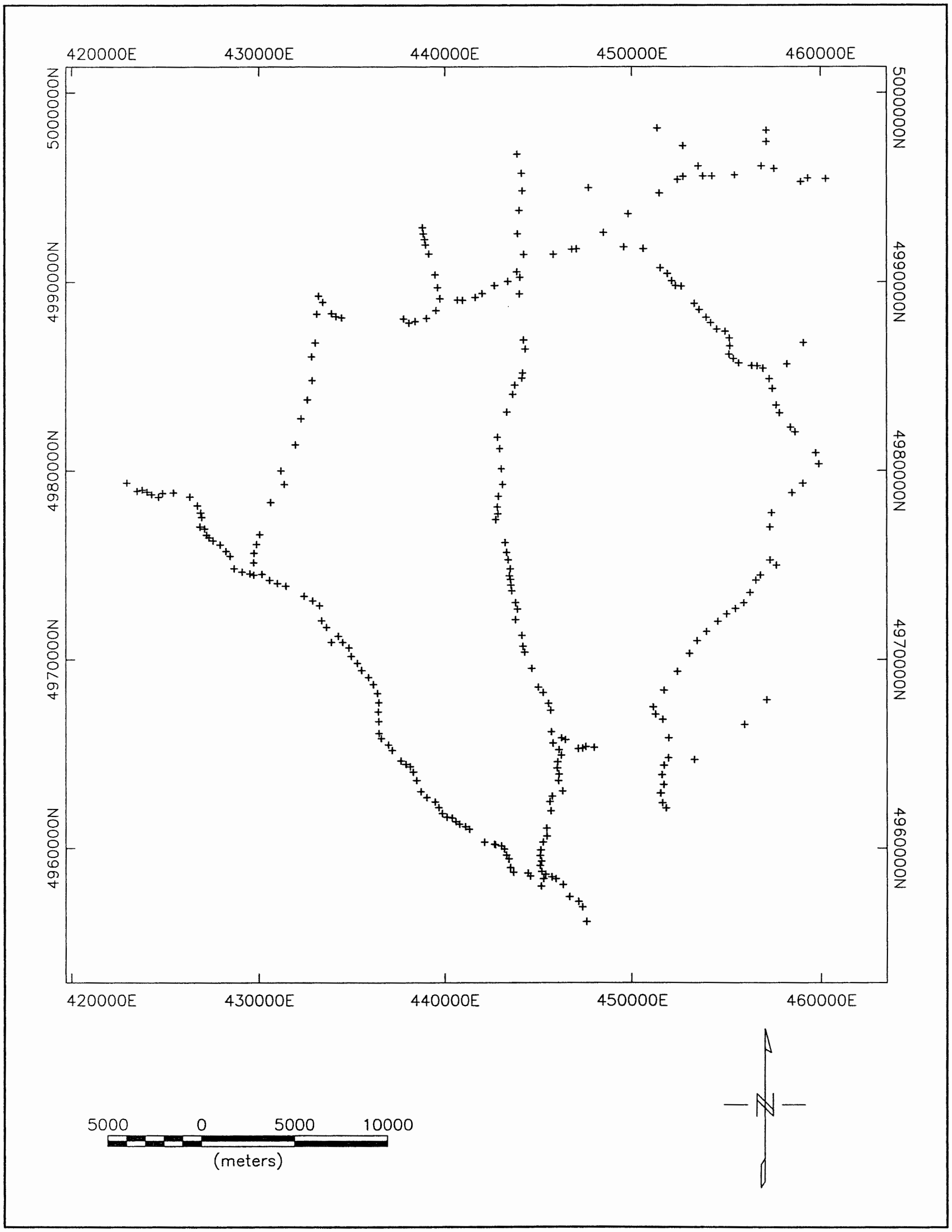

Figure 3.2 Map showing the location of gravity stations obtained from this study.

Figure 3.3 Photos showing a good gravity station with a control monument and its marker. Often the marker is not present or the control monument is damaged or missing.

elevation data at these stations is less than that of stations located at control monuments). The uncertainty of elevation results in an estimated error of ± 0.8 mGal for gravity stations not located at control monuments, whereas, measurements taken at control monuments are accurate to within ± 0.01 mGal.

Data for this study were collected using a Lacoste and Romberg gravimeter (Appendix A) on loan from the Geological Survey of Canada.

3.3 Density Determinations

Density values for the Halifax and Goldenville Formations were determined from samples available from the Nova Scotia Department of Natural Resources (APPENDIX B). Density data for the South Mountain Batholith were also acquired from the Nova Scotia Department of Natural Resources.

3.4 Data Reduction

Raw gravity data acquired directly from the gravity meter during a survey must first go through several processes to correct, or reduce, it into a form that can be used for analysis. Several factors, other than subsurface rock density contrasts, cause gravity to change throughout the period of the survey: (1) instrumental drift, (2) change in latitude, (3) change in elevation, and (4) tidal variations.

Readings taken directly from the gravity meter are not in milliGals, they must be converted into milliGals using a conversion factor provided with the gravity meter (see Appendix A).

3.4.1 *Drift Correction*

Instrumental drift is the first factor to correct for. It is caused by the relaxing of the spring within the gravimeter over time and results in incorrect measurements. Drift is corrected for by repeating a station at different times throughout the day and plotting the gravimeter reading against time (Fig. 3.4a). The value for the later readings should be the same as that of the first reading, so the appropriate amount is removed or added to the later readings to make them equal to the first. Drift corresponding to other gravity stations is corrected for by using the same drift curve. A value of drift *d* is removed or added to each station that matches the time *t* of the measurement.

Instrumental drift must also be corrected for when the survey spans more than one day. The same method applies as when correcting for drift in one day. A station is repeated from one day to the next. Theoretically they should both have the same reading, therefore, the difference between them is subtracted or added to the entire second day's data to bring it back to the same datum level as the first day's data (Fig. 3.4b)

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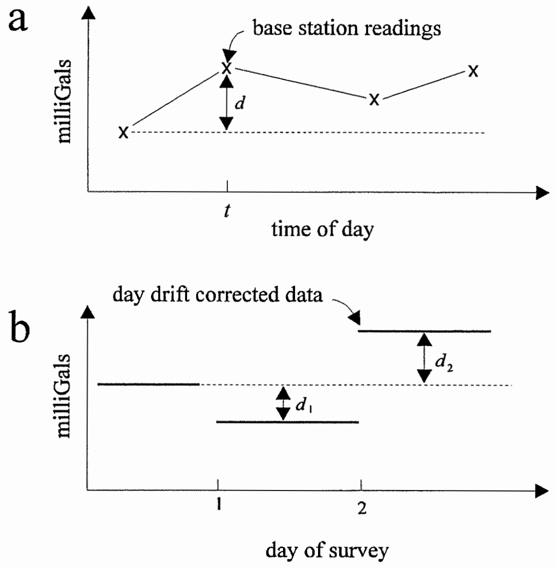


Figure 3.4 Sketch illustrating drift correction: (a) throughout a day, and (b) from day to day.

3.4.2 *Latitude Correction*

The earth is rotating, as result the earth is actually an oblate spheroid where its radius *R* is greater at the equator than at the poles. Since gravity decreases with the increase of *R,* gravity increases from the equator to the poles. In order to compare gravity measurements at different locations this change in gravity with latitude must be corrected for.

The north-south gravity gradient at latitude ϕ is

$$0.812\sin(2\phi) \text{ mGal km}^{-1}. \qquad 3.1$$

For this study $\phi = 44.8^0$ (latitude of base station 1). The appropriate number of milliGals is then subtracted from the drift corrected data for every kilometre north of the reference latitude, to correct for the increase in gravity, and added to the drift corrected data for every kilometre south of the reference latitude, to correct for the decrease in gravity.

3.4.3 *Elevation Corrections*

Gravity decreases with distance from the centre of the earth. Since gravity stations have various elevations, the free-air correction (FAC)is applied to remove the effects of elevation and reduce all the data points to the same datum (sea-level). The equation

$$FAC = 0.3086h \text{ mGal} \tag{3.2}$$

is applied where h is the elevation of the station in meters. The free-air correction is positive for stations above sea level to account for the decrease in gravity with increased distance.

The free-air correction only accounts for the change in h, yet there is rock between datum and elevation h that produces a gravitational effect, this must be corrected for. The Bouguer correction (BC) is applied and assumes that there is a layer of rock beneath the station location that has infinite horizontal dimensions, a uniform density, and a thickness equal to h. The equation

$$BC = 0.04191\varrho h \tag{3.3}$$

is applied where ϱ is the rock density in g/cm^3. This study used a density of $2.71 g/cm^3$ (average Meguma density). For land stations, the Bouguer correction is subtracted from the free-air corrected data.

The Bouguer correction assumes that the topography is flat. To account for further local topographic relief the terrain correction can be applied. This correction, however, is extremely time consuming and was not applied in this study since the topography is fairly flat.

3.5 Data compilation

Upon completion of data reduction the new data set was combined with the old data set obtained from Howells and Clarke after some adjustment. In order for the two data sets to be combined the new data set had to be referenced to the same datum as the old data set. This was done by repeating several stations from the old data set and comparing the values. An average difference was calculated (Table 3.1) and this amount was subtracted from each station in the new data set. Since the values in the old data set were referenced to absolute gravity, the values in the new data set were converted from relative gravity measurements to absolute gravity measurements following this procedure.

Station #	Value from this study (mGal)	Value from Howells and Clarke, 1995 (mGal)	Difference (mGal)
36	9.02	-11.59	20.61
41	13.64	-7.28	20.92
68	12.46	-8.89	21.35
64	7.89	-12.77	20.66
75	11.60	-9.55	21.15
79	8.83	-11.85	20.68
110	6.48	-12.53	19.01
168	1.78	-18.82	20.60
187	7.26	-13.33	20.59
			Avg. = 20.62
			STD = 0.66

Table 3.1 Calculation of average difference between data sets. STD = standard deviation.

CHAPTER 4 RESULTS

4.1 Bouguer Gravity Data

Appendix C contains the corrected gravity data calculated from this study. The table includes the initial gravity meter readings, the total drift corrected gravity values, the amount of latitude, free-air and Bouguer corrections, as well as the total corrected Bouguer gravity values relative to base station 1 and relative to the old data set obtained from Howells and Clarke 1995 (absolute values). Station numbers are plotted on Map 1.

A quick glance at the data in Appendix C suggests that there is a general increasing trend in the Bouguer gravity values as the distance north increases. This trend is due to the decreasing regional gravitational influence of the granite bodies to the south and the increasing influence of the Halifax Formation within the Rawdon Syncline to the north.

4.2 Bouguer Gravity Contour Map

When the data from this study are combined with the pre-existing data set the result is a much more detailed data coverage (Fig. 4.1). A contour map produced from the combined data set (Fig. 4.2) shows several interesting features that can be classified into three distinct gravity zones (Fig. 4.3). Zone 1 (approximately south of

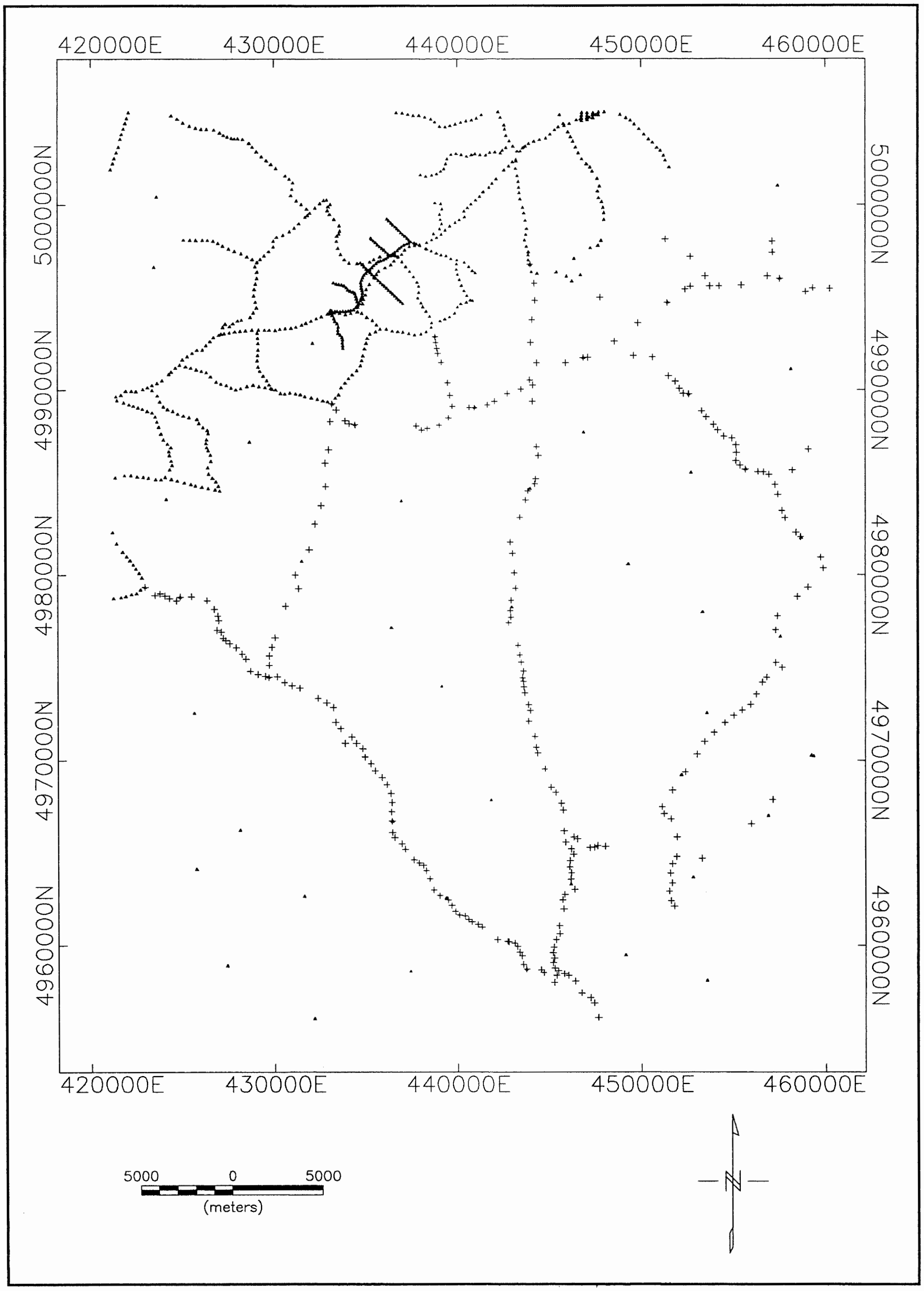


Figure 4.1 Diagram showing the distribution of gravity stations within the study area after combining the new and old data sets. Triangles represent previously existing data and crosses represent data obtained from this study.

