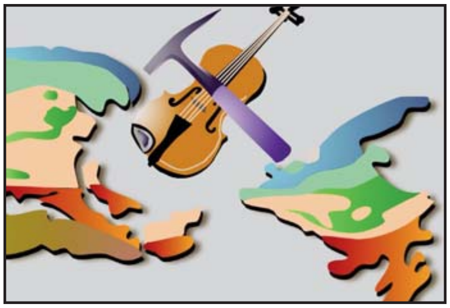
# Harold Williams Series



## Connecting Cape Breton Island and Newfoundland, Canada: Geophysical Modeling of pre-Carboniferous 'Basement' Rocks in the Cabot Strait Area

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### SUMMARY

Magnetic and gravity data from northeastern Cape Breton Island, southwestern Newfoundland, and the intervening Cabot Strait area were compiled and used to generate a series of maps displaying magnetic (filtered total field, first and second derivative) and gravity (Bouguer anomaly onshore, free-air anomaly offshore) information to enhance the anomaly pattern associated with regional geology. With further constraints from previously published seismic reflection interpretations and detailed maps of onshore geology, five two-dimensional subsurface models were generated. Potential field anomalies in the offshore can be correlated with onshore faults, rock units, and pre-Carboniferous terranes. In Newfoundland, the Cabot – Long Range Fault separates Grenvillian basement to the northwest from peri-Gondwanan Port aux Basques subzone basement in the southeast and can be traced to the Wilkie Brook Fault on Cape Breton Island. The Cape Ray Fault/Red Indian Line merges offshore with the Cabot – Long Range Fault so that Notre Dame subzone rocks do not extend across the Cabot Strait area. The Port aux Basques – Exploits subzone boundary crosses the strait but is likely buried by younger rocks onshore in Cape Breton Island. Magnetic halos in the Exploits subzone are probably caused by Silurian – Devonian plutons like those in the Burgeo Intrusive Suite. The Exploits – Bras d'Or terrane boundary is located within the Ingonish magnetic anomaly, which was resolved into four overlapping components representing basement sources intruded into metasedimentary rocks and dioritic and granodioritic plutons of the Bras d'Or terrane. The Bras d'Or terrane can be traced to the Cinq-Cerf block and Grey River areas in southern Newfoundland. The interpretations suggest that Bras d'Or terrane 'basement' may underlie all of Exploits subzone, and that the Aspy terrane of Cape Breton Island is part of that subzone.

### SOMMAIRE

Les données magnétométriques et gravimétriques du nord-est de l'île du Cap-Breton, dans le sud-ouest de Terre-Neuve, et de la région du détroit de Cabot contigu, ont été compilées et utilisées pour produire une série de cartes affichant les particularités magnétiques (champ total filtré, dérivé première et seconde) et gravimétriques (anomalie de Bouguer de la côte, anomalie à l'air libre extracôtière) pour ajouter à la compréhension des motifs d'anomalie de la géologie régionale. En tenant compte des limitations imposées par les interprétations de données de levés de sismique réflexion déjà publiées et de cartes détaillées de géologie continentale, cinq modèles 2D du sous-sol ont été produits. Des anomalies de champ potentiel en zone extracôtière peuvent être corrélées avec des failles, des unités lithologiques et des terranes pré-carbonifères sur la côte. Sur l'île de Terre-Neuve, la faille de Cabot-Long Range qui sépare le socle grenvillien au nord-ouest de la sous-zone de socle péri-gondwanienne, de Port-aux- Basques au sud-est, peut être reliée à la faille de Wilkie Brook sur l'île du Cap-Breton. La faille du Cap Ray et la linéation de Red Indian se fondent au large avec la faille de Cabot – Long Range, ce qui signifie que les roches de la sous-zone de Notre-Dame ne traversent pas la région du détroit de Cabot. La limite de la sous-zone de Port aux Basques-

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Exploits traverse le détroit, mais elle est vraisemblablement enfouie sous des roches plus jeunes sur l'île du Cap-Breton. Les halos magnétiques dans la sous-zone Exploits sont probablement causés par des plutons siluro-dévoniens comme c'est le cas de ceux de la séquence intrusive de Burgeo. La limite du terrane Exploits-Bras d'Or est située dans l'anomalie magnétique Ingonish, laquelle s'est révélée être constituée de quatre composantes superposées représentant des sources de socle engoncées dans des roches métasédimentaires, et dans des plutons dioritiques et granodioritiques du terrane de Bras d'Or. On peut suivre le terrane de Bras d'Or jusque dans les régions du bloc de Cinq-Cerf et de Grey River dans le sud de Terre-Neuve. Les interprétations permettent de penser que le « socle » du terrane de Bras d'Or pourrait constituer l'assise rocheuse de la sous-zone Exploits, et que le terrane Aspy de l'île du Cap-Breton ferait partie de cette sous-zone.

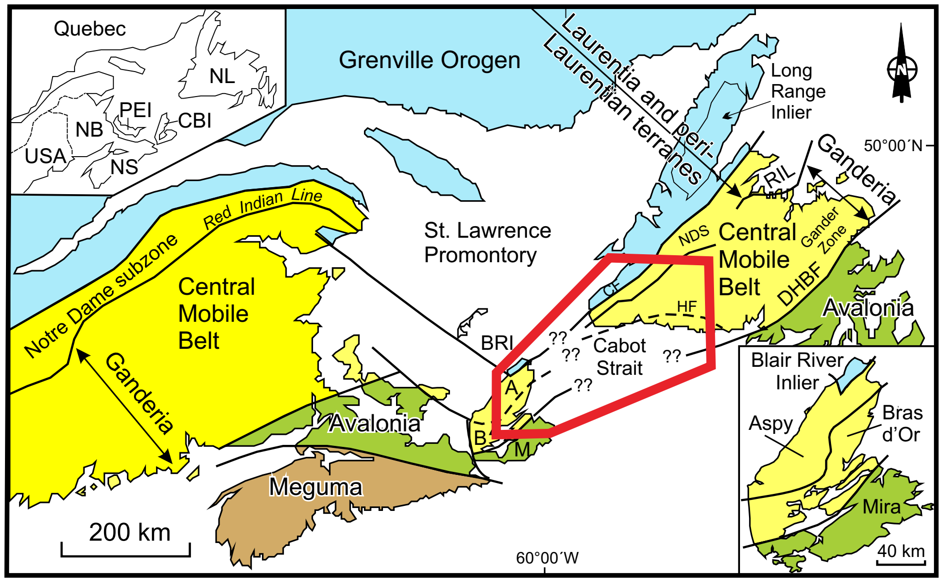



**Figure 1.** Components of the northern Appalachian orogen after Hibbard et al. (2006) showing the location of the study area centred on the Cabot Strait between Cape Breton Island and Newfoundland. Abbreviations: DHBF, Dover – Hermitage Bay Fault; HF, Hermitage Flexure; NDS, Notre Dame subzone; RIL, Red Indian Line. Inset map on upper left shows political areas in northeastern United States (USA) and Canada: CBI, Cape Breton Island; NB, New Brunswick; NS, Nova Scotia; NL, Newfoundland; PEI, Prince Edward Island. Lower right inset map shows an enlarged view and key to abbreviations for subdivisions in Cape Breton Island.

## INTRODUCTION

On his pioneering map emphasizing along-orogen correlations of pre-Carboniferous rocks in the Appalachian mountain belt, Williams (1978) inferred that all of Cape Breton Island is part of the Avalon Zone. In contrast, Newfoundland, only a few 10s of kilometres away across the Cabot Strait, was divided into the Humber, Dunnage, Gander, and Avalon zones, interpreted to represent both Laurentian and Gondwanan continental margins and the intervening Iapetus Ocean. Subsequent decades of geological and geophysical research resulted in an updated and more detailed map of the Appalachian orogen (Hibbard et al. 2006) on which Cape Breton Island, like Newfoundland, includes both Laurentian and Gondwanan components, and with only the southernmost terrane, Mira, considered part of Avalonia (Fig. 1). However, even though Laurentian and Gondwanan components are now recognized in Cape Breton Island, the details of how they correlate with their counterparts across the Cabot Strait in Newfoundland are still uncertain (e.g. Barr et al. 1998; Valverde-Vaquero et al. 2006; Lin et al. 2007). Part of the uncertainty can be attributed to the narrowness of the orogen in Cape Breton Island compared to Newfoundland (Lin et al. 1994), making it unsurprising that fewer components have been preserved in the relatively small area of Cape Breton Island. In addition, Carboniferous cover is relatively more extensive in Cape Breton Island compared to most of Newfoundland, also likely a factor in obscuring older units. However, less easily explained is the presence of rock units in parts of Cape Breton Island that do not appear to have counterparts in southwestern Newfoundland.

Linked to the uncertainty in correlations between units exposed onshore in Cape Breton Island and Newfoundland is the unknown identity of the pre-Carboniferous rocks that underlie the intervening Cabot Strait. Carboniferous rocks under the Cabot Strait are reasonably well known based on their seismic characteristics (e.g. Langdon and Hall 1994; Pascucci et al. 1999, 2000), but underlying pre-Carbonferous units have not been well imaged in seismic studies (e.g. Marillier et al. 1989). Both Langdon and Hall (1994) and Pascucci et al. (1999, 2000) focused on Carboniferous units and faults affecting those units. They showed pre-Carboniferous basement on their interpretations, but did not speculate on the nature of that basement. Because the Carboniferous units contribute little to the magnetic field signatures, magnetic data have the potential to enable interpretation of the pre-Carboniferous units by comparison to the onshore areas, where geophysical signatures can be linked to particular areas and in some cases to particular units (e.g. Wiseman and Miller 1994; Ethier 2001). In contrast, the offshore pre-Carboniferous units have thicker sediment accumulations above them than their onshore equivalents, and thus Carboniferous units have greater influence on gravity anomalies in the offshore, especially in basins with thicker sequences.

Loncarevic et al. (1989) used magnetic and gravity maps to infer correlations based on map patterns, but no modeling of the data was attempted. In this study we use both recompiled magnetic and gravity maps and geophysical modeling, supported by previously published seismic reflection data, as a basis for interpreting pre-Carboniferous units and structures under the Cabot Strait and their correlations with onshore units in both Cape Breton Island and southwestern Newfoundland. We then use these data to discuss geological similarities and differences between northeastern Cape Breton Island and southwestern Newfoundland, and possible reasons for them.

## GEOLOGICAL BACKGROUND

### Pre-Carboniferous Rocks

The Appalachian orogen developed during the Paleozoic on the southeastern margin of Laurentia. The Laurentian margin formed as a result of rifting of Gondwanan continental blocks from Laurentia to open the Iapetus Ocean, likely a protracted process during which larger blocks were removed first followed by smaller Laurentian fragments with Grenvillian basement, such as the Dashwoods block in Newfoundland (e.g. Waldron and van Staal 2001; Cawood et al. 2001; Li et al. 2008; van Staal et al. 2013). Those fragments were later re-attached along the margin during the Taconic orogeny. Similar detachment of fragments from the Gondwanan side of the ocean resulted in the opening of another ocean, known as Rheic, between those fragments and Gondwana (e.g. Nance and Linnemann 2009), and the transport of the fragments across the closing Iapetus Ocean to successively accrete to the Laurentian margin in a series of events known as the Salinic, Acadian, and Neoacadian orogenies. Ultimately, the arrival of the main mass of Gondwana at the margin resulted in the Carboniferous – Permian Alleghanian orogeny. This long-lasting series of events was accompanied by protracted and widespread deformation, metamorphism, volcanism, and plutonism along the growing Laurentian margin throughout much of the Paleozoic (see summary in van Staal and Barr 2012).

In central Newfoundland, the Cabot (or Long Range) Fault separates several Grenvillian inliers and their cover sequences of the Laurentian margin (traditionally known as the Humber Zone; Williams 1978, 1979) from the mainly peri-Laurentian oceanic and arc rocks of the Notre Dame subzone, which includes the Dashwoods block (Fig. 1). The boundary between these peri-Laurentian rocks and now-adjacent peri-Gondwanan rocks is a deformed zone known as the Red Indian Line. East and southeast of the Red Indian Line is Ganderia, which consists of Gondwana-derived continental fragments and their cover sequences, traditionally termed the Gander Zone (Williams 1978), and associated complexly deformed, mainly oceanic and volcanic-arc rocks of the Exploits subzone (e.g. van Staal et al. 2009). Ganderia extends to the east across central Newfoundland as far as the Dover – Hermitage Bay Fault (Fig. 1) which separates these rocks from mainly less deformed and metamorphosed but also Gondwana-derived rocks of Avalonia and associated cover sequences.

However, distinction among Laurentian, Ganderian, and Avalonian components is less clear along the southern coast of Newfoundland, an area known as the Hermitage Flexure (Williams 1978). No Laurentian basement rocks are exposed in this area, and the Cabot – Long Range Fault juxtaposes Carboniferous cover rocks against Lower Paleozoic rocks of the Notre Dame subzone (Fig. 2). The Cape Ray Fault marks the eastern margin of the Notre Dame subzone in southwestern Newfoundland, and is generally interpreted to connect with the Red Indian Line and