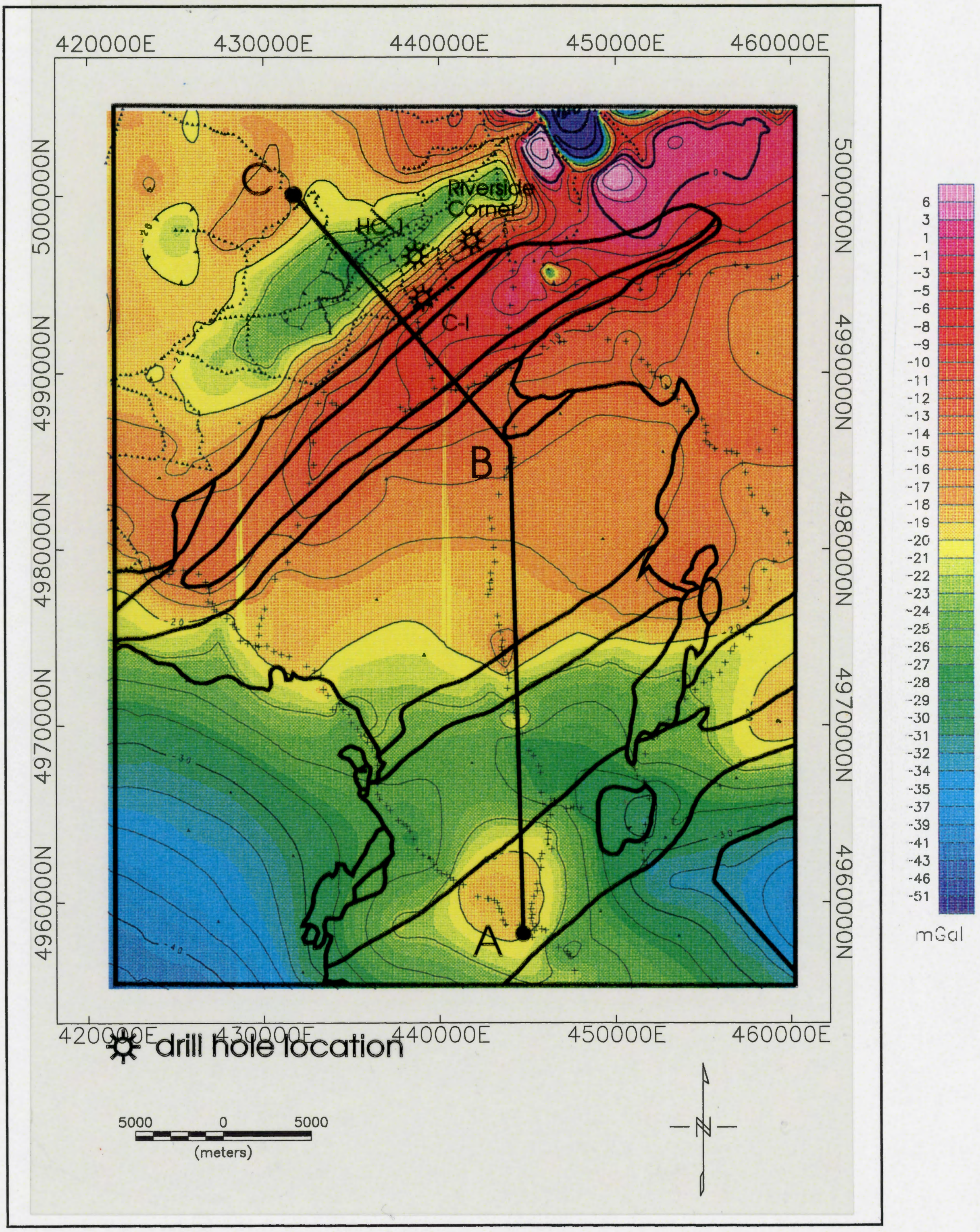


Figure 4.2 Bouguer gravity contour map with station locations and geology on an overlay (see Figure 1.2 for description of geology). Triangles represent data from Howells and Clarke (1995) and crosses are station locations from this study. Contour interval is 2.5 mGal. Line A-B-C represents a 2.5 dimensional profile discussed in the following chapter.

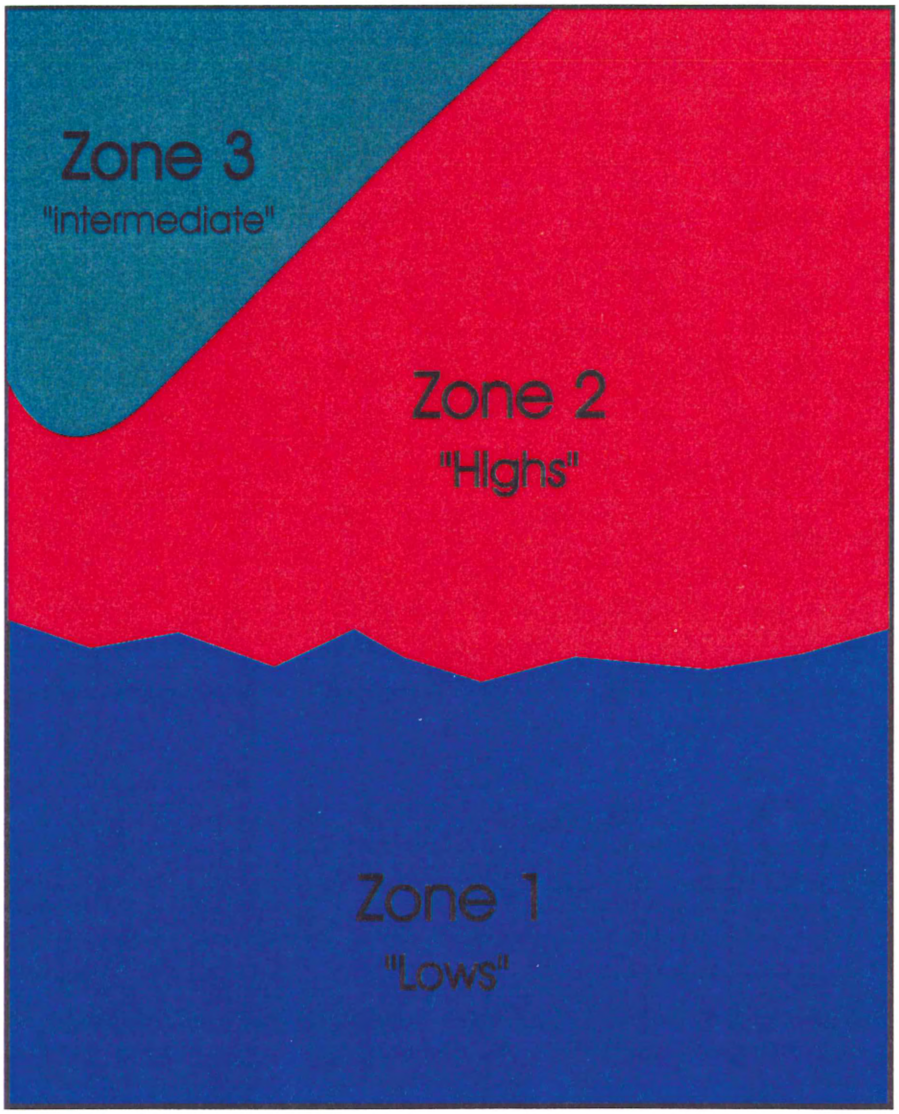


Figure 4.3 Diagram illustrating the three broad zones within the Bouguer gravity contour map.

4975000mN) covers the southern portion of the map area and is dominated by gravity lows. In fact, the lowest lows (less than -30 mGal) are located in the southwest and south-east corners of the map area. When the geology is placed on the contour map it is clear that the lowest lows are associated with the South Mountain and Musquodoboit Batholiths. A small negative anomaly located just to the north-west of the Musquodoboit anomaly corresponds to the location of the Kinsac Pluton. The only positive anomaly found in the low gravity zone is located in the southernmost central region of the map. Although the actual values are negative, they are high compared to the adjacent contours. This local high zone correlates with the southern portion of the Kinsac Syncline. This suggests that the syncline is massive enough in this area to produce a gravity signature that is strong enough to be discernible against the regional effects of the large granite bodies. A signature from the Kinsac Syncline farther to the northeast is more difficult to pick out.

Zone 2 is a zone of gravity highs. It extends from the top of zone 1 to approximately 4988000 meters north in the west and to the top of the map area in the east. The most obvious feature of this zone is the linear gravity high trending to the north-west. This feature matches the location of the Rawdon Syncline. The decreasing contour values to the south-east section of the syncline suggest that the structure deepens to the north-east. This is consistent with the geology since it was stated earlier that the Rawdon Syncline is north-east plunging.

The much shallower Uniacke Syncline is more difficult to distinguish on these contour maps. However, upon comparison of the geology and gravity, a small anomaly just north of the centre of the -20 mGal contour (~ 440000mE - 4975000mN) and the southward extension of a gravity high (~ 453000 - 4980000mN) may be the signature of the syncline.

Zone 3 has gravity values between those of zone 1 and 2. It encompasses the north-west corner of the map area and contains some lows, but not as low as those of zone 1, and some highs, but not as high as those of zone 2. Zone 3 is composed of Carboniferous rocks and the lows are likely due to salt within the lower Windsor Group.

A cluster of extremely high and extremely low values are located along the northern edge of the study area around 447000 meters East. A detailed survey was performed earlier in this area by a private company, likely in search of salt. Inspection of the data in the area shows extremely low values in the order of -500 mGal but no extremely high values. Further discussion of this area will not be included in this thesis.

Another interesting feature presented on the contour map is the steep gravity gradient along the north limb of the Rawdon Syncline that separates zones 2 and 3. The steep gradient indicates a strong density change between rocks in the subsurface as a result of change in lithology. This contrast is due to the Rawdon Fault which separates the Carboniferous rocks to the north-west from the denser Meguma rocks to the south. The contours may trace the fault within the map area.

Three dimensional surface plots of data are useful visual representation purposes. Figure 4.4 is such a plot of the gravity data within the map area. The main features are clearly visible: 1) zone 1 to the south with the lowest lows representing the batholiths in the southern corners, and the high in between representing the Kinsac Syncline, 2) zone 2 with the gravity high along the Rawdon Syncline, 3) intermediate values of zone 3 in the north-west corner, and 4) the steep gradient along the boundary between zones 2 and 3.

4.3 Density Determinations

A knowledge of density values for different rock types is needed for modelling purposes. Appendix B contains the data and method used to determine the bulk density values for the Halifax Formation and the Goldenville Formation. Table 4.1 outlines the values adopted for the above, and other units within the study area.

Previous to this study, no attempt was made to subdivide the Halifax Formation within the study area on the basis of density values. O'Reilly (1976) noted that several of his slate samples had bulk density values higher than the average Meguma value and attributed this to high sulphide content. Previous gravity studies by O'Reilly (1976) and Douma (1978) focused on entire the SMB. Unlike this study, subdivision of the Meguma Group was not required for such large scale investigations.

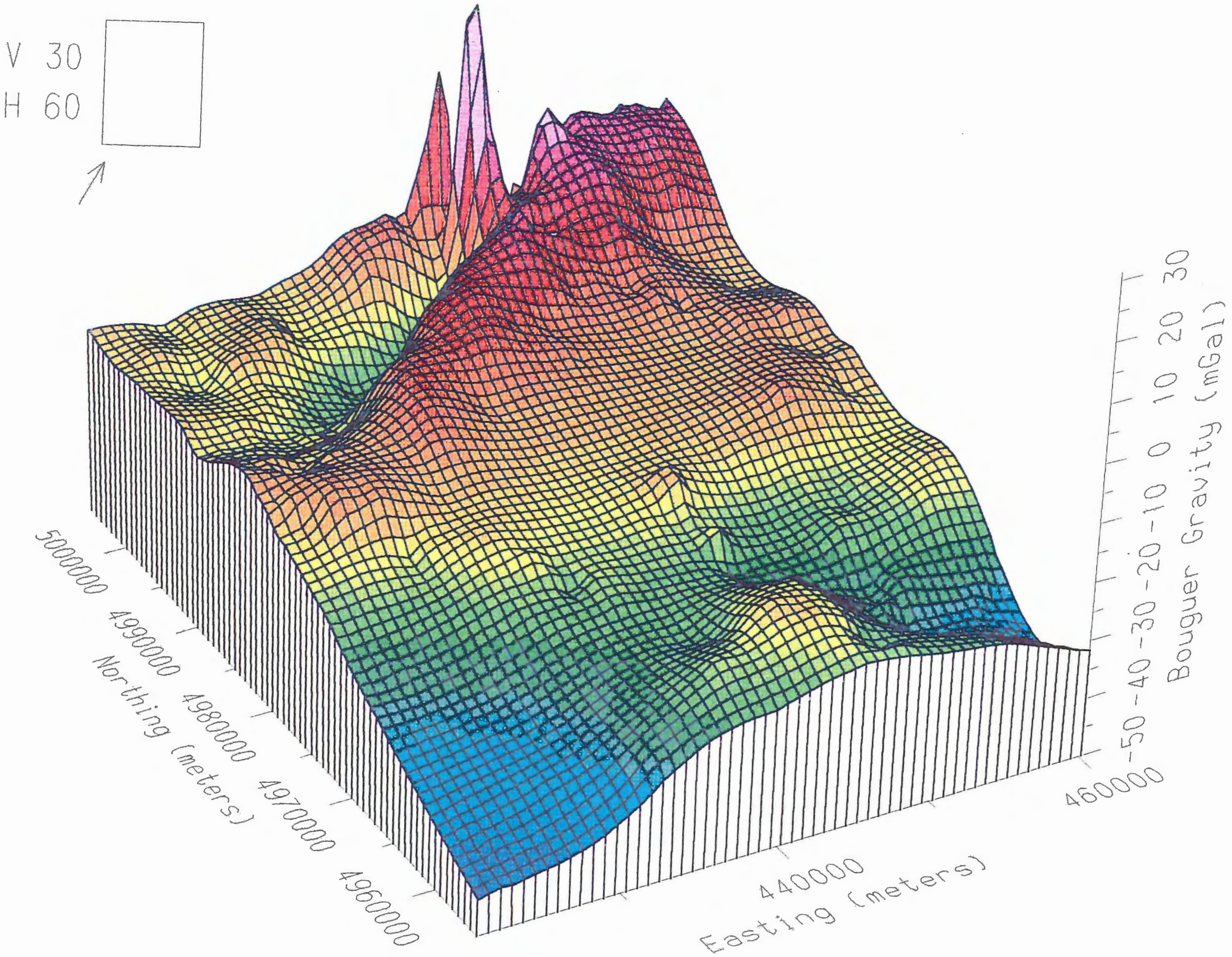


Figure 4.4 Three dimensional perspective view of the Bouguer gravity within the study area.

	Bulk Density						
Unit	**This Study**	**O'Reilly (1975)**	**Douma (1978)**	**MacDonald (1996)**	**Howells (1986)**	**Adopted Value**	**Density Contrast**
Meguma Group							
Halifax Formation Rawdon Unit	2.77					2.77	+0.09
Halifax Formation Glen Brook Unit	2.74					2.74	+0.06
Undivided Halifax Formation			2.76			2.75	+0.07
Goldenville Formation	2.68		2.69			2.68	0.00
Undivided Meguma Group		2.73	2.73		2.65		
SMB		2.63	2.64	2.63		2.63	-0.05
Carboniferous rocks							
Watering Brook Formation, Scotch Village Formation and Upper Windsor Group (above halite)					2.55	2.55	-0.13
Lower Windsor Group (evaporites, carbonates and minor sediments)					2.28	2.28	-0.40
Carrols Corner Formation (anhydrite/gypsum)					2.82	2.82	+0.14
Horton Group					2.60	2.60	-0.08

Table 4.1 Density determination results from this study and from other sources. The density contrasts, which were calculated using the Goldenville Formation as a reference, are used during the modelling process. All values are in g/cm^3.

CHAPTER 5 MODELLING AND DISCUSSION

5.1 Constraints On Modelling

Several constraints were used in the modelling process: (1) density determinations, (2) geology, (3) structure of rock units, (4) drill cores, (5) previous models, and to a lesser extent, magnetic susceptibility. Fixing density values for specific units allows only the geometry to be variable. Geological maps constrain the location of units near the surface of the model. Structure indicates the subsurface projection of a synformal feature. Previous models of Carboniferous rocks (Howells, 1986) constrain the north-western section of the profile in this study area, as do simple magnetic susceptibility models for the Rawdon Syncline.