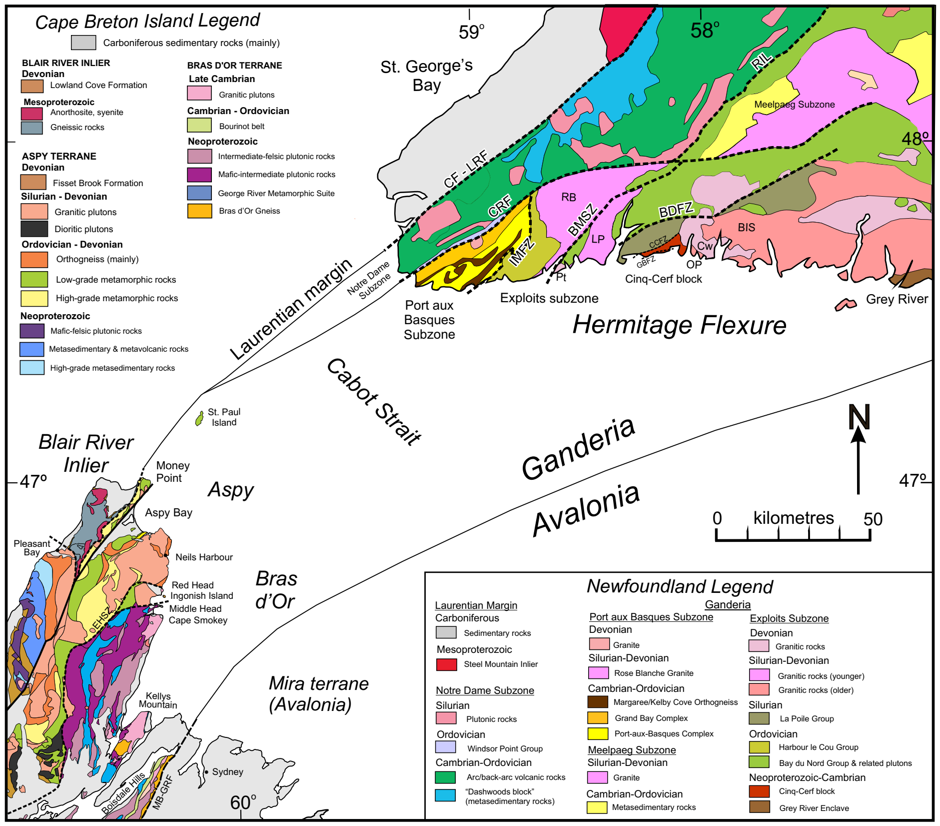



**Figure 2**. Simplified geological map of northeastern Cape Breton Island and southwestern Newfoundland modified after Barr et al. (1992), Valverde-Vaquero et al. (2000, 2006), Hibbard et al. (2006), and Lin et al. (2007). Terrane boundaries in the Cabot Strait area are after Hibbard et al. (2006). Fault abbreviations (in alphabetical order): BDFZ, Bay d'Est Fault Zone; BMSZ; Bay le Moine Shear Zone; CCFZ, Cinq Cerf Fault Zone; CF-LRF, Cabot Fault – Long Range Fault; CRF, Cape Ray Fault; EHSZ, Eastern Highlands Shear Zone; GBFZ, Grand Bruit Fault Zone; IMFZ, Isle-aux-Morts Fault Zone; MB-GRF, McIntosh Brook – Georges River Fault. Unit abbreviations in Newfoundland (in alphabetical order): BIS, Burgeo Intrusive Suite; Cw, Chetwynd Granite; LP, La Poile Granite; OP, Otter Point Granite; Pt, Petites Granite; RB, Rose Blanche Pluton. Relevant units in Cape Breton Island are identified in Figure 3.

hence to separate peri-Laurentian and peri-Gondwanan components (Fig. 2). Metasedimentary and metavolcanic rocks east of the Cape Ray Fault are generally assigned to Ganderia (e.g. Schofield et al. 1998; Valverde-Vaquero et al. 2000; Hibbard et al. 2006, 2007; Lin et al. 2007), and the Isle-aux-Morts Fault Zone separates the Port aux Basques (Gander) subzone from the Exploits subzone (Fig. 2). South of the Bay d'Est Fault Zone in the Exploits subzone (Fig. 2), Silurian volcanic and sedimentary rocks of the La Poile Group lie unconformably on Late Neoproterozoic – Late Cambrian rocks (e.g. Dunning and O'Brien 1989; Dunning et al. 1990b; O'Brien et al. 1991; Valverde-Vaquero et al. 2006; Lin et al. 2007). The Late Neoproterozoic rocks include granodiorite and tonalite, together with porphyry intrusions and metavolcanic rocks, yielding U–Pb zircon ages ranging from ca. 686 – 548 Ma but mostly from ca. 585 – 557 Ma (Valverde-Vaquero et al. 2006). Also present are Late Cambrian intrusions dated at ca. 499 – 495 Ma (Valverde-Vaquero et al. 2006). Hibbard et al. (2007) termed this area the Cinq-Cerf block, a term also adopted here (Fig. 2). Some workers in Newfoundland have interpreted the Cinq-Cerf block to be part of Avalonia, rather than Ganderia, based on the Neoproterozoic ages (e.g. O'Brien et al. 1991; Valverde-Vaquero et al. 2006). Most of the rest of the Hermitage Flexure consists of Silurian and Devonian plutonic rocks, except in the Grey River area (Fig. 2) where Neoproterozoic rocks form a fault-bounded coastal strip intruded by Devonian granite (Blackwood 1985; Dickson et al. 1989; Kerr and McNicoll 2012).

In Cape Breton Island, rocks representing the Notre Dame subzone appear to be absent (Barr et al. 1998). Laurentian rocks of the Grenvillian Blair River Inlier, correlated with Grenvillian basement inliers in the Humber Zone (Barr and Raeside 1989; Miller et al. 1996; Miller and Barr 2000), are juxtaposed against peri-Gondwanan rocks in the area known as the Aspy terrane. The Blair River Inlier is composed of gneiss, syenite and anorthosite that have been metamorphosed partly to granulite facies and overprinted at amphibolite- and greenschist-facies conditions (Miller et al. 1996). The Blair River Inlier has age, compositional, and metamorphic similarities to Grenvillian rocks in the Humber Zone of Newfoundland, although in the Blair River Inlier the Grenvillian rocks were affected by Silurian orogenic activity dated at 425 Ma based on U–Pb ages from titanite and zircon (Miller et al. 1996; Barr et al. 1998). Also in contrast to the Humber Zone, the Blair River Inlier lacks a widespread Cambrian – Ordovician passive margin sedimentary sequence, although minor calc-silicate and marble lenses interpreted to be either xenoliths or fault-bound enclaves in the gneissic rocks may be remnants of such a cover (Barr et al. 1998; Miller and Barr 2000). The ca. 580 Ma gabbroic dikes in the Blair River Inlier are similar to other mafic units found along the northeastern Laurentian margin that are likely associated with opening of the Iapetus Ocean (Miller and Barr 2004).

Both the Aspy and Bras d'Or terranes to the south of the Blair River Inlier are considered to be part of Ganderia (e.g. Hibbard et al. 2006). The Aspy terrane is characterized by Ordovician and Silurian metasedimentary and metavolcanic rocks affected by Devonian thermal events and widespread granitic magmatism (Fig. 3). The metasedimentary and metavolcanic rocks are assigned to a number of different units based on age and stratigraphic, structural and metamorphic characteristics, and show similarities in ages and rock types to the La Poile Group and possibly other units in the Hermitage Flexure area in Newfoundland (Barr and Jamieson 1991; Lin et al. 2007). Major plutonic units in the Aspy terrane include the ca. 375 Ma Black Brook Granitic Suite (Yaowanoiyothin and Barr 1991) and ca. 402 Ma Cameron Brook Granodiorite (Dunning et al. 1990a). The Neils Harbour Gneiss includes components of the Cameron Brook Granodiorite and Black Brook Granitic Suite, as well as biotite-rich paragneiss of uncertain protolith and age (Yaowanoiyothin and Barr 1991). Also potentially important in the present study is the Ingonish Island rhyolite, a magnetite-rich rhyolite that crops out only on Ingonish Island (Barr and Raeside 1998; Fig. 3). St. Paul Island, located in the Cabot Strait about 25 km northeast of the northeastern tip of Cape Breton Island (Fig. 2), consists of rocks inferred to correlate with those of the Money Point area (Lin 1994; Barr et al. 1998). The western part of the Aspy terrane contains Late Neoproterozoic metamorphic and plutonic rocks similar to those of the Bras d'Or terrane (Lin et al. 2007; Tucker 2011).

The Bras d'Or terrane is characterized by low-pressure cordierite – andalusite (or sillimanite) gneiss and low- to high-grade metasedimentary and minor metavolcanic rocks, both intruded by abundant ca. 565 – 555 Ma and ca. 500 Ma plutonic rocks (Barr et al. 1990; Dunning et al. 1990a; Raeside and Barr 1990). The older plutons (565 – 555 Ma) are composed of diorite, tonalite, granodiorite and granite, and are interpreted to have formed in a continental margin subduction zone (e.g. Barr and Setter 1986; Farrow and Barr 1992). The ca. 500 Ma plutons are of granitic composition and may have formed by crustal melting during post-orogenic uplift or during periods of localized extension within the terrane, perhaps linked to the initial stages of separation from Gondwana in the Middle to Late Cambrian (White et al. 1994; van Staal and Barr 2012). The variation in level of exposure in Bras d'Or terrane is consistent with the Bras d'Or terrane having been thrust over the Aspy terrane; subsequent erosion thus exposes deeper levels of the terrane near its boundary with the Aspy terrane (Barr et al. 1995; Lin 2001).

The boundary between the Bras d'Or terrane and the Avalonian Mira terrane to the southeast is placed at the McIntosh Brook – Georges River Fault (Fig. 2). These Carboniferous faults are inferred to mark a major change in crustal composition, demonstrated by differences in pre-Carboniferous rock types and tectonothermal history across the boundary (e.g. Barr et al. 1990, 1995, 1998; Raeside and Barr 1990). King (2002) showed systematic contrasts in physical properties and geophysical characteristics between Precambrian rocks in the Bras d'Or and Mira terranes, and modeled the terrane boundary as sub-vertical at surface, shallowing to a dip of 50–70° northwest at depth. Magnetic and

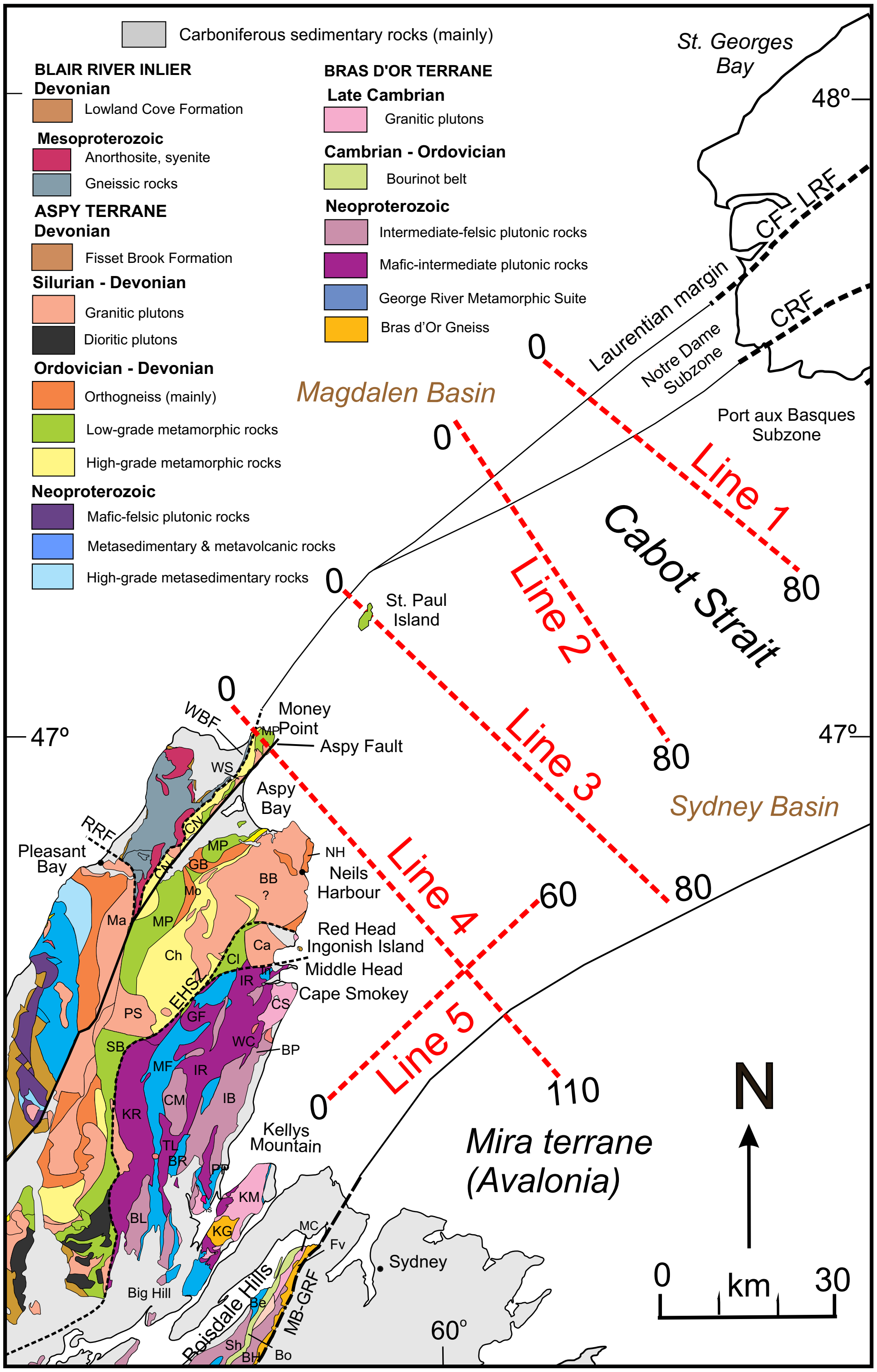



**Figure 3**. Enlarged view of the geological map of northeastern Cape Breton Island from Figure 2 with map units relevant to this study identified. Locations of potential field models 1 through 5 are also shown. Terrane boundaries in the Cabot Strait area are after Hibbard et al. (2006). Abbreviations: BB, Black Brook Granitic Suite; Be, Benacadie Brook Formation; BH, Boisdale Hills pluton; BL, Bell Lakes Plutonic Suite; Bo, Bourinot belt; BP, Birch Plain Granite; BR, Barachois River Formation; Ca, Cameron Brook Granodiorite; Ch, Cheticamp Lake Gneiss; Cl, Clyburn Brook formation; CM, Cross Mountain Pluton; CN, Cape North Group; CS, Cape Smokey Pluton; Fv, Frenchvale Road Metamorphic Suite; GB, Glasgow Brook Orthogneiss; GF, Gisborne Flowage Quartz Diorite; IB, Indian Brook Granodiorite; IR, Ingonish River Tonalite; KG, Kellys Mountain Gneiss; KM, Kellys Mountain Granite; KR, Kathy Road Diorite; Ma, Margaree Pluton; MB-GRF, McIntosh Brook – George River Fault; MC, Mount Cameron Syenogranite; MF, McMillan Flowage Formation; Mo, Middle Aspy River Orthogneiss; MP, Money Point Group; NH, Neils Harbour Gneiss; PS, Park Spur Granite; RRF, Red River Fault; SB, Sarach Brook Metamorphic Suite; Sh, Shunacadie pluton; TL, Timber Lake Diorite; WBF, Wilkie Brook Fault; WC, Wreck Cove Dioritic Suite; WS, Wilkie Surgarloaf Granite.

gravity map patterns indicate that the original terrane boundary has been cut and offset by other faults, consistent with a dynamic post-Devonian tectonic history (e.g. Pascucci et al. 2000; King 2002).