Three cores (Fig. 4.2) drilled by the Nova Scotia Department of Mines and Energy are useful for this study to constrain the relationship between the Meguma and Carboniferous rocks: (1) the Riverside Corner core, drilled in 1986, (2) the 1986 Hants County C-1 diamond drill hole, and (3) the HC-1 Clarksville drill hole which was drilled in 1975.

The Riverside Corner core intersected Windsor Group salt at a depth of 657 metres (Howells, 1986). No encounters were made with the Meguma Group despite its lateral proximity. Meguma Group rocks lie at a greater depth below the Windsor Group.

The 647 metre Drill hole C-1 is located just to the north-west of the West Gore antimony-gold deposit . It encountered 110.1 meters of Horton Group sedimentary rocks, followed by a 4 meter thick graphitic zone (Smith and Webber, 1986). The rest of the core is dominated by sulphide rich sediments of the Halifax Formation, probably the Rawdon Unit.

HC-1 was drilled to a depth of 371 meters through sedimentary rocks, including Windsor Group halite and anhydrite, but did not encounter any Halifax Formation rocks (Boehner, 1986). This change in geology over such a short distance, as in the case of the Riverside Corner hole, indicates the presence of a steeply dipping fault(s). Unfortunately cores useful for this study are not found further south. Holes drilled within the Meguma rocks are not deep enough to constrain variables involved with this study.

5.2 Modelling - 3D

The basic input into the three dimensional modelling program consists of: (1) a file containing the vertex coordinates and density contrasts for one or more vertical prisms, and (2) a grid file defining the location of the study area. Full control over the shape of the prism(s) is given in the x-y plane. However, the prism(s) dimensions along the z-axis are limited to defining the depth to the top and bottom surfaces, i.e. the prisms are vertical extensions of two dimensional shapes (Fig 5.1). The program then calculates and combines the gravitational effects of each prism on each grid point in the map area. The basic output is a grid file containing the calculated gravity values that can be contoured using a separate program. The program does not actually output a three dimensional view of the model.

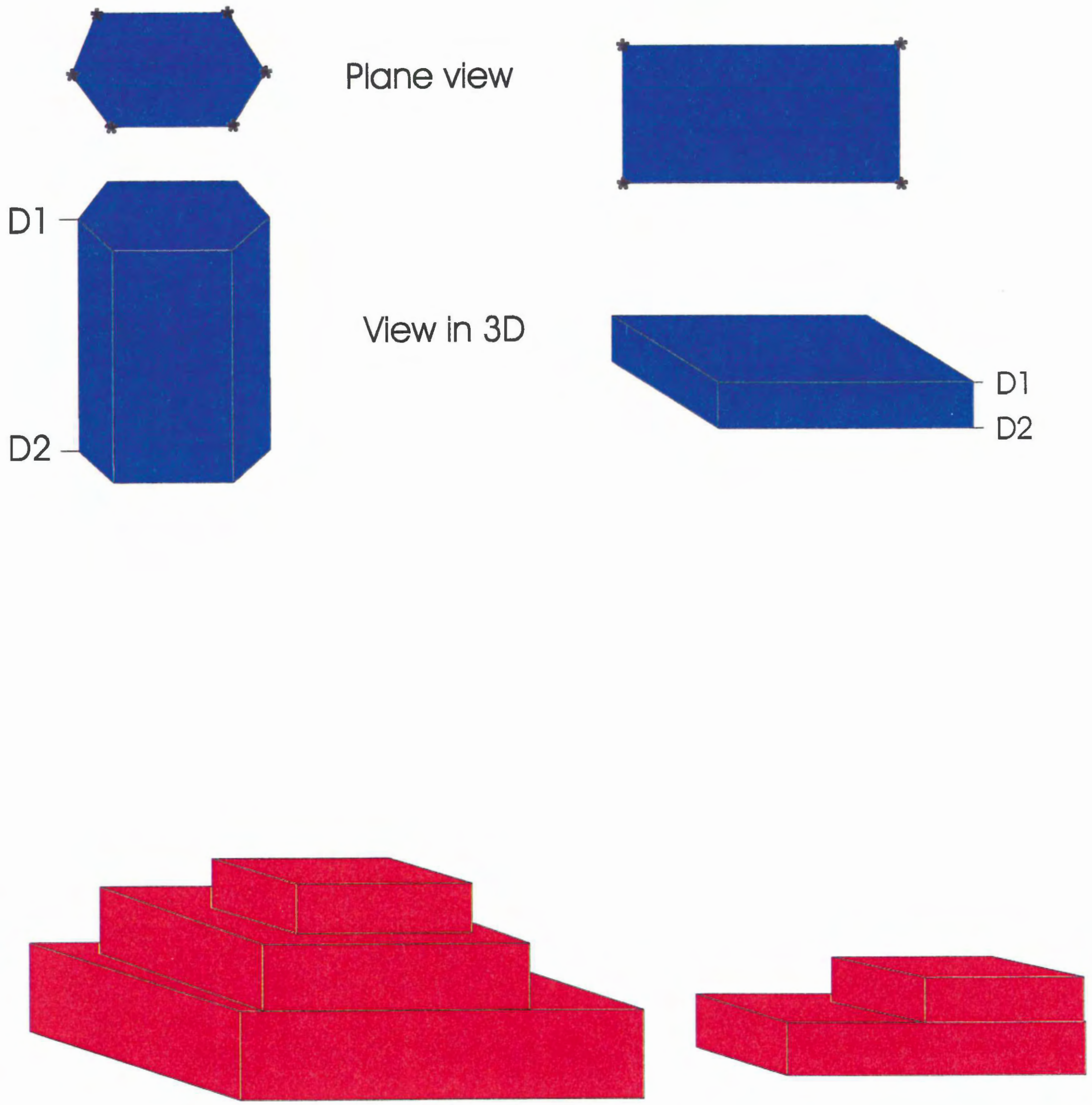


Figure 5.1 Description of vertical prisms used for 3D modelling. (a) Plane view and 3D view. Asterisks are vertices that are defined in the input file. D1 and D2 are the depth to top and bottom surfaces, respectively, that are also defined in the input file. (b) Example of a model constructed of several vertical prisms.

The gravitational modelling process consists of constructing a structure of vertical prisms that yield calculated gravity values similar to gravity measurements observed in the field. Regional structures, such as the SMB and MB, are modelled first to obtain regional gravity trends. Local features are then added to the model to generate the second order gravitational effects.

Figure 5.2 is a calculated gravity contour map for the study area, constructed using a total of 35 vertical prisms to generalise the geology. Many prisms extend outside the study area to minimise end effects and to produce regional gravity trends. The location and depth of the prisms used to model the granite bodies and the Halifax Formation within the study are shown in APPENDIX D. The density contrasts calculated in Table 4.1 were applied to the appropriate prisms. The same density contrast was used for the SMB, MB and Kinsac Pluton.

Since the three dimensional modelling program calculates gravity for vertical prisms, detailed three dimensional modelling of the Rawdon and Glen Brook Units of the Halifax Formation would be extremely difficult and time consuming. Therefore, an intermediate density contrast of +0.07 (Table 4.1) was chosen for three dimensional modelling of the Rawdon Syncline. This value is weighted towards that of the dominant Glen Brook Unit. A density contrast of +0.09 (Table 4.1) was used for the Uniacke Syncline since it is composed only of the Rawdon Unit. The Kinsac Syncline has not been subdivided into the Rawdon and Glen Brook Units. The intermediate density contrast of +0.07 was therefore applied to this feature.

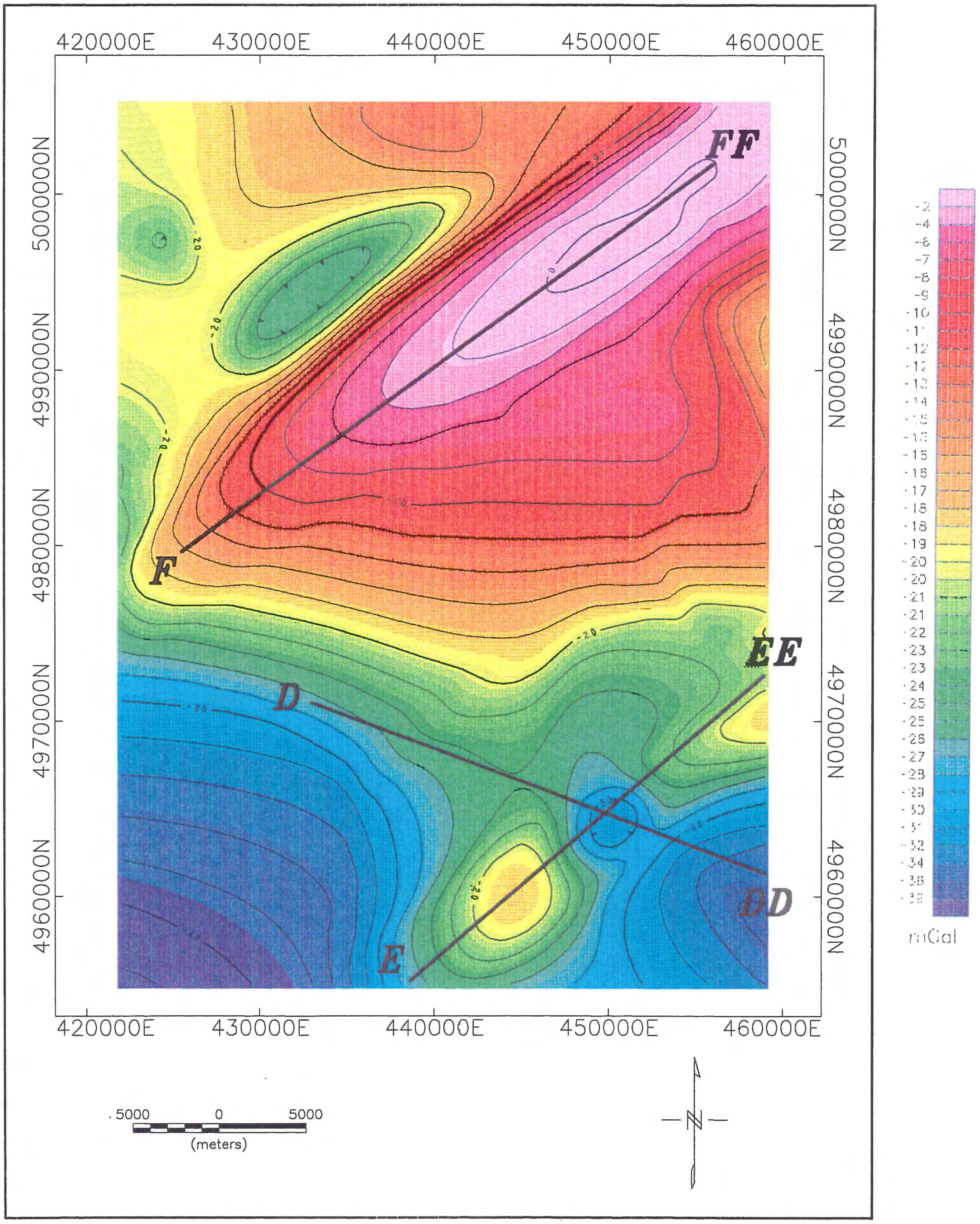


Figure 5.2 Map showing calculated gravity values from the 3D model. Contour interval is 2 mGal. D-DD, E-EE, and F-FF are lines of cross-sections shown in Figure 5.5.

The ideal model would yield calculated gravity values indistinguishable from the observed gravity values, i.e. the maps would look the same. Figure 5.3 is a map of the study area which represents the difference between the observed Bouguer gravity (Fig. 4.2) and the calculated gravity (Fig. 5.1). Areas where values are 0, are areas where the calculated gravity is equal to the observed Bouguer gravity. Areas of notable disagreement include: (1) west of the MB in the south-east corner of the map area (~ 450000mE and 4955000mN), (2) the southeastern edge of the SMB around 435000mE and 4959000mN, and (3) along the edge of the Carboniferous rocks, around 450000mE and 4987000mN. The errors associated with the SMB and MB are due to the granite being modelled to close to the surface in these areas. As a result, the values are to low and when subtracted from the observed Bouguer gravity produce a positive error.

Good agreement (0-4 mGal difference) exists around the geological structures of interest to this study. For example, between the SMB and MB, and around the Kinsac Pluton, the calculated error range is between 0 and 2 mGal. Also, the Rawdon syncline area exhibits errors of between 0 and 4 mGal. The larger errors are associated with the Carboniferous rocks that cover the north-east portion of the syncline.

Overall, Figure 5.3 shows that the model is a good representation of the geology within the study area.

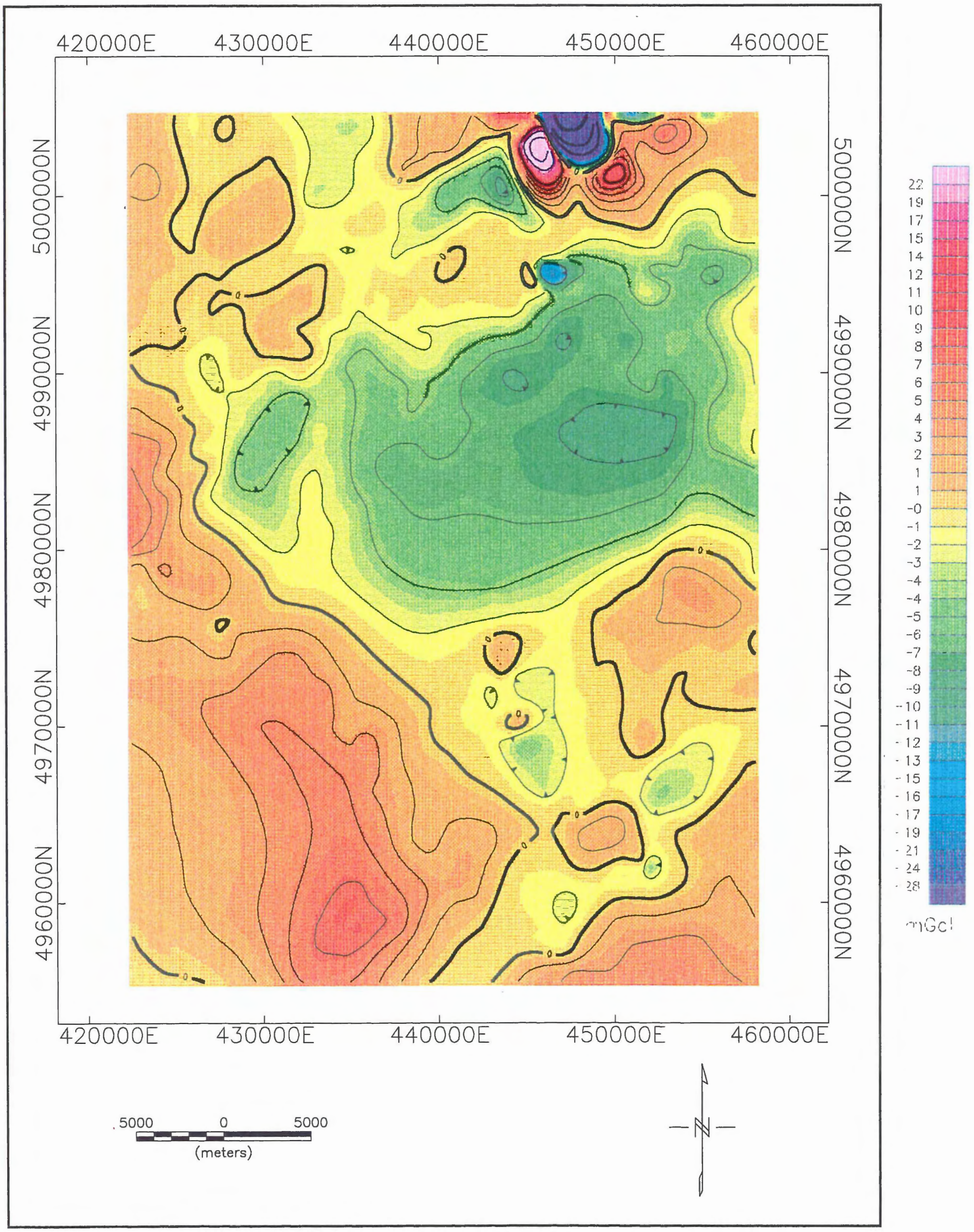


Figure 5.3 Map of the study area representing the difference between the observed Bouguer in Figure 4.2 and the calculated gravity shown in Figure 5.2. Contour interval is 2 mGal.