## Maritimes Basin

Onshore, Devonian and Carboniferous sedimentary rocks of the Maritimes Basin overlie the older rock units around the periphery of the Cape Breton Highlands (Fig. 2). Locally, Devonian sedimentary and bimodal volcanic rocks of the Fisset Brook Formation underlie the Carboniferous units, forming the early fill in extensional basins that developed after Devonian orogenesis. The more widespread Tournaisian Horton Group occupies fault-bounded basins across Atlantic Canada (e.g. Hamblin and Rust 1989; Gibling et al. 2008). It is overlain by the Viséan Windsor Group, which also oversteps pre-Carboniferous units and includes clastic rocks as well as carbonate and evaporite rocks deposited in a marine environment. The Windsor Group is overlain conformably by Viséan to Serpukhovian lacustrine rocks of the Mabou Group, which are in turn unconformably overlain by Pennsylvanian fluvial/lacustrine rocks of the Cumberland Group and red mudstone and sandstone of the Pictou Group, which extends in places into the Permian (e.g. Pascucci et al. 2000). In southwestern Newfoundland west of the Cabot Fault in the Bay St. George sub-basin, the Anguille and Codroy groups are equivalent to the Horton and Windsor groups, respectively, and the Barachois group of Newfoundland is probably equivalent to parts of the Mabou and Cumberland groups (e.g. Knight 1983; Langdon and Hall 1994).

Carboniferous sedimentary rocks are generally less than 2 km thick onshore in Cape Breton Island but thicken significantly in the offshore, both to the north in the Magdalen Basin, and to the east in the Sydney Basin, extending onto southwestern Newfoundland (Fig. 3). Both basins are part of the regional Maritimes Basin, which includes most Carboniferous rocks in Atlantic Canada (e.g. Gibling et al. 1987). In the Sydney Basin, the Horton Group fills extensional basins within pre-Carboniferous 'basement blocks', bordered by south-dipping master fault zones (Pascucci et al. 2000). The Horton Group is overstepped by the overlying Windsor and Mabou groups, which also rest on pre-Carboniferous basement rocks (Pascucci et al. 2000). The varied styles of superimposed basins have generated a composite depocentre in the Sydney Basin (Pascucci et al. 2000).

The sediment fill in the Magdalen Basin is thicker than in the Sydney Basin but contains equivalent stratigraphic units, as well as extensive volcanic rocks in the central part of the basin and widespread evaporite rocks and associated salt tectonics (e.g. Langdon and Hall 1994). The Cabot Strait area is located at the boundary between these two basins, and is characterized by structural complexity involving both salt tectonics and strike-slip faults (Langdon and Hall 1994). Langdon (1996) and Langdon and Hall (1994) used industry reflection seismic data to identify several major strike-slip faults in the Cabot Strait and St. George's Bay area. According to Langdon and Hall (1994) the Cabot Fault is the main fault along which most of the strike-slip displacement occurred during late Carboniferous deformation of the sedimentary fill in the Magdalen and Sydney basins. They interpreted St. Paul Island to be located on a restraining bend along the Cabot Fault.

## METHODS

Most of the digital magnetic and all of the gravity data used in this project were obtained from the Geological Survey of Canada (Natural Resources Canada). Additional digital aeromagnetic data for the St. George's Bay area were obtained from the Newfoundland and Labrador Department of Natural Resources. The magnetic and gravity data were acquired in point form from previously gridded compilations to allow them to be re-gridded in the desired datum and projection. The datum used for all of the acquired digital data is World Geodetic System 1984 (WGS84), using a geographic coordinate system. Grids were generated from the gravity and magnetic digital data using Generic Mapping Tools (GMT 4.5.8), open-source software that includes about 65 tools for the manipulation of geographic and Cartesian data sets. The GMT software was developed and is maintained by Paul Wessel and Walter H.F. Smith (http://gmtsoest.hawaii.edu/).

The digital magnetic data obtained from the Geological Survey of Canada are composed of a compilation of marine survey data and aeromagnetic (1 km) gridded data. The marine survey data, of various vintages and line orientations, had already been compiled and adjusted by Verhoef et al. (1996) to account for variations in the magnetic field, to correct crossover errors, and to filter and remove acquisition and gridding artefacts. Wavelengths exceeding 400 km were removed from the marine data grid, and the marine and aeromagnetic survey blocks were then assembled into a new 500 m grid. All data have been reduced to the IGRF (International Geomagnetic Reference Field).

The data set for the St. George's Bay area, obtained from the Newfoundland and Labrador Department of Natural Resources, was collected by Sander Geophysics Ltd. for the Hunt Oil Company in 1993. The airborne survey was flown with a line spacing of 7500 m in the northeast direction, and 3000 m in the southeast direction. The data were converted from NAD 27, UTM Zone 21, to WGS84 at the Newfoundland and Labrador Department of Natural Resources. This data set was adjusted and leveled so that it could be merged smoothly with the magnetic data obtained from the GSC.

The merged magnetic data sets were gridded at a spacing of 0.00625 degrees (~1 km) with an adjustable-tension continuous-curvature-surface algorithm using a cylindrical Mercator projection; the datum remained WGS84 (Wessel and Smith 2012). For the total magnetic field anomaly map, the data were displayed using GMT in UTM projection. Additional data filtering was applied to enhance anomalies in the study region, and the first and second vertical derivatives were calculated using GMT (Wessel and Smith 2012).

The digital gravity data obtained for this study are a compilation of gravity measurements collected from marine and ground surveys. The spacing for measurements was 5–10 km on land, and 2–5 km for ship tracks offshore. All necessary data corrections had been applied to produce merged grids, at 2 km resolution, of free-air anomalies for onshore and Bouguer anomalies for offshore. The gravity anomaly data were re-gridded at 1.5 km (~0.8 minutes) into the UTM projection for this study. The gravity and magnetic anomaly maps are all displayed using an artificial illumination angle of 315° to enhance southwest – northeast-trending features.

The program GM-SYS® (PRO) 4.8 was used to generate 5 forward models using magnetic and gravity data along selected lines across key features in the study area (Fig. 3). The models use a present day magnetic field strength of 43.136552 A/m, inclination of 75.686°, and declination of –24.836°. Such models are non-unique, in that a set of specific magnetic and gravity data can be matched by an infinite number of models. However, some constraints are provided by magnetic susceptibility data available for rock units in the Bras d'Or and Aspy terranes and Blair River Inlier in Cape Breton Island. These data were obtained using a hand-held Exploranium KT-9 Kappameter and are tabulated in King (2002), Cook (2005), and Zsámboki (2012). Data for selected units are summarized in Appendix A. Some measured density data are available from previous work (King 2002; Cook 2005) but in general, density values used in the models were guided by data from similar rock types (e.g. Tenzer et al. 2011).

## MAGNETIC AND GRAVITY MAPS

The various geologic zones and subzones in the study area are characterized by differences in magnetic and gravity anomaly signatures, such as differences in amplitude, wavelength, and degree of variability of the anomalies, evident in map view (Figs. 4–7). These signatures are summarized here, focusing on onshore areas where they can be related at least in part to known geological units. Geological contacts and faults from Figures 2 and 3 are shown as white lines for reference on maps of total magnetic field anomalies (Fig. 4), first and second vertical derivatives of magnetic field (Figs. 5, 6), and gravity anomalies (Fig. 7). Carboniferous cover units have generally low susceptibility (< 2 x $10^{-3}$ SI units) and hence have little effect on magnetic signatures. Because they also have relatively low density (< 2600 kg/m$^3$), variations in sediment thickness have a significant effect on gravity anomalies (Fig. 7). The gravity anomaly map also shows a series of lows in the Cabot Strait, trending to the southeast, which are associated with the deeper water of the Laurentian Channel. These anomalies are caused by the juxtaposition of lower density water in the deeper Laurentian Channel against the higher density sedimentary deposits located on either side of the channel.