5.2.1 *Granite bodies*

Modelling the granite bodies within the study area consisted of first inputting prisms, or sheets, that approximated outcrop patterns, then, deeper sheets were input and each made 1 km thick. Each sheet extended farther from the outcrop than the one above.

The three dimensional model shows that the SMB, and MB are connected at approximately 4.5-5 km depth, and that the Kinsac Pluton is connected to the larger MB at about 1-1.5 km depth (Fig, 5.4). The granite extends to approximately 4980000mN where it sharply drops to a depth of 15-20 km before reaching the Rawdon Syncline. A depth of 15-20 km to the bottom of the granite agrees with previous modelling by Douma (1978).

Figure 5.5a is a cross-section of the three dimensional model showing the relationship between the SMB, MB, and Kinsac Pluton. The model suggests that the contact between the granite and Meguma rocks in the southern map area is fairly shallow dipping (elevation of granite drops 4.5 km in about 7-10 km on the surface).

In the study area, the western edge of the MB is faulted against Meguma rocks (Fig. 1.2). This was thought to be the reason for the sharp change from east-west to south-east-trending contours in the south-eastern most corner of the map. Attempts at modelling the fault, or local Meguma-granite boundary, as deep (about 3 km) and near vertical failed. No configuration could be found to produce a representative gravity anomaly. Thus, the fault is either less than 500 m in vertical extent (thickness of top sheet) or is lost in deeper granite and therefore can not be identified by gravity methods.

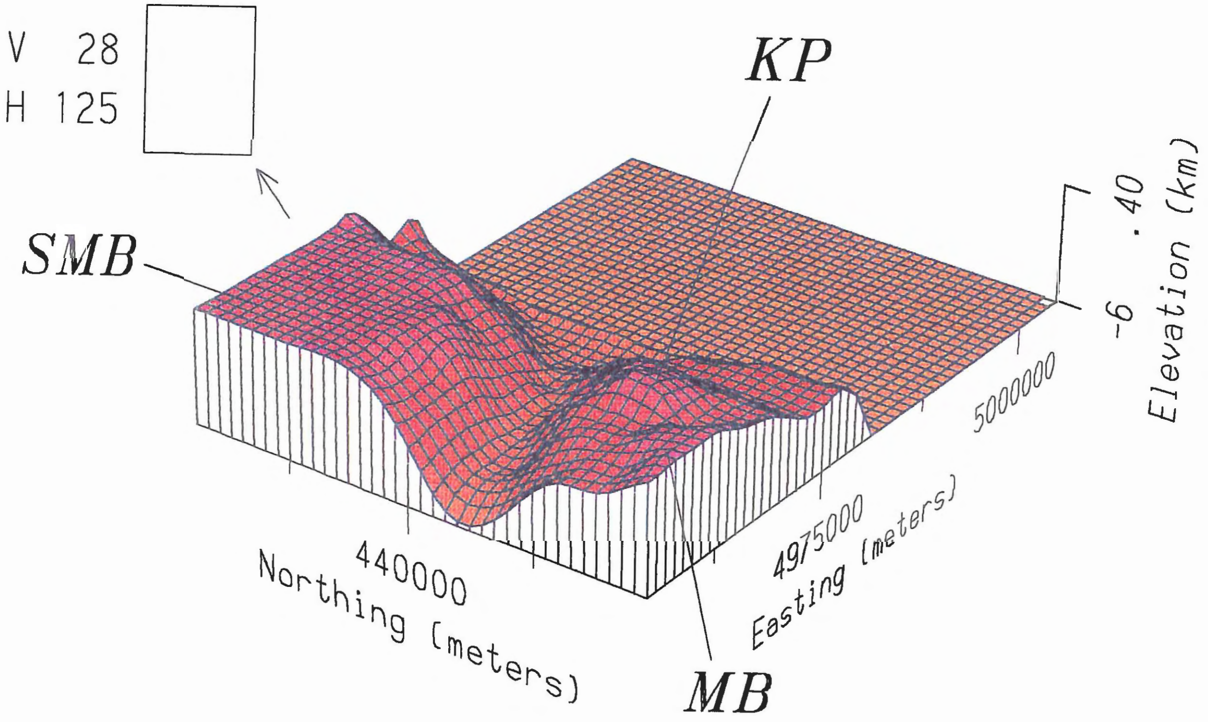


Figure 5.4 Three dimensional perspective view of the surface of the granite within the study area, constructed from the 3D model. SMB = South mountain Batholith, MB = Musquodoboit Batholith, KP = Kinsac Pluton.

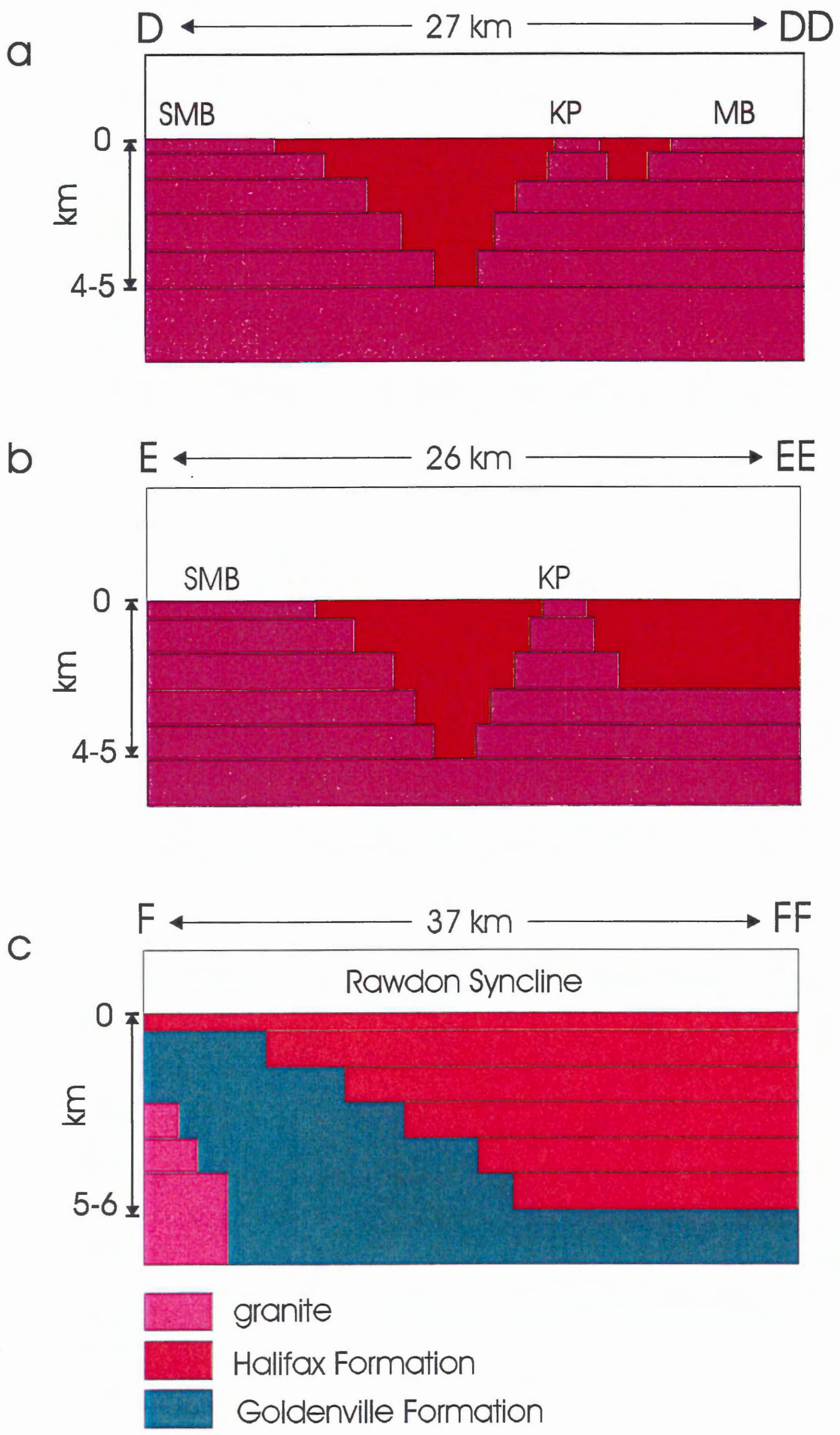


Figure 5.5 Approximated cross-sections of the three dimensional model along lines (a) D-DD showing the configuration of the granite bodies at depth, (b) E-EE showing the relationship between the granite and the Kinsac Syncline and, (c) F-FF showing the configuration of the Rawdon Syncline.

The Kinsac Pluton was modelled as a vertical extension of the larger MB. The two granite bodies join at 1-1.5 km depth, and then both step down to 4.5-5 km depth to join the SMB. The plan view of the pluton was kept roughly circular and the sides were modelled as steep.

The observed Bouguer gravity map (Fig. 4.2) shows the negative anomaly associated with the Kinsac Pluton and the MB extending farther to the north-west (~ 445000mE and 4968000mN). In order to produce a similar anomaly from the model, the sheet that joins the Kinsac Pluton and the MB was extended farther to the north-west and was thickened in that area so that it was 1 km below the surface. Thus, another granite upwelling may be located just to the north-west of the Kinsac Pluton.

5.2.2 *Kinsac Syncline*

The Kinsac Syncline lies between the SMB and Kinsac Pluton (Fig. 5.5b). The width of the syncline and steep dip measurements (limbs dipping inwards at about 75^0; Faribault, 1909) indicate that the slate within the syncline should be much thicker than the 4.5 km. A large portion of the slate belt has therefore been replaced by the intruded granite, as indicated by the presence of the Kinsac Pluton within the Kinsac Syncline. It was stated earlier that the density for a particular unit would be assumed to be constant. However, in the case of the Kinsac Syncline, its geometry is constrained by the geometry of the younger intruded granite, which was determined in the previous section. Therefore with the geometry set, varying density slightly with depth is the only way to generate the required gravity values. The amount of density change per unit depth is variable. This model constructed for this study used a density 2.90 g/cm^3 between 2.5 and 4.5 km depth.

5.2.3 *Uniacke Syncline*

Due to data gaps, identification of the Uniacke Syncline on the observed Bouguer gravity map is difficult, and 3D modelling was considered inappropriate. Trial three dimensional modelling of the Uniacke Syncline, even using a thickness of 250 m, produces a very noticeable signature. Projection of surface dip measurements (~ 65^0; Faribault, 1908) suggest that the Uniacke Syncline is at least 2 km thick.

5.2.4 *Rawdon Syncline*

The Rawdon syncline is a simple feature to reconstruct three dimensionally. A step-like configuration similar to the one used for the granite bodies was used for this structure. The model (Fig. 5.5c) shows that the syncline thins to 750-500 m towards the SMB, and thickens to 5-6 km towards the north-east (FF on the profile). This configuration is consistent with geological mapping, which shows the syncline to be plunging north-east (Horne, 1993) and should therefore thicken in that direction. The major fold axis of the syncline is also inclined (Horne, 1993). However, variation of the model to mimic the asymmetric structure did not noticeably change the appearance of the calculated anomaly.

Contact with the Carboniferous rocks along the north limb of the syncline is modelled as vertical along the Rawdon Fault. The sudden decrease in density across the steep boundary creates a zone of tight contours very similar to those shown for the same area in Figure 4.2.

5.2.5 *Carboniferous rocks*

Configuration of the Carboniferous rocks to the north of the Rawdon Syncline is taken after a previous model by Howells (1986). Salt of the Lower Windsor Group is responsible for the low negative anomaly just to the north of the Rawdon Syncline. Prisms used for other areas of Carboniferous rocks were positioned simply to produce an appearance similar to the observed Bouguer gravity.

5.3 Modelling - 2.5 D

Figure 5.6 illustrates 2.5 dimensional modelling. The basic input into the 2.5D program is a file containing the location and observed gravity values along a line profile. The data are displayed on the screen with the calculated values while bodies are added to the model. The aim is to construct a model that yields calculated gravity values similar to the observed Bouguer gravity data.

Due to time constraints, 2.5 dimensional modelling allowed for a more detailed interpretation of the subsurface than 3 dimensional modelling because there was less restriction on the shapes of bodies.

Figure 4.2 shows the location of a 2.5D profile running approximately north to north-west from point A to point C. A kink was placed in the profile at point B so that it would cross the Rawdon Syncline at an angle perpendicular to the trend of the structure.

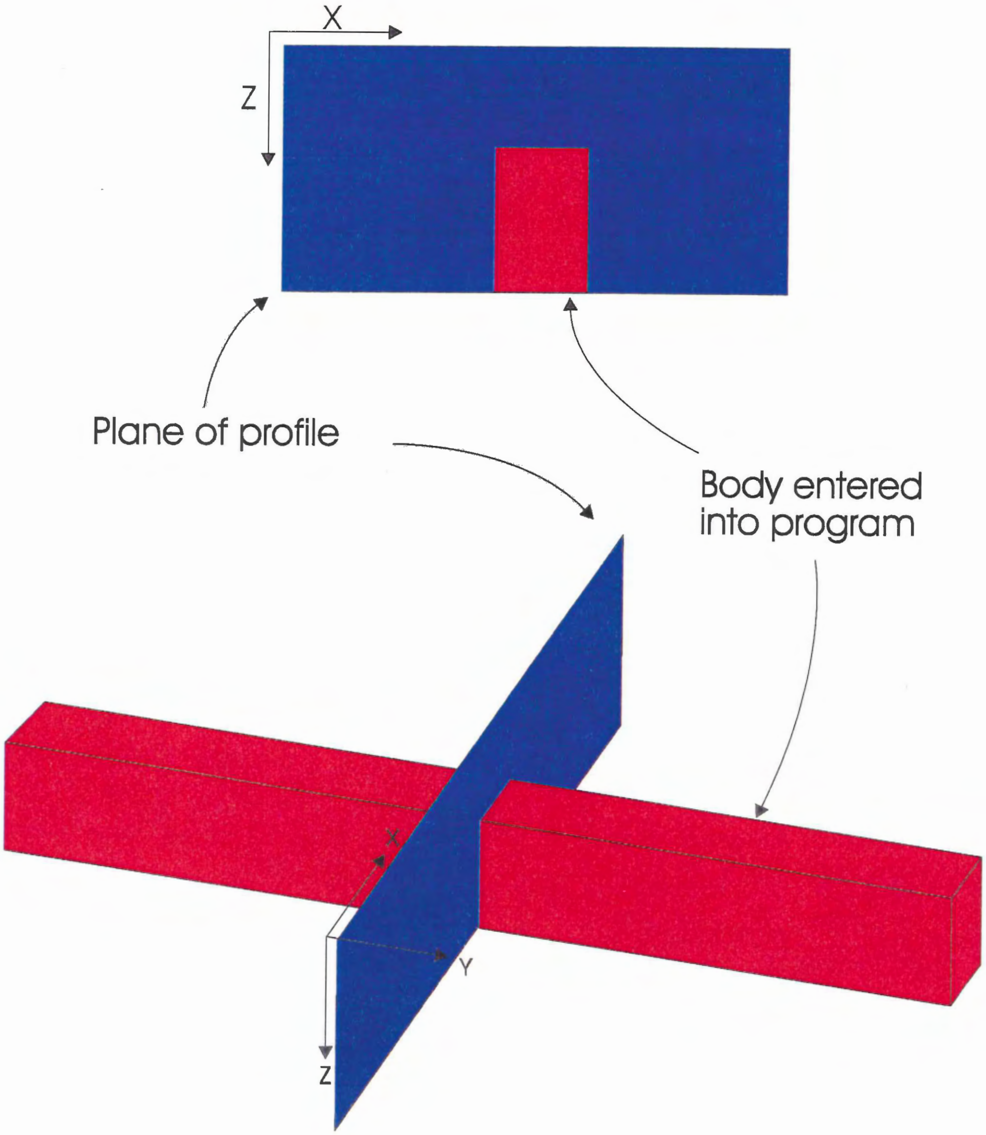


Figure 5.6 Explanation of 2.5D modelling. (a) View seen when using the program. (b) The program calculates the gravitational effects of a body that extends in and out of the profile plane.

The profile was extracted from the gridded gravity data, i.e. the values along the profile do not necessarily represent actual gravity stations. The profile between points A and B approximately follows the Beaverbank Road to ensure that the extracted data are representative of observed values and not an artefact of the contouring program trying to deal with data gaps.

Figure 5.7 shows the extracted observed Bouguer gravity data along profile A-B-C with a model and its calculated gravity. The calculated gravity fits the observed gravity nicely in that it shows the positions of synclines with reasonable accuracy.

The same density contrasts that were applied to the three dimensional modelling were applied to the 2.5 dimensional modelling. All bodies extend 15 km out of the plane of the profile.

5.3.1 *Granite*

Granite is only present in the southern portion of the profile. However, the influence of the granites is observed along the entire length of the profile as the granites provide a regional trend.

The model suggests that the granite reaches its highest elevation on the profile A-B-C around 9 km from point A (~ 1 km below the surface). Northward, it drops down to a fairly flat plateau at 6.5 - 7.0 km depth and extends to near point B where it sharply drops off. To the south it drops below the Kinsac Syncline. A large granite bulge placed between the Kinsac Syncline and the Uniacke Syncline was the only way to produce such a low negative between two highs. This is reasonable since the Kinsac Pluton is only a few kilometres away.

5.3.2 *Synclines*

The Kinsac, Uniacke and Rawdon synclines all produce identifiable gravity highs. The Kinsac Syncline is approximately 8 km wide and is modelled to a depth of about 4 km where it is replaced by granite. Further north, the smaller Uniacke Syncline (about 2.75 km wide), which was not able to be modelled in three dimensions, is modelled to be approximately 2 km thick, and the 7 km wide Rawdon Syncline is modelled to be about 5.5 km thick.

The Rawdon Fault was modelled as being steep and slightly reversed. Howells (1986) similarly modelled the fault, however he used an average Meguma rock density of 2.65 g/cm^3 . King (1994) used magnetic susceptibility data to model the northern limb of the syncline as dipping gently to the north. Results from gravity modelling do not support King's interpretation.

5.3.3 *Hypothesis review*

One of the original hypotheses of this study was that the density contrast between the Rawdon and Glen Brook Units of the Halifax Formation would allow gravity methods to be used to model them at depth. Results of density determinations (Table 4.1) show that, at least for the samples collected, there is a density contrast of +0.03g/cm^3

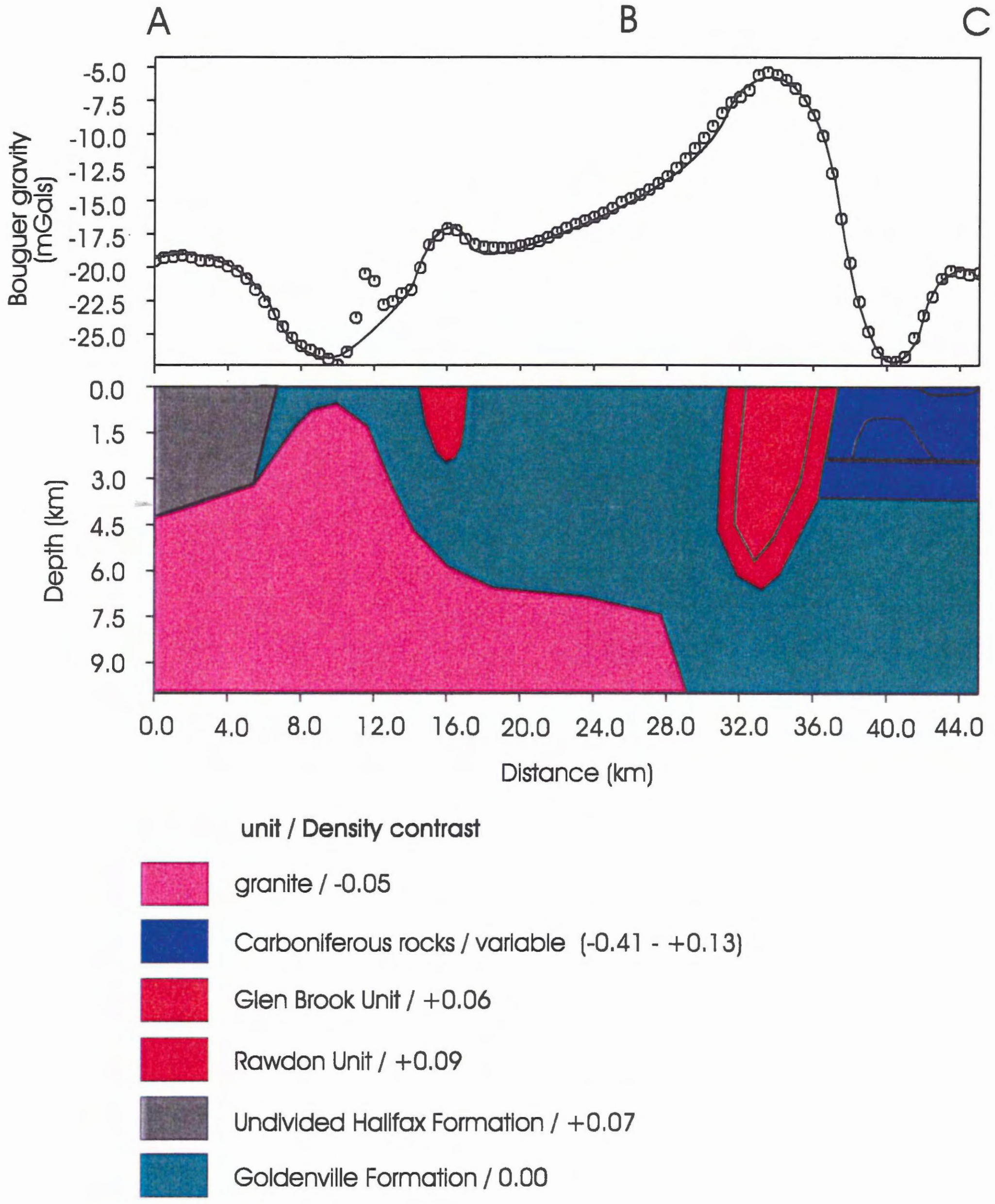


Figure 5.7 Profile A-B-C. Circles represent observed Bouguer gravity and the solid line represents the calculated gravity from the model below. Configuration of Carboniferous rocks after Howells (1986).

between the denser Rawdon Unit and the less dense Glen Brook Unit. Profile A-B-C shows that despite the higher density of the Rawdon Unit, which was expected to create positive gravity anomalies above the north and south limbs of the syncline, the distribution of data across the Rawdon Syncline is smoothly curved. Thus, at the scale of this investigation gravity data are not able to distinguish the Rawdon Unit from the Glen Brook Unit. Even though distinction of the two units is not possible from looking at the data, they can still be placed in logical positions in the model. The Rawdon Unit was modelled as composing outermost portion of the syncline with a constant thickness, while the core of the syncline was comprised of the Glen Brook Unit. Calculated gravity from this configuration fit the observed Bouguer gravity well.

5.3.4 *Carboniferous rocks*

General configuration of the Carboniferous rocks in the northern section of the profile was taken from Howells (1986). Minor modifications were made.

5.4 Comparison Between 3D And 2.5D Modelling

2.5 dimensional modelling programs produce models that are most representative of geological features that are linear in nature. Error becomes a factor when attempts are made to model geological structures that vary in 3 dimensions with a 2.5 dimensional program. The result may be a model that best describes the data but does not represent the actual geology.

Results from three dimensional and 2.5 dimensional modelling are comparable. The configuration of the southern portion of the profile is similar to the geometry suggested by the three dimensional model. The Kinsac Syncline extends to approximately the same depth (~ 4 km) in both models where it is replaced by the underlying granite. A granite bulge is located between the Uniacke and Kinsac Syncline , as suggested by the 2.5 and three dimensional models. Unlike the three dimensional model, the 2.5 dimensional model suggests that the granite curves downward to a plateau approximately 6-6.5 km below the surface. The models do agree, however, that the granite drops off steeply before it reaches the Rawdon Syncline. Thickness of the Rawdon Syncline, at the location of the profile, is approximately the same in both models.

Due to the three dimensional nature of the granites in the southern portion of the map area, the 2.5D model is of ambiguous validity in this region. This may explain the slight discrepancies between the two models.

A major difference between the two models is the density of the Kinsac Syncline. The three dimensional model suggests that the density of the rocks within the structure increases slightly with depth. The 2.5 dimensional model, however, maintains a constant density value. This is due to a lesser volume of granite shown in the 2.5 dimensional model. Thus, the density needed to counterbalance the effects of the granite and produce the required anomaly is less.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The detailed gravity survey described in this study clearly shows that gravity methods can be used to successfully model small scale features, such as, the Halifax Formation slate belts, as well the larger scale regional granitic intrusions that characterise the lower portion of the study area.

Modelling Bouguer gravity data suggests that: (1) The MB and SMB join to form a larger granitic body at approximately 4-5 km depth near the centre of the southern map area. (2) The Kinsac Pluton sharply descends to join the larger MB at a depth of approximately 1-1.5 km, before the MB joins the SMB. (3) The Kinsac Syncline extends to a depth of about 4-5 km where it is replaced by granite. Also, the rock density of the Kinsac Syncline may increase with depth. (4) The Uniacke syncline extends to between 2 and 2.5 km depth. (5) The Rawdon Syncline is approximately 5-6 km deep at its thickest location. (6) The density contrasts determined for Rawdon and Glen Brook Units are not capable of producing noticeable gravity anomalies. Thus, gravity methods were not successful in distinguishing the sulphide rich Rawdon Unit from the overlying Glen Brook Unit.

6.2 Recommendations

It is a recommendation of this study that further density determinations be acquired for the Glen Brook and Rawdon Units to arrive at more representative values. Also, acquisition of density data across the GHT may help constrain and improve the subsurface model.

REFERENCES CITED

Binney, W.P., Jenner, K.A., Sangster, A.L, and Zentilli, M. 1986. A stratabound zinc-lead deposit in Meguma Group metasediments of Eastville, Nova Scotia. Maritime Sediments and Atlantic Geology, **22**: 65-88.

Boehner, R.C. 1986. Salt and Potash Resources in Nova Scotia. Nova Scotia Department of Mines and Energy, Bulletin **5**: 29-33.

Coolen, P.R. 1974. The Geology of the Kinsac Pluton. B.Sc. thesis, Dalhousie University, Halifax, Nova Scotia.

Dobrin, M.B., and Savit, C.H. 1988. Introduction to Geophysical Prospecting, Fourth Edition. *Edited by* J. Zumerchik and S. Tenney. McGraw-Hill, New York, pp. 498-629.

Douma, M. 1978. Gravitational Interpretation and Modelling of the South Mountain Batholith, Southern Nova Scotia. B.Sc. thesis, Dalhousie University, Halifax, Nova Scotia.

Faribault, E.R. 1909. Waverley Sheet, Map No. 67. Geological Survey of Canada.

Faribault, E.R. 1908. Elmsdale Sheet, Map No. 66. Geological Survey of Canada.

Fletcher, H. and Faribault, E.R. 1911. Southeast Nova Scotia. Canada Department of Mines, Geological Survey, Map 53a, scale 1:250000.

Fox, D.L. 1994. Geological mapping in the Upper-Rawdon-Ardoise area, Hants county, Nova Scotia. *In* Program and Summaries, Eighteenth Annual Review of Activities. *Edited by* D.R. MacDonald, Nova Scotia Department of Natural Resources, Mines and Minerals Branches Report **94-2**: 21.

Garland, G.D. 1953. Gravity meaurments in the Maritime Provinces. Publications of Dominion Obs. 16, no. **7**: 185-275.

Graves, M.C., and Zentilli, M. 1988. The lithochemistry of metal-enriched coticules in the Goldenville-Halifax transition zone of the Meguma Group, Nova Scotia. Geological Survey of Canada Paper **88-1B**: 251-261.

Haysom, S.J., Horne, R.J., and Pe-Piper, G. *in press.* The opaque minerology of the Meguma Group metasediments, Beaverbank - Rawdon area, Nova Scotia.

Horne, R.J. 1993. Preliminary Report on the Geology of the Rawdon Area. *In* Mines and Minerals Branch, Report of Activities 1992. Nova Scotia Department of Natural Resources, Mines and Energy Branches Report **93-1**: 61-67.

Howells, K. 1986. Interpretation of a gravity profile across the Windsor Kennetcook area of the Minas Sub-basin of Nova Scotia. Geophysics Section, Applied Science Division, Nova Scotia Research Foundation Corporation, project 16511, report 4.

Howells, K., and Clarke, E.D. 1995. Reprocessing of Nova Scotia gravity data from the NSRFC gravity database (1952-1988), Open File Report 95-005. Industry and Information Services, Nova Scotia Research Foundation Corporation, Dartmouth, Nova Scotia.

Keary, P., and Brooks, M. 1991. An Introduction to Geophysical Exploration, Second Edition. *Edited by* A. Hallam. Blackwell Scientific Publications, Boston, pp. 119-147.

Keppie, J.D. 1979. Geological map of Nova Scotia. Nova Scotia Department of Mines.

Keppie, J.D. and Dallmeyer, R.D. 1987. Dating transcurrent terrane accretion: an example from the Meguma and Avalon composite terranes in the northern Appalachians. Tectonics, **6**: 831-847.

King, M.S. 1994. Magnetic mineralogy and susceptibility of the north-central Meguma Group: implications for the interpretation of aeromagnetic total field, first derivative and second derivative. Nova Scotia Department of Natural Resources, Open File Report 94-004.

King, M.S. 1995. Assessment of aeromagnetic studies in Nova Scotia. *In* Program and Summaries, Nineteenth Annual Review of Activities, Nova Scotia Department of Natural Resources, Mines and Minerals Branch, November 7-8, 1995, Halifax, Nova Scotia: 14.