### Bras d'Or Terrane

Strong positive magnetic anomalies (200–500 nT) are associated with the plutons that form much of the eastern Bras d'Or terrane (e.g. Indian Brook Granodiorite and similar plutons, Birch Plain Granite, Wreck Cove Dioritic Suite, Ingonish River Tonalite; Fig. 3). These units are also characterized by high average measured magnetic susceptibilities in the range of 3–12 x $10^{-3}$ SI units (Appendix A; Zsámboki 2012). Their host metamorphic units are associated with low magnetic signatures, consistent with their lower measured susceptibilities (average 0.3 – 5 x $10^{-3}$ SI units; Appendix A). A strong linear magnetic anomaly trends east-west through the Middle Head area and appears to connect with a very prominent anomaly in the offshore referred to here as the Ingonish magnetic anomaly (Fig. 4). Assessing the cause of this large (up to 500 nT) circular anomaly is an important aspect of this study. The granitic and dioritic rocks on Middle Head have been correlated with the Cape Smokey Granite (average k = 3.2 x $10^{-3}$ SI units) and Wreck Cove Dioritic Suite (average k = 10.4 x $10^{-3}$ SI units) on the basis of overall petrological characteristics (Raeside and Barr 1992). Farther south, magnetic anomalies associated with the Kellys Mountain and especially the Boisdale Hills areas are more subdued, consistent with the fact that these areas are dominated by metamorphic rocks and intermediate to felsic plutonic rocks (e.g. Barr and Setter 1986; Raeside and Barr 1990) that are generally less magnetic than the mafic to intermediate plutons to the north.

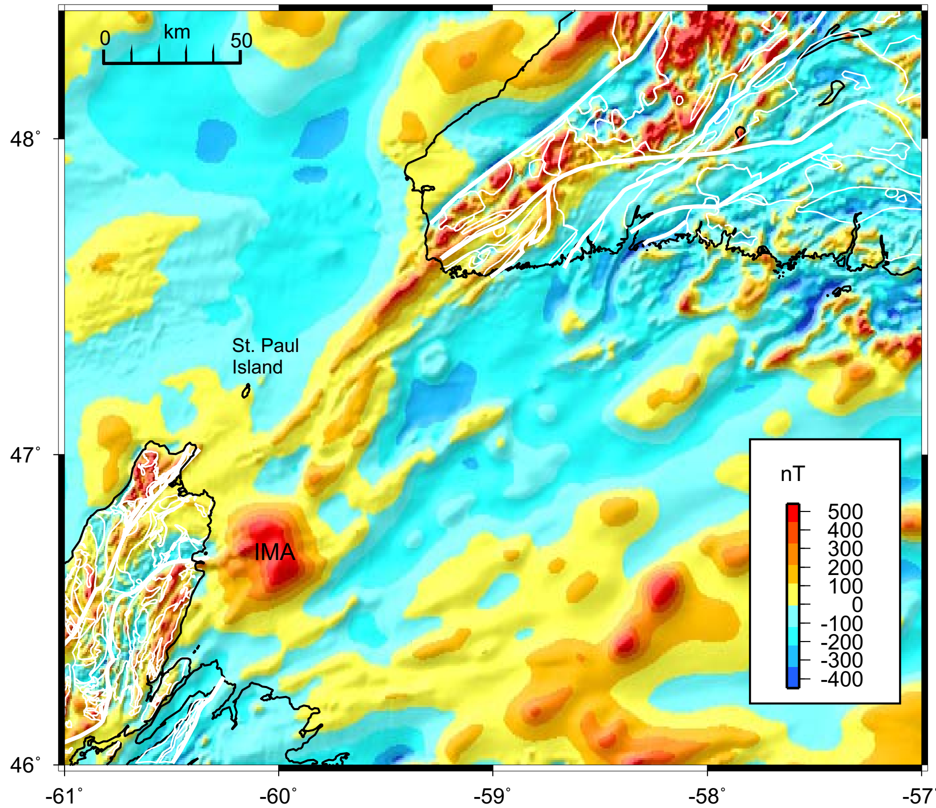



**Figure 4**. Total field magnetic anomaly map of the Cabot Strait area, compiled as described in the text. White lines are the onshore geological map unit boundaries and faults from Figure 2. The large positive anomaly east of Cape Breton Island is the Ingonish magnetic anomaly (IMA).

On the first derivative magnetic map (Fig. 5), strong linear anomalies associated with Bras d'Or terrane plutons are more prominent than on the total field anomaly map, particularly in the offshore. The Middle Head linear anomaly is accentuated on the first derivative map and extends into the area of the Ingonish magnetic anomaly in the offshore. On this map, the Ingonish magnetic anomaly appears less circular, and has been resolved into two parts, a southern part superimposed on a northeast-trending linear anomaly, and an elongate east-west northern part (Fig. 5).

On the second derivative magnetic map (Fig. 6), linear trends from onshore magnetic (plutonic) units of the eastern Bras d'Or terrane into the offshore are even more apparent, and it seems likely that all of the pre-Carboniferous units of the Bras d'Or terrane extend northeast into the offshore. In particular, the Wreck Cove Dioritic Suite and Indian Brook Granodiorite/Birch Plain Granite appear to

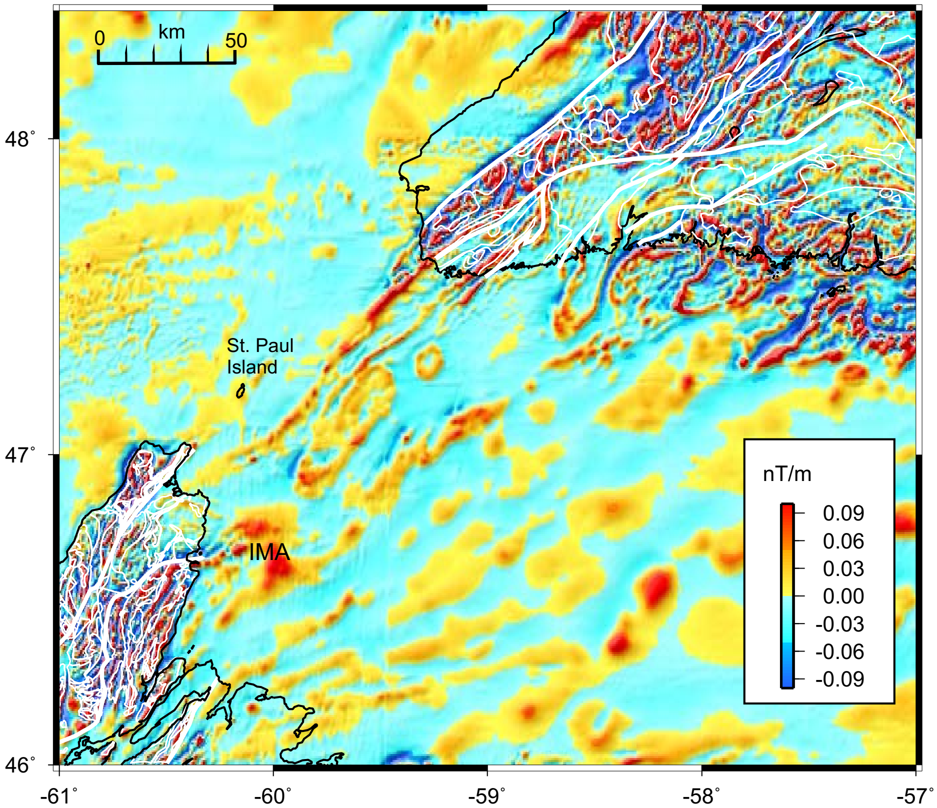



**Figure 5.** First vertical derivative of the total field magnetic anomaly map of the Cabot Strait study area. White lines are the onshore geological map unit boundaries and faults from Figure 2. Labels for St. Paul Island and Ingonish magnetic anomaly (IMA) are in the same positions as in Figure 4 for reference. Small artifacts are apparent at the contacts between data sets of different initial resolutions, and can be distinguished by their north-south or east-west orientation (e.g. at 59.5°W).

continue into the area of the Ingonish magnetic anomaly, which has been resolved into smaller elliptical anomalies superimposed on the linear anomalies. Also prominent are linear trends extending into the offshore from Kellys Mountain and the Boisdale Hills (Fig. 6). These trends are more northeasterly than those associated with the Mira terrane south of the MacIntosh Brook – Georges River Fault (Fig. 3).