Klein, C., Hurlbut, C.S., Jr. 1985. Manual of Mineralogy, Twenty-First Edition (After James D. Dana). *Edited by* Klein and Hurlbut. John Wiley & Sons, Inc., New York, pp. 350-369.

MacDonald, M.A. and Clarke, D.B. 1985. The petrology, geochemistry, and economic potential of the Musquodoboit Batholith, Nova Scotia. Canadian Journal of Earth Sciences, **22**: 1633-1642.

MacDonald, M.A. 1996. Unpublished density data for the South Mountain Batholith.

MacMichael, T.P. 1975. The origin of the lead-zinc-silver ores and the alteration of the surrounding granites at the Dunbrack Mine, Musquodoboit Harbour, Nova Scotia. B.Sc. thesis, Dalhousie University, Halifax, Nova Scotia.

Manual for model G gravity meter.

McKenzie, B. 1976. Gravitational modelling of the Meguma and intrusive granite in the Halifax area. B.Sc. (Hons) thesis, Dalhousie University, Halifax, Nova Scotia.

Muecke, G.K., Elias, P., Reynolds, P.H. 1988. Hercynian overprinting of an Acadian Terrane: $^{40}Ar/^{39}Ar$ studies in the Meguma Zone, Nova Scotia, Canada. Chemical Geology (Isotope Geoscience) **73**: 153-167.

O'Brien, B. 1988. A study of the Meguma Terrane in Lunenburg County, Nova Scotia. Geological Survey of Canada, Open File Report **1823**.

O'Reilly, C.T. 1975. Gravitational interpretation and modelling of the South Mountain Batholith utilizing two and three dimensional computer programming. B.Sc. thesis, Dalhousie University, Halifax, Nova Scotia.

Reynolds, P.H., Zentilli, M., Muecke, G.K., 1981. K-Ar and $^{40}Ar/^{39}Ar$ geochronology of granitoid rocks from southern Nova Scotia: its bearing on the geological evolution of the Meguma Zone of the Appalachians. Canadian Journal of Earth Sciences, **18**: 386-394.

Ryan, R.J. 1994. Preliminary investigations of Meguma Group stratigraphy in the Beaverbank area, Nova Scotia. *In* Mines and Mineral Branch, Report of Activities 1993. Nova Scotia Department of Natural Resources, Mines and Minerals Branch Report **94-1**: 137-140.

Sangster, A.A. 1992. Light stable isotope evidence for a metamorphic origin for bedding-parallel gold-bearing vein in Cambrian flysch, Meguma Group, Nova Scotia. Exploration and Mining Geology, Vol.1, No. **1**: 69-79.

Schenk, P.E. 1983. The Meguma Terrane of Nova Scotia, Canada - an aid to trans-Atlantic correlation. *In* Regional Trends in the Geology of the Appalachian-Caledonian-Hercynian-Mauritanide Orogen. *Edited by* P.E. Schenk, NATO ASI Series C, **116**: 121-130.

Schenk, P.E. 1991. Events and sea-level changes on Gondwana's margin; The Meguma Zone (Cambrian to Devonian) of Nova Scotia, Canada. Geological Survey of America Bulletin, v. **103**: 512-521.

Smith, P.K. and Webber, D.E. 1986. Preliminary geological description of the C-1 diamond-drill hole and its antimony-gold potential, Hants County, Nova Scotia. *In* Nova Scotia Department of Mines and Energy Report **86-1**: 89-105

Williams, H., and Hatcher, R.D. Jr. 1983. Appalachian suspect terranes. Geological Society of America Memoir, **158**: 33-53.

Woodman, J.E. 1904. The sediments of the Meguma Series of Nova Scotia. The American Geologist, **34**: 14-34.

Zentilli, M., Graves, M.C., Mulja, T. and MacInnis, I. 1986. Geochemical characterisation of the Goldenville-Halifax transition of the Meguma Group of Nova Scotia: preliminary report. *In* Current research, part A. Geological Survey of Canada, Paper **86-1A**: 432-428.

APPENDIX A GRAVITY METER DESCRIPTION

Data for this study was acquired using a Model G Lacoste and Romberg gravity meter number 112.

The gravity meter consists of a hinged beam holding a mass supported by a spring (Fig. C1). If gravity increases the mass moves down, thus increasing length of the spring and decreasing the angle φ. The change in gravity can then be calculated.

The operation procedure is as follows: (1) Place the gravity meter on the concave levelling dish, (2) turn on the lights for the levels and the optical system, (3) level the gravity meter, (4) unlock the gravity meter to allow the beam (cross-hair) to move, (5) position the cross-hair along the reading line (2.6 on the scale; Fig. C2), (6) record the gravity meter reading from counter and dial.

Readings must be converted to mGals. The counter reading can be converted to mGal using a chart provided with the gravity meter. For example, a counter reading of 4000 is 4231.51 mGal. All the readings obtained in this study began with the counter reading 4000. The difference between the original counter reading and 4000 is then calculated (e.g. 4054.36 - 4000 = 54.36). The difference is multiplied by a interval factor, also taken from the chart provided. For a counter reading of 4000 the interval factor is 1.06030 (e.g. 54.36 X 1.06030 = 57.64 mGal). The product is then added to 4231.51 mGal to obtain the total value in mGal.

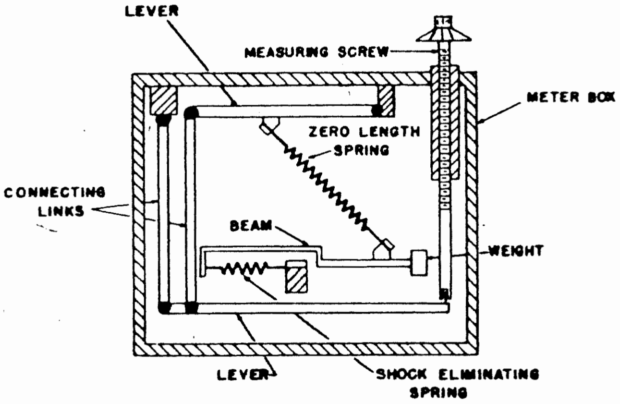


Figure C1 Structure of the Lacoste and Romberg gravity meter (from gravity meter manual).

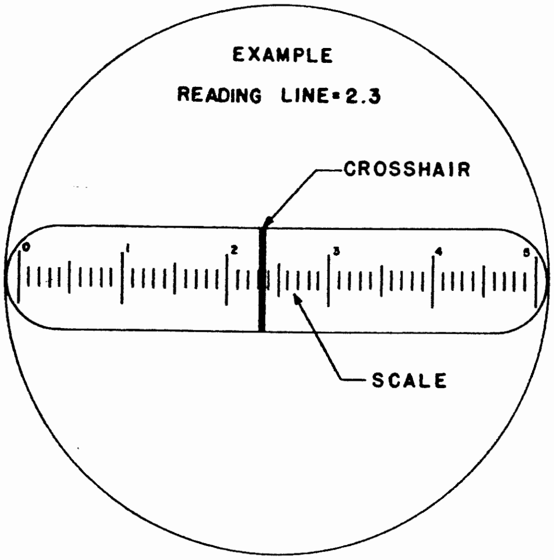


Figure C2 View as seen in eyepiece. Reading line is 2.6 for the gravity meter used in this study (from gravity meter manual).

APPENDIX B DENSITY DETERMINATIONS

The procedure used to determining the bulk density of a sample was as follows:

(1) The sample was cleaned to remove any lose particles.

(2) The mass of the dry sample (m_{dry}) was determined in air using an electronic suspension scale that measured mass to the second decimal place (ex. 2.76 g/cm^3).

(3) The mass of the sample was determined while it was completely submerged in water (m_{wet}).

(4) The bulk density (ϱ_{bulk}) was determined using the following formula

$$\varrho_{bulk} = \frac{m_{dry}}{m_{dry} - m_{wet}} \tag{B1}$$

Halifax Formation				Goldenville Formation	
Rawdon Unit		Glen Brook Unit			
Sample #	Bulk Density (g/cm^3)	Sample #	Bulk Density (g/cm^3)	Sample #	Bulk Density (g/cm^3)
1	2.78	21	2.84	31	2.65
2	2.74	22	2.79	32	2.67
3	2.86	23	2.72	33	2.64
4	2.69	24	2.73	34	2.63
5	2.80	25	2.74	35	2.68
6	2.72	26	2.72	36	2.63
7	2.98	27	2.65	37	2.68
8	2.76	28	2.73	38	2.71
9	2.81	29	2.78	39	2.79
10	2.72	30	2.68	40	2.73
11	2.83		**Average = 2.74**	41	2.64
12	2.78		**STD = 0.05**	42	2.71
13	2.79				**Average = 2.68**
14	2.75				**STD = 0.04**
15	2.65				
16	2.74				
17	2.83				
18	2.72				
19	2.69				
20	2.77				
Average = 2.77 STD = 0.07					

Table B1. Bulk density values for various rock samples of the Halifax Formation (Rawdon and Glen Brook Units) and the Goldenville Formation. STD = standard deviation.

$\phi = 44.8^0$
$\rho = 2.71\ g/cm^3$
h = elevation in meters
R = Gravity meter reading
Fi = Interval factor

corr = corrected
B1 = Base Station 1
KH = Data from K. Howells

Station	**Gravity (mgal)**	**Total drift corr**	**Latitude correction**	**FA correction**	**Bouguer correction**	**Corr Bouguer**	**Bouguer gravity**	**Bouguer gravity**
	(R-4000)Fi+4231.51	**gravity (mGal)**	**0.812sin(2ϕ) mgal/km**	**0.3086h**	**BC=0.04191ρh**	**gravity (mGal)**	**relative to B1**	**relative to KH**
Base 1	4283.6	4283.6	0	26.09	9.6	4300.09	0	-20.62
1	4287.58	4287.58	1.75	16.6	6.11	4296.32	-3.77	-24.39
2	4284.53	4284.53	2.76	19	6.99	4293.78	-6.31	-26.93
3	4288.34	4288.34	3.97	15.22	5.6	4293.99	-6.1	-26.72
4	4280.42	4280.42	4.66	26.02	9.58	4292.2	-7.89	-28.51
5	4280.75	4280.75	6.16	44.65	16.43	4302.8	2.71	-17.91
6	4270.5	4270.5	7.55	58.24	21.43	4299.75	-0.34	-20.96
7	4279.33	4279.29	9.44	53.91	19.84	4303.92	3.82	-16.8
8	4285.1	4285.06	9.73	46.35	17.06	4304.62	4.52	-16.1
9	4285.68	4285.64	10.12	44.11	16.24	4303.4	3.3	-17.32
10	4286.08	4286.04	10.44	41.88	15.41	4302.06	1.97	-18.65
11	4292.87	4292.82	11.84	33.99	12.51	4302.47	2.38	-18.24
12	4293.07	4293.02	12.09	33.2	12.22	4301.91	1.82	-18.8
13	4292.83	4292.79	12.38	34	12.51	4301.89	1.8	-18.82
14	4294.91	4294.86	12.83	31.93	11.75	4302.21	2.12	-18.5
15	4293.8	4293.75	13.35	34.74	12.79	4302.36	2.27	-18.35
16	4292.47	4292.42	14.01	38.83	14.29	4302.94	2.85	-17.77
17	4288.61	4288.57	14.87	47.74	17.57	4303.87	3.78	-16.84
18	4288.36	4288.31	15.36	49.36	18.17	4304.14	4.05	-16.57
19	4289.27	4289.22	16.43	50.53	18.6	4304.72	4.63	-15.99
20	4292.5	4292.44	17.2	48.37	17.8	4305.81	5.72	-14.9
21	4291.66	4291.6	17.6	50.37	18.54	4305.84	5.75	-14.87
22	4294.47	4294.41	17.9	47.2	17.37	4306.34	6.25	-14.37
23	4295.83	4295.76	18.11	44.71	16.46	4305.91	5.81	-14.81
24	4300.3	4300.24	19.14	39.58	14.57	4306.1	6.01	-14.61
25	4305.91	4305.84	19.53	34.65	12.75	4308.21	8.12	-12.5
26	4310.64	4310.56	21.5	30.29	11.15	4308.2	8.11	-12.51
Base 2	4313.19	4313.21	22.44	30.29	11.15	4309.91	9.82	-10.8
27	4309.64	4309.66	22.28	36.89	13.58	4310.69	10.6	-10.02

Station	Gravity (mgal)	Total drift corr	Latitude correction	FA corr	Bouguer corr	Corr Bouguer	Bouguer gravity	Bouguer gravity
	(R-4000)Fi+4231.51	gravity (mGal)	0.812sin(2f) mgal/km	0.3086h	BC=0.04191rh	gravity (mGal)	relative to B1	relative to KH
28	4310.02	4310.03	23.19	42.33	15.58	4313.59	13.5	-7.12
29	4307.29	4307.29	24.07	53.8	19.8	4317.23	17.14	-3.48
30	4305.75	4305.75	25.06	61.14	22.5	4319.34	19.24	-1.38
31	4311.1	4311.09	25.9	54.09	19.91	4319.37	19.28	-1.34
32	4311.27	4311.26	26.65	52.2	19.21	4317.6	17.5	-3.12
33	4320.97	4320.95	27.47	35.71	13.14	4316.05	15.96	-4.66
34	4309.36	4309.33	26.03	55.3	20.35	4318.25	18.15	-2.47
35	4313.96	4313.92	23.42	29.35	10.8	4309.05	8.96	-11.66
36	4311.64	4311.6	23.41	33.11	12.19	4309.12	9.02	-11.6
37	4311.51	4311.47	23.19	37.21	13.69	4311.79	11.7	-8.92
38	4285.78	4285.71	-1.97	22.1	8.13	4301.64	1.55	-19.07
39	4312.31	4312.33	22.03	31.35	11.54	4310.1	10.01	-10.61
40	4305.41	4305.41	21.77	47.6	17.52	4313.72	13.63	-6.99
41	4314.69	4314.67	24.33	37.02	13.62	4313.74	13.64	-6.98
42	4308.91	4308.88	24.07	45.68	16.81	4313.69	13.6	-7.02
43	4307.27	4307.25	23.82	48.71	17.93	4314.21	14.12	-6.5
44	4307.59	4307.56	23.59	49.47	18.21	4315.23	15.13	-5.49
45	4306.63	4306.6	23.21	51.26	18.86	4315.79	15.69	-4.93
46	4303.95	4303.91	22.32	54.22	19.95	4315.86	15.77	-4.85
47	4306.14	4306.1	21.3	45.44	16.73	4313.52	13.42	-7.2
48	4313.11	4313.04	24.91	36.52	13.44	4311.21	11.11	-9.51
49	4322.03	4321.95	25.79	37	13.62	4319.54	19.44	-1.18
50	4312.54	4312.45	26.38	42.93	15.8	4313.2	13.1	-7.52
51	4313.87	4313.78	26.52	40.78	15.01	4313.03	12.94	-7.68
52	4312.78	4312.68	26.53	39.11	14.39	4310.87	10.78	-9.84
53	4310.77	4310.81	26.96	48.28	17.77	4314.36	14.27	-6.35
54	4330.27	4330.3	28.57	32.33	11.9	4322.16	22.07	1.45
55	4314.76	4314.79	27.81	50.64	18.64	4318.98	18.89	-1.73
56	4311.2	4311.23	26.53	39.55	14.56	4309.69	9.6	-11.02
57	4311.51	4311.53	26.56	36.1	13.28	4307.78	7.69	-12.93
58	4313.14	4313.16	26.96	35.24	12.97	4308.47	8.38	-12.24
59	4317.6	4317.62	26.28	24.48	9.01	4306.8	6.71	-13.91
60	4315.98	4316	26.44	27.13	9.99	4306.71	6.61	-14.01

Station	Gravity (mgal)	Total drift corr	Latitude correction	FA corr	Bouguer corr	Corr Bouguer	Bouguer gravity	Bouguer gravity
	(R-4000)Fi+4231.51	gravity (mGal)	0.812sin(2f) mgal/km	0.3086h	BC=0.04191rh	gravity (mGal)	relative to B1	relative to KH
61	4316.27	4316.28	26.41	25.24	9.29	4305.82	5.73	-14.89
62	4317.81	4317.83	28.48	42.78	15.74	4316.38	16.29	-4.33
63	4315.48	4315.49	27.99	41.37	15.22	4313.64	13.54	-7.08
64	4315.22	4315.23	26.84	31.01	11.41	4307.98	7.89	-12.73
65	4311.17	4310.64	21.85	35.36	13.01	4311.13	11.04	-9.58
66	4305.48	4304.95	21.51	43.59	16.04	4310.98	10.88	-9.74
67	4302.71	4302.17	21.35	47.45	17.46	4310.8	10.71	-9.91
68	4301.93	4301.38	21.23	51.27	18.87	4312.56	12.46	-8.16
69	4301.86	4301.31	21.24	51.72	19.04	4312.76	12.67	-7.95
70	4302.72	4302.16	20.79	50.69	18.66	4313.4	13.31	-7.31
71	4299.95	4299.38	20.46	52.75	19.41	4312.26	12.17	-8.45
72	4298.2	4297.62	20.32	57.24	21.07	4313.48	13.38	-7.24
73	4296.43	4295.85	20.26	58.52	21.54	4312.58	12.49	-8.13
74	4295.61	4295.03	20.44	59.98	22.08	4312.5	12.41	-8.21
75	4303.11	4302.52	20.48	46.92	17.27	4311.69	11.6	-9.02
76	4304.26	4303.66	20.53	44.98	16.56	4311.56	11.47	-9.15
77	4306.1	4305.5	20.65	41.98	15.45	4311.38	11.29	-9.33
78	4308.93	4308.33	21.14	36.59	13.47	4310.32	10.23	-10.39
79	4314.88	4314.28	21.4	25.4	9.35	4308.93	8.83	-11.79
Base 3	4282.68	4282.18	9.47	45.36	16.69	4301.37	1.28	-19.34
80	4279.69	4279.18	10	50.88	18.73	4301.33	1.24	-19.38
81	4279.63	4279.12	10.41	51.45	18.94	4301.23	1.14	-19.48
82	4281.1	4280.59	10.78	50.48	18.58	4301.71	1.62	-19
83	4284.44	4283.93	11.2	46.13	16.98	4301.88	1.79	-18.83
84	4287.41	4286.89	12.57	44.85	16.51	4302.67	2.58	-18.04
85	4292.45	4291.93	13.34	39.97	14.71	4303.85	3.75	-16.87
86	4292.88	4292.35	13.93	42.35	15.59	4305.19	5.1	-15.52
87	4288.34	4287.81	15.04	55.71	20.5	4307.98	7.88	-12.74
88	4292.55	4292.02	16.16	53.26	19.6	4309.52	9.42	-11.2
89	4300.15	4299.61	16.96	44.4	16.34	4310.71	10.62	-10
90	4304.6	4304.06	17.79	39.4	14.5	4311.17	11.07	-9.55
91	4321.4	4320.85	18.81	14.11	5.19	4310.96	10.86	-9.76
92	4307.89	4307.34	19.41	37.97	13.97	4311.93	11.84	-8.78

Station	Gravity (mgal) (R-4000)Fi+4231.51	Total drift corr gravity (mGal)	Latitude correction 0.812sin(2f) mgal/km	FA corr 0.3086h	Bouguer corr BC=0.04191rh	Corr Bouguer gravity (mGal)	Bouguer gravity relative to B1	Bouguer gravity relative to KH
93	4314.87	4314.32	20.63	25.4	9.35	4309.74	9.65	-10.97
94	4281.15	4280.48	9.52	47.73	17.57	4301.13	1.03	-19.59
95	4279.5	4278.83	9.6	48.95	18.02	4300.17	0.08	-20.54
96	4278.96	4278.29	9.74	51.12	18.81	4300.86	0.76	-19.86
97	4276.87	4276.2	10.27	55.15	20.3	4300.78	0.69	-19.93
98	4275.74	4275.07	10.48	57.93	21.32	4301.2	1.1	-19.52
99	4277.05	4276.38	10.76	51.73	19.04	4298.31	-1.78	-22.4
100	4278.53	4277.86	10.94	55.42	20.4	4301.94	1.85	-18.77
101	4277.8	4277.13	11.07	57.75	21.25	4302.55	2.46	-18.16
102	4278.86	4278.19	11.18	57.12	21.02	4303.11	3.01	-17.61
103	4279.62	4278.95	11.45	57.12	21.02	4303.59	3.5	-17.12
104	4278.58	4277.91	11.53	60.61	22.31	4304.69	4.59	-16.03
105	4277.64	4276.97	11.94	65.11	23.96	4306.18	6.09	-14.53
106	4277.25	4276.58	12.13	67.07	24.68	4306.83	6.74	-13.88
107	4281.95	4281.28	12.44	61.18	22.51	4307.51	7.41	-13.21
108	4286.65	4285.98	12.81	52.72	19.4	4306.49	6.39	-14.23
109	4292.25	4291.58	12.99	44.68	16.44	4306.82	6.73	-13.89
110	4294.8	4294.13	12.97	40.21	14.8	4306.57	6.48	-14.14
111	4295.05	4294.38	12.8	40.85	15.03	4307.39	7.29	-13.33
112	4297.23	4296.56	12.91	37.56	13.82	4307.38	7.29	-13.33
113	4298.95	4298.28	13.03	34.19	12.58	4306.86	6.76	-13.86
114	4300.28	4299.61	13.11	31.7	11.67	4306.53	6.43	-14.19
115	4301.85	4301.18	13.05	27.72	10.2	4305.65	5.56	-15.06
116	4306.27	4305.6	13.41	18.62	6.85	4303.96	3.87	-16.75
117	4281.79	4281.1	9.5	47.17	17.36	4301.41	1.31	-19.31
118	4277.99	4277.3	9.25	53.42	19.66	4301.82	1.72	-18.9
119	4277.52	4276.83	9.11	54.09	19.91	4301.9	1.81	-18.81
120	4278.49	4277.8	9	52.91	19.47	4302.24	2.14	-18.48
122	4279.54	4278.84	8.56	49.16	18.09	4301.34	1.25	-19.37
123	4278.65	4277.95	8.37	49.69	18.29	4300.99	0.9	-19.72
124	4275.83	4275.13	8.16	52.24	19.22	4299.98	-0.11	-20.73
125	4276.89	4276.19	7.51	51.73	19.04	4301.37	1.28	-19.34
126	4276.28	4275.58	7.23	51.03	18.78	4300.6	0.51	-20.11

Station	Gravity (mgal) (R-4000)Fi+4231.51	Total drift corr gravity (mGal)	Latitude correction 0.812sin(2f) mgal/km	FA corr 0.3086h	Bouguer corr BC=0.04191rh	Corr Bouguer gravity (mGal)	Bouguer gravity relative to B1	Bouguer gravity relative to KH
127	4274.6	4273.9	6.58	50.32	18.52	4299.11	-0.98	-21.6
128	4273.87	4273.17	6.86	49.61	18.26	4297.66	-2.43	-23.05
129	4273.63	4272.92	6.58	50.42	18.56	4298.2	-1.9	-22.52
130	4272.12	4271.41	6.36	51.28	18.87	4297.47	-2.63	-23.25
131	4273.29	4272.58	5.99	47.22	17.38	4296.43	-3.66	-24.28
132	4271.72	4271.01	5.7	46.56	17.14	4294.73	-5.36	-25.98
133	4273.91	4273.2	5.39	48.44	17.83	4298.43	-1.67	-22.29
134	4274.14	4273.42	5.09	47.03	17.31	4298.05	-2.04	-22.66
135	4272.52	4271.8	4.78	48.5	17.85	4297.67	-2.42	-23.04
136	4271.3	4270.58	4.4	49.98	18.39	4297.77	-2.32	-22.94
137	4269.28	4268.56	4	51.45	18.94	4297.07	-3.02	-23.64
138	4270.67	4269.95	3.61	48.79	17.96	4297.18	-2.92	-23.54
139	4271.41	4270.68	3.19	44.68	16.44	4295.73	-4.37	-24.99
140	4271.82	4271.1	2.69	42.2	15.53	4295.08	-5.02	-25.64
141	4273.19	4272.46	2.47	39.64	14.59	4295.04	-5.05	-25.67
Base 4	4273.28	4272.46	2.47	39.64	14.59	4295.04	-5.05	-25.67
142	4274.14	4273.32	2.19	37.52	13.81	4294.85	-5.25	-25.87
143	4273.94	4273.12	1.97	37.19	13.69	4294.66	-5.43	-26.05
144	4274	4273.19	1.51	36.19	13.32	4294.55	-5.54	-26.16
145	4273.67	4272.85	1.37	35.8	13.18	4294.11	-5.98	-26.6
146	4273.43	4272.62	1.26	36.2	13.32	4294.23	-5.86	-26.48
147	4273.69	4272.88	1.03	35.01	12.89	4293.97	-6.12	-26.74
148	4272.53	4271.72	0.67	35.78	13.17	4293.66	-6.43	-27.05
149	4273.51	4272.7	0.19	34.28	12.61	4294.17	-5.92	-26.54
150	4272.48	4271.67	-0.05	36.33	13.37	4294.68	-5.41	-26.03
151	4272.28	4271.47	-0.24	36.99	13.61	4295.09	-5	-25.62
152	4272.19	4271.39	-0.49	37.6	13.84	4295.63	-4.46	-25.08
153	4272.84	4272.03	-0.74	36.94	13.59	4296.12	-3.98	-24.6
154	4272.92	4272.11	-0.9	37.94	13.96	4296.99	-3.1	-23.72
155	4272.29	4271.49	-0.93	39.52	14.54	4297.4	-2.7	-23.32
156	4271.69	4270.88	-1.09	41.61	15.31	4298.27	-1.82	-22.44
157	4275.46	4274.7	-1.2	38.04	14	4299.93	-0.16	-20.78
158	4277.03	4276.26	-1.31	35.97	13.24	4300.3	0.2	-20.42

Station	Gravity (mgal) (R-4000)Fi+4231.51	Total drift corr gravity (mGal)	Latitude correction 0.812sin(2f) mgal/km	FA corr 0.3086h	Bouguer corr BC=0.04191rh	Corr Bouguer gravity (mGal)	Bouguer gravity relative to B1	Bouguer gravity relative to KH
159	4276.06	4275.28	-1.42	38.82	14.29	4301.24	1.14	-19.48
160	4277.23	4276.46	-1.97	38.48	14.16	4302.75	2.66	-17.96
161	4276.39	4275.61	-2.06	39.76	14.63	4302.8	2.71	-17.91
162	4276.43	4275.66	-2.07	39.52	14.54	4302.71	2.62	-18
163	4278.22	4277.44	-2.14	35.68	13.13	4302.12	2.03	-18.59
164	4278.96	4278.18	-2.27	33.5	12.33	4301.62	1.52	-19.1
165	4281.94	4281.16	-2.52	28.27	10.4	4301.55	1.45	-19.17
166	4282.84	4282.06	-2.69	26.49	9.75	4301.49	1.39	-19.23
167	4285.93	4285.15	-3.06	21.95	8.08	4302.08	1.98	-18.64
168	4521.24	4283.38	-3.26	24.1	8.87	4301.87	1.78	-18.84
169	4323.04	4322.08	24.12	21.16	7.79	4311.34	11.25	-9.37
170	4321.64	4320.68	23.5	18.72	6.89	4309.01	8.92	-11.7
171	4322.25	4321.3	23.43	14.2	5.23	4306.85	6.75	-13.87
172	4321.59	4320.63	22.6	17.6	6.48	4309.16	9.06	-11.56
173	4322.13	4321.18	22.37	15.98	5.88	4308.91	8.82	-11.8
174	4321.81	4320.86	22.06	16.22	5.97	4309.06	8.96	-11.66
175	4322.35	4321.4	21.85	14.69	5.41	4308.84	8.75	-11.87
176	4320.35	4319.4	21.82	16.87	6.21	4308.24	8.15	-12.47
177	4319.71	4318.75	21.08	13.59	5	4306.26	6.16	-14.46
178	4319.88	4318.93	20.81	14.14	5.2	4307.05	6.96	-13.66
179	4321.84	4320.89	20.49	8.94	3.29	4306.05	5.96	-14.66
180	4321.3	4320.35	20.25	9.34	3.44	4306	5.9	-14.72
181	4322.44	4321.49	19.97	8.34	3.07	4306.79	6.69	-13.93
182	4323.15	4322.19	19.89	8.55	3.15	4307.7	7.61	-13.01
183	4321.25	4320.29	19.6	10.49	3.86	4307.32	7.23	-13.39
184	4320.39	4319.44	19.26	11.92	4.39	4307.71	7.62	-13
185	4320.76	4319.8	18.91	10.21	3.76	4307.35	7.26	-13.36
186	4320.08	4319.13	18.72	11.4	4.2	4307.62	7.53	-13.09
187	4319.79	4318.84	18.54	11.15	4.1	4307.35	7.26	-13.36
188	4322.21	4321.25	18.43	8.64	3.18	4308.28	8.19	-12.43
189	4320.73	4319.77	18.49	11.18	4.12	4308.35	8.25	-12.37
190	4317.46	4316.51	19.4	15.39	5.66	4306.83	6.74	-13.88
Base 5	4308.71	4307.21	9.88	4.35	1.6	4300.08	-0.02	-20.64