The Bras d'Or terrane north of the Kellys Mountain area is associated with a strong positive gravity anomaly (20–40 mGal) that extends into the adjacent offshore (Fig. 7). This anomaly may be associated with heavy deep crustal rocks that have been brought to shallower depths as the Bras d'Or terrane was thrust over the Aspy terrane, as suggested in the tectonic models of Barr et al. (1995) and Lin (2001).

### Aspy Terrane

The total field magnetic anomaly map (Fig. 4) shows low and negative magnetic anomalies associated with units in the eastern part of the Aspy terrane such as the Black Brook Granitic Suite, Neils Harbour Gneiss, Cameron Brook Granodiorite, Clyburn Brook Formation, Cheticamp Lake Gneiss, and Park Spur Granite (Fig. 3). These units all have low average magnetic susceptibility, generally less than 1 x $10^{-3}$ SI units, although the Cameron Brook Granodiorite is somewhat higher at 3.5 x $10^{-3}$ SI units (Appendix A). Rhyolite exposed only on Ingonish Island has an average susceptibility of 8.4 x $10^{-3}$ SI units, but the lack of an associated anomaly suggests that it is of limited extent. The low and negative magnetic anomalies associated with the Aspy terrane extend into the offshore, where they appear to terminate against the Ingonish magnetic anomaly. A possible link is suggested between a strong northeast-trending linear anomaly having a source that appears to coincide with the Money Point Group, and an anomaly with a similar trend in Aspy Bay. Strong anomalies that trend east-southeast characterize the northeastern part of the Aspy terrane south of Aspy Bay.

Units farther west and south in the Aspy terrane have positive magnetic signatures, including part of the Money Point Group and the Margaree Pluton (Figs. 3, 4), consistent with variable but generally relatively high measured susceptibilities (Appendix A). The Neoproterozoic units in the western part of the terrane have also strong anomalies, consistent with their possible link to the Bras d'Or terrane (Barr and Raeside 1989).

The first derivative magnetic map (Fig. 5) brings out the prominent east-southeast-trending linear anomalies in the Black Brook Granite Suite south of Aspy Bay (Fig. 3). They extend to the west into the Money Point Group and Glasgow Brook granodiorite, although samples from all of those units in that area have low magnetic susceptibilities (Appendix A). The fact that these linear features intensify on the first derivative map (Fig. 5) compared to the total field map (Fig. 4) suggests that they are caused by shallow features such as mafic dykes; however, no evidence for mafic dykes or faults was observed during field work in those areas (Yaowanoiyothin and Barr 1991). They terminate in the offshore at weak southwest-trending linear anomalies associated with the edge of the northern part of the Ingonish magnetic anomaly (Fig. 5). These anomalies are also prominent on the second derivative magnetic map (Fig. 6).

The northeastern part of the Aspy terrane is characterized by a weaker gravity signature (0–10 mGal) compared to the neighbouring Bras d'Or terrane (Fig. 7). However, positive (~20 mGal) gravity anomalies are present in the western part of the terrane where Precambrian rocks crop out at surface, and in the south where they may indicate the presence of similar rocks at depth.

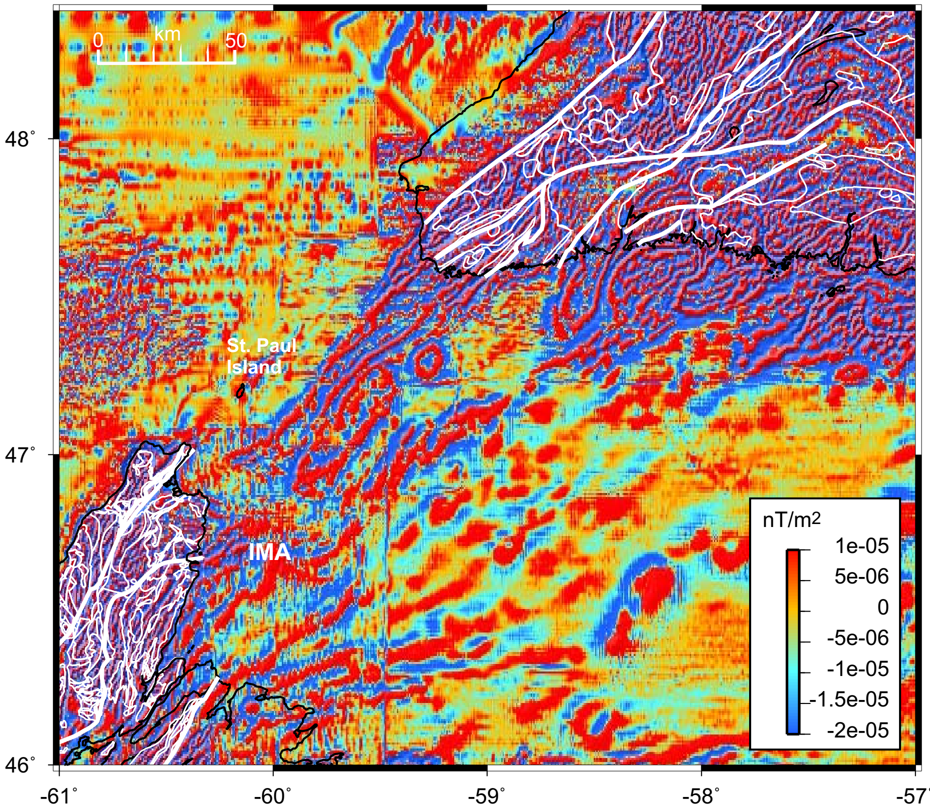



**Figure 6**. Second vertical derivative of the total field magnetic anomaly map of the Cabot Strait study area. White lines are the onshore geological map unit boundaries and faults from Figure 2. Labels for St. Paul Island and Ingonish magnetic anomaly (IMA) are in the same positions as in Figure 4 for reference.

### Blair River Inlier

On the total field anomaly map, the Blair River Inlier is characterized by strong positive anomalies (200–500 nT) that contrast in orientation and magnitude with those in the adjacent Aspy terrane (Fig. 4). Susceptibility measurements are relatively high in both gneissic and plutonic components of the Blair River Inlier (Appendix A). Both the first and second derivative magnetic maps show less linearity in the anomalies of the Blair River Inlier compared to adjacent areas (Figs. 5, 6). A positive anomaly west of the Blair River Inlier implies that similar rocks may continue in the offshore in that area. The abrupt change in signal intensity at the Carboniferous contact suggests that an east-west-trending fault might be present, with thick Carboniferous rocks to the north. In contrast to its strong magnetic signal, the gravity anomalies associated with the Blair River Inlier are weak (0–10 mGal), but indicate some continuation in the offshore (Fig. 7). Dehler and Potter (2002) proposed that the Blair River Inlier is down-faulted in this area but continues west under Carboniferous cover.

### Southwestern Newfoundland

The Laurentian margin northwest of the Cabot – Long Range Fault in southwestern Newfoundland is characterized by subdued magnetic anomalies characteristic of thick Carboniferous cover on Grenvillian basement, as previously investigated by Miller et al. (1990). However, farther north, Grenvillian basement is exposed in the Steel Mountain Inlier, which has a prominent magnetic signature (300–500 nT), further accentuated on the first and second derivative magnetic maps (Figs. 4–6). The anomaly extends to the southwest into the Bay St. George Carboniferous basin, an area known to have shallow Grenville basement (e.g. Knight 1982, 1983). The magnetic signature of the Steel Mountain Inlier is similar to that of the Blair River Inlier, consistent with the presence of similar rock types in those two areas.

The Notre Dame subzone is characterized by strong positive and negative anomalies that extend only a short distance into the offshore to the southwest, where they appear to terminate abruptly, likely at the extension of the Cape Ray Fault (Fig. 4). The strong positive anomalies (200–500 nT) are linked to ophiolitic and tonalitic arc rocks that characterize the subzone (e.g. van Staal et al. 2009). Younger (Silurian) plutonic units display both strong and weak signatures, suggesting that they are compositionally varied. The metasedimentary rocks of the Dashwoods block (Fig. 2) show a strong negative magnetic anomaly, although a southern lobe assigned to that unit by Hibbard et al. (2006) has a strongly positive magnetic signature, more consistent with its designation as Notre Dame arc rocks (Colman-Sadd et al. 1990). A strong linear anomaly (400 nT) near the Cape Ray fault and extending offshore appears to be associated with granodioritic rocks of the Cape Ray Igneous Complex. The Notre Dame subzone also displays strong positive gravity anomalies (0 to 40 mGal).

The adjacent Port aux Basques subzone shows more subdued anomalies, which extend to the southwest into the offshore. A prominent linear anomaly characterizes the Isle-aux-Morts Fault, and an adjacent, similar anomaly appears to be associated with the Margaree orthogneiss, a metaplutonic unit of Ordovician age (Valverde-Vaquero et al. 2000). The Exploits subzone southeast of the Isle-aux-Morts Fault is dominated by a pattern of negative anomalies that extends at least to the eastern edge of the map area. These low and relatively featureless magnetic signals are associated with the Bay du Nord and Harbour le Cou groups; plutonic components can be discerned as having generally lower magnetism than associated stratified and volcanic units. This pattern differs from that of the Meelpaeg subzone (Fig. 2), consistent with the inclusion of the latter area in the Gander rather than the Exploits subzone (e.g. Hibbard et al. 2006). An elliptical anomaly with a 'halo' effect characteristic of plutons (e.g. Cook et al. 2007) is associated with the Silurian – Devonian La Poile Batholith (Fig. 2) and extends 30

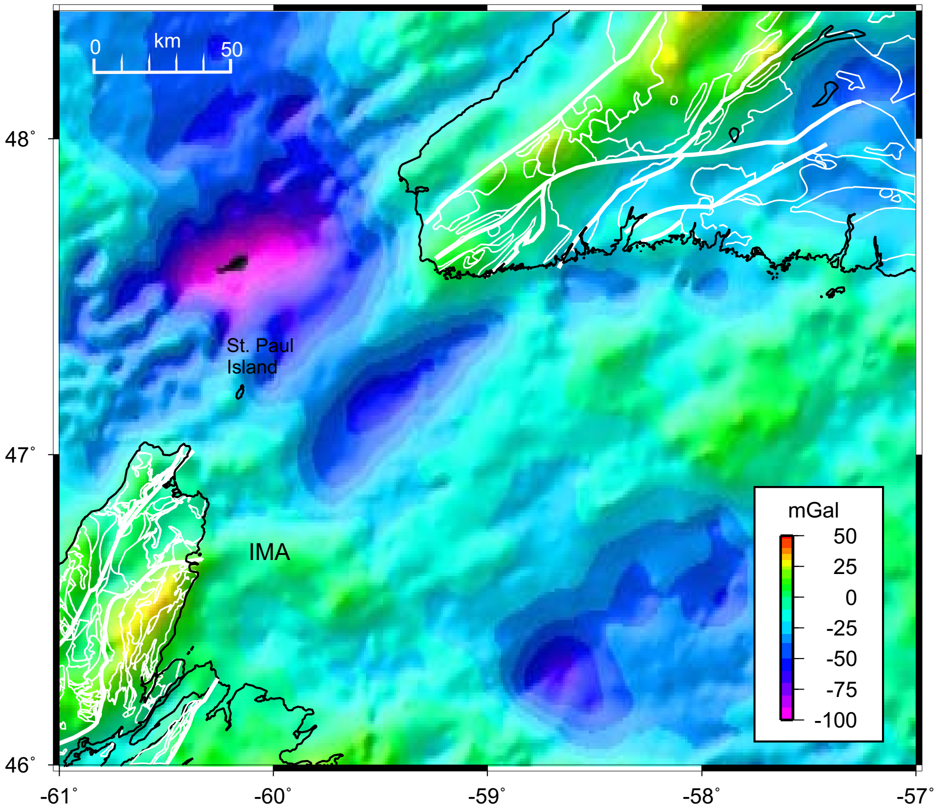



**Figure 7**. Bouguer (onshore) and free-air (offshore) gravity anomaly map of the Cabot Strait study area. White lines are the onshore geological map unit boundaries and faults from Figure 2. Labels for St. Paul Island and Ingonish magnetic anomaly (IMA) are in the same positions as in Figure 4 for reference.

km into the offshore (Figs. 5, 6). The continuation into the offshore with no loss in magnitude indicates that it is a near-surface feature. Similar elliptical and in this case overlapping halo anomalies are associated with the Burgeo Intrusive Suite (Fig. 2); this pattern is consistent with a composite body comprising separate plutons extending into the offshore about 20–30 km (Figs. 5, 6). Anomalies associated with this plutonic suite continue east to the Grey River area and make it difficult to trace the eastward extent of the relatively small Cinq-Cerf block (Silurian and older rocks) located west and north of the intrusive suite and south of the Bay d'Est Fault, or to infer how they might link to the Neoproterozoic metamorphic rocks of the Grey River area. The gravity anomaly map shows few significant anomalies in the Port aux Basques and Exploits subzones, in contrast to those of the Notre Dame subzone (Fig. 7). The Port aux Basques subzone has higher positive gravity anomalies (~10 mGal) than the Exploits subzone, suggesting that it may have different basement.

## Cabot Strait

The large Ingonish magnetic anomaly is a prominent feature on the total field magnetic anomaly map (Fig. 4). The central part of the anomaly shows the highest magnitude (400 – 500 nT) and as noted above, a narrow anomaly on the western side of the main anomaly appears to connect it to Cape Breton Island in the Middle Head area. On the first derivative map, the Ingonish magnetic anomaly is resolved into a number of smaller anomalies, some of which are elliptical and some of which are linear (Fig. 5). The latter appear to connect with linear trends defined by the onshore Bras d'Or terrane. In contrast to its strong magnetic signature, the area of the Ingonish magnetic anomaly displays only weak gravity anomalies, up to 10 mGal (Fig. 7).

In the Cabot Strait, a long narrow anomaly extends offshore from Aspy Bay and appears to widen and increase in intensity (100 to 500 nT) as it nears Newfoundland, where it terminates against a set of anomalies that characterize the offshore extension of the Notre Dame subzone. To the northwest, a weaker linear anomaly extends from Money Point through and past St. Paul Island, where it fades away. This anomaly supports the correlation between rocks on St. Paul Island and the Money Point