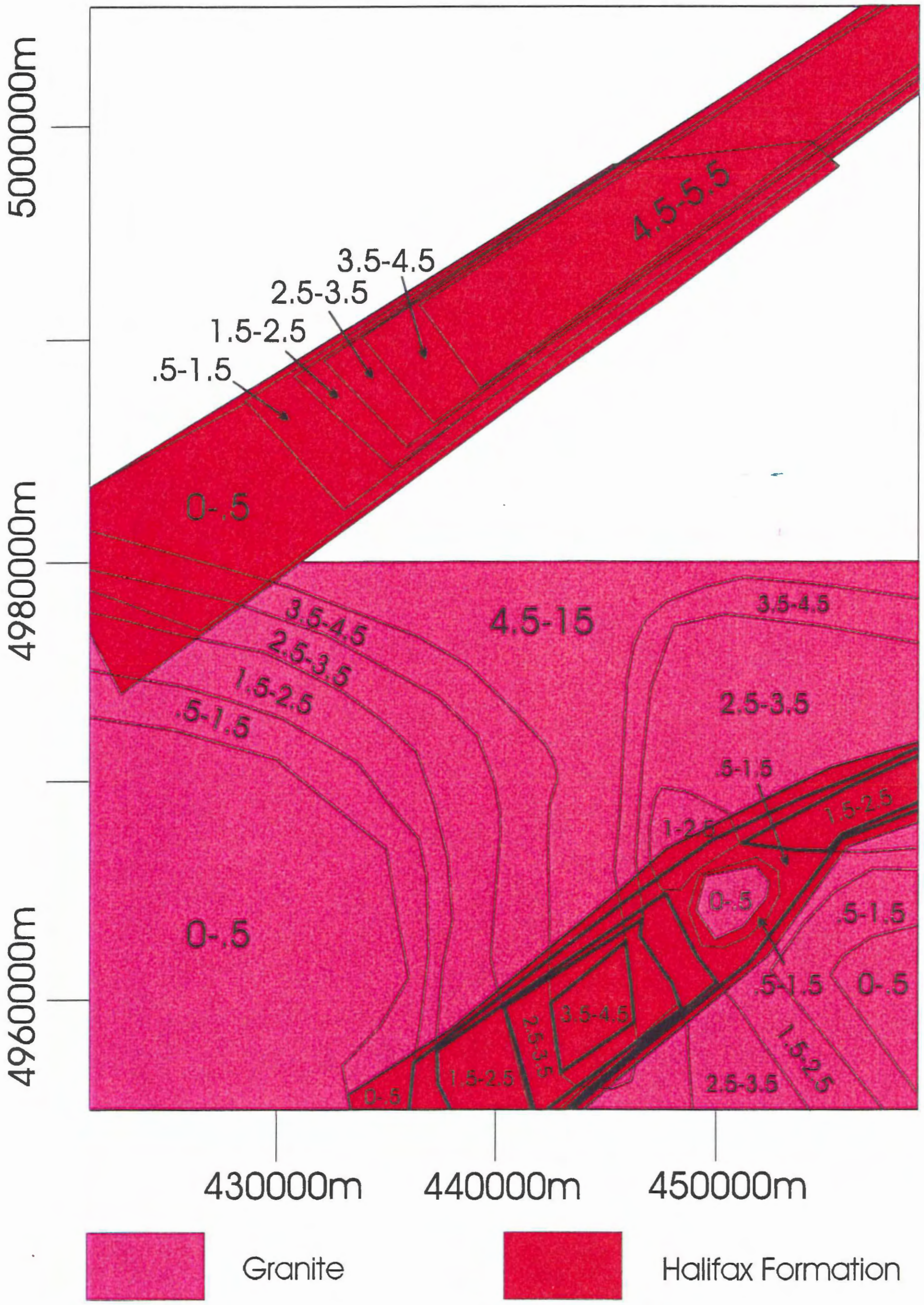
Station	Gravity (mgal)	Total drift corr	Latitude correction	FA corr	Bouguer corr	Corr Bouguer	Bouguer gravity	Bouguer gravity
	(R-4000)Fi+4231.51	gravity (mGal)	0.812sin(2f) mgal/km	0.3086h	BC=0.04191rh	gravity (mGal)	relative to B1	relative to KH
191	4306.34	4304.72	10.11	8.74	3.22	4300.14	0.05	-20.57
192	4312.29	4310.53	11.52	7.25	2.67	4303.59	3.5	-17.12
193	4312.9	4311.02	12.13	7.2	2.65	4303.44	3.34	-17.28
194	4312.85	4310.81	12.98	4.8	1.76	4300.86	0.77	-19.85
195	4315	4312.88	13.38	7.05	2.6	4303.96	3.86	-16.76
196	4317	4314.74	14.22	4.89	1.8	4303.61	3.52	-17.1
197	4317	4314.6	14.69	8.68	3.2	4305.4	5.31	-15.31
198	4315.54	4312.98	15.78	10.24	3.77	4303.67	3.58	-17.04
199	4317.96	4315.28	16.4	8.46	3.12	4304.22	4.13	-16.49
200	4317.66	4314.93	16.73	9.12	3.36	4303.96	3.87	-16.75
201	4318.87	4316.04	17.44	10.13	3.73	4305	4.91	-15.71
202	4319.53	4316.64	17.86	11.03	4.06	4305.74	5.65	-14.97
203	4320.71	4317.71	18.31	11.18	4.12	4306.48	6.38	-14.24
204	4321.14	4318.09	18.41	9.93	3.65	4305.96	5.87	-14.75
205	4315.4	4312.17	15.58	10.11	3.72	4302.98	2.89	-17.73
206	4309.52	4306.09	9.47	5.04	1.85	4299.8	-0.29	-20.91
207	4309.26	4305.83	9.24	5.05	1.86	4299.78	-0.32	-20.94
208	4306.06	4302.62	8.72	8.71	3.2	4299.4	-0.69	-21.31
209	4303.09	4299.65	8.28	12.1	4.45	4299.01	-1.08	-21.7
210	4302.5	4299.06	8.03	12.12	4.46	4298.68	-1.41	-22.03
211	4302.38	4298.93	7.8	11.59	4.27	4298.46	-1.63	-22.25
212	4303.41	4299.97	7.48	9.97	3.67	4298.78	-1.31	-21.93
213	4302.84	4299.39	7.05	7.95	2.93	4297.36	-2.73	-23.35
214	4300.64	4297.19	6.66	9.79	3.6	4296.72	-3.37	-23.99
215	4301.71	4298.26	6.11	6.19	2.28	4296.06	-4.03	-24.65
216	4300.72	4297.26	5.34	8.7	3.2	4297.43	-2.67	-23.29
217	4299.8	4296.35	4.54	8.56	3.15	4297.22	-2.87	-23.49
218	4297.54	4294.08	3.82	7.41	2.73	4294.95	-5.14	-25.76
219	4296	4292.53	3.51	7.13	2.62	4293.53	-6.56	-27.18
220	4294.9	4291.44	3.29	9.06	3.34	4293.87	-6.22	-26.84
221	4292.53	4289.06	2.49	5.71	2.1	4290.18	-9.91	-30.53
222	4291.14	4287.67	1.64	6.01	2.21	4289.84	-10.26	-30.88
223	4290.43	4286.95	1.33	5.95	2.19	4289.39	-10.7	-31.32

Station	Gravity (mgal) (R-4000)Fi+4231.51	Total drift corr gravity (mGal)	Latitude correction 0.812sin(2f) mgal/km	FA corr 0.3086h	Bouguer corr BC=0.04191rh	Corr Bouguer gravity (mGal)	Bouguer gravity relative to B1	Bouguer gravity relative to KH
224	4290.05	4286.58	0.91	7.22	2.66	4290.23	-9.86	-30.48
225	4289.94	4286.46	0.49	8.72	3.21	4291.48	-8.61	-29.23
226	4291.77	4288.29	0.13	6.75	2.48	4292.42	-7.67	-28.29
227	4292.29	4288.81	-0.29	6.39	2.35	4293.14	-6.96	-27.58
228	4285.27	4281.79	-0.51	6.97	2.56	4286.71	-13.38	-34
229	4280.92	4277.44	1.56	28.05	10.32	4293.6	-6.49	-27.11
230	4275.63	4272.15	3.07	42.21	15.53	4295.75	-4.34	-24.96
231	4279.13	4275.65	4.13	43.96	16.18	4299.3	-0.79	-21.41
232	4284.03	4280.88	0.22	28.07	10.33	4298.41	-1.68	-22.3
233	4286.39	4283.25	0.66	28.22	10.39	4300.43	0.33	-20.29
234	4286.03	4282.9	0.94	26.17	9.63	4298.5	-1.59	-22.21
235	4287.89	4284.77	1.2	23.41	8.62	4298.36	-1.73	-22.35
236	4289.4	4286.29	1.47	20.07	7.38	4297.5	-2.59	-23.21
237	4290.83	4287.73	1.98	16.5	6.07	4296.18	-3.91	-24.53
238	4289.25	4286.16	2.27	19.04	7.01	4295.93	-4.17	-24.79
239	4287.26	4284.18	2.49	20.2	7.43	4294.46	-5.63	-26.25
240	4288.98	4285.9	2.41	18.25	6.72	4295.02	-5.07	-25.69
241	4289.74	4286.68	2.03	17.55	6.46	4295.74	-4.36	-24.98
242	4289.27	4286.22	2.05	16.92	6.23	4294.86	-5.23	-25.85
243	4291.97	4288.92	2.11	12.4	4.56	4294.64	-5.45	-26.07
244	4290.39	4287.35	2.08	10.31	3.8	4291.79	-8.31	-28.93
245	4287.39	4284.41	3.68	19.96	7.35	4293.34	-6.75	-27.37
246	4285.73	4282.75	4.43	24.53	9.03	4293.82	-6.27	-26.89
247	4282.73	4279.76	5.47	34	12.51	4295.77	-4.32	-24.94
248	4281.81	4278.84	6.42	39.87	14.67	4297.62	-2.47	-23.09
249	4277.54	4274.59	6.89	47.04	17.31	4297.43	-2.66	-23.28
250	4277.06	4274.12	12.28	58.41	21.5	4298.75	-1.34	-21.96
251	4275.95	4273.01	8.28	60.96	22.43	4303.25	3.16	-17.46
252	4277.93	4275	8.79	60.3	22.19	4304.31	4.22	-16.4
253	4278.39	4275.46	9.04	59.63	21.94	4304.1	4.01	-16.61
254	4280.52	4277.6	9.28	57.11	21.02	4304.41	4.32	-16.3
255	4292.04	4289.14	10.86	37.86	13.94	4302.21	2.11	-18.51
256	4285.74	4282.93	-0.24	26.52	9.76	4299.93	-0.17	-20.79

Station	Gravity (mgal) (R-4000)Fi+4231.51	Total drift corr gravity (mGal)	Latitude correction 0.812sin(2f) mgal/km	FA corr 0.3086h	Bouguer corr BC=0.04191rh	Corr Bouguer gravity (mGal)	Bouguer gravity relative to B1	Bouguer gravity relative to KH
257	4285.27	4282.45	-0.63	27.8	10.23	4300.66	0.56	-20.06
258	4283.4	4280.58	-1.38	29.59	10.89	4300.65	0.56	-20.06
259	4287.13	4284.31	-1.71	24.18	8.9	4301.31	1.21	-19.41
260	4289.03	4286.21	-2.31	20.51	7.55	4301.48	1.39	-19.23
261	4289.12	4286.3	-2.55	19.74	7.27	4301.32	1.23	-19.39
262	4288.65	4285.82	-2.79	19.45	7.16	4300.9	0.81	-19.81
263	4289.18	4286.36	-2.98	18.22	6.71	4300.85	0.76	-19.86
264	4290.93	4288.1	-3.22	15.83	5.83	4301.33	1.23	-19.39
265	4289.52	4286.68	-3.53	16.23	5.97	4300.47	0.38	-20.24
266	4286.89	4284.05	-3.85	19.12	7.04	4299.98	-0.11	-20.73
267	4287.4	4284.54	-3.29	22.62	8.33	4302.13	2.04	-18.58
268	4286.31	4283.45	-3.42	22.93	8.44	4301.36	1.27	-19.35
269	4290.15	4287.28	-3.35	16.04	5.9	4300.76	0.66	-19.96
270	4289.82	4286.94	-3.46	15.52	5.71	4300.21	0.12	-20.5
271	4287.79	4284.91	-3.53	18.11	6.67	4299.89	-0.21	-20.83
272	4286.93	4284.05	-3.79	15.45	5.69	4297.6	-2.49	-23.11
273	4284.39	4281.51	-4.31	16.17	5.95	4296.04	-4.06	-24.68
274	4282.68	4279.79	-4.52	17.53	6.45	4295.38	-4.71	-25.33
275	4281.62	4278.72	-4.75	18.61	6.85	4295.23	-4.86	-25.48
276	4285.62	4282.72	-5.37	16.25	5.98	4298.36	-1.73	-22.35

APPENDIX D LOCATION OF VERTICAL PRISMS

The following page contains a diagram showing, in plane view, the location of the vertical prisms (sheets) used to model the Halifax Formation and granite bodies. The labels are placed on the top surface of each sheet and indicate depth to the top and bottom surfaces in kilometres.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450000m
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0-.5
4.5-5.5
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2.5-3.5
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1-2.5
1.5-2.5
0-.5
.5-1.5
0-.5
0-.5
.5-1.5
0-.5
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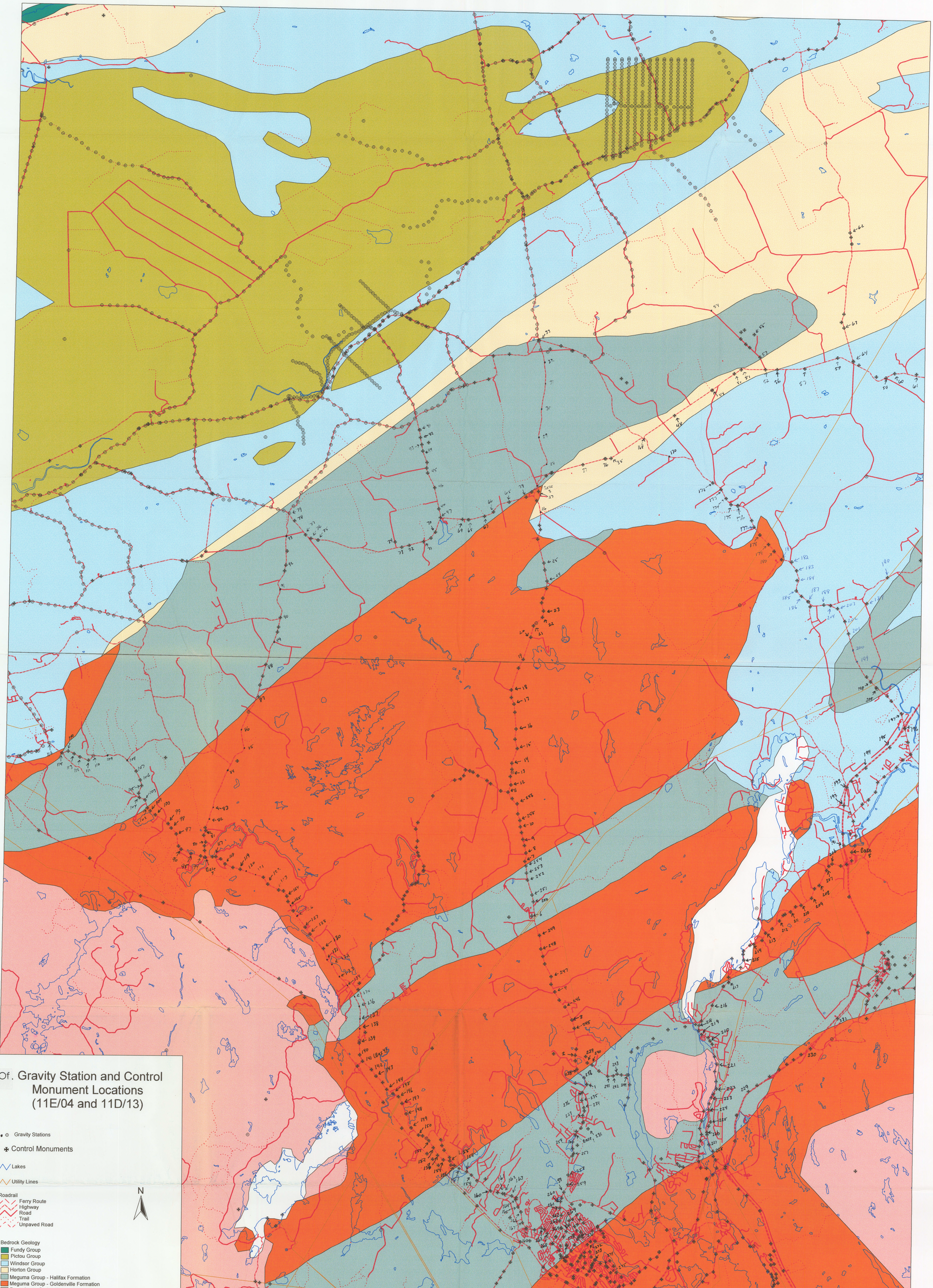
1.5-2.5
0-.5
2.5-3.5
1.5-2.5
Granite
Halifax Formation



Map Of. Gravity Station and Control Monument Locations (11E/04 and 11D/13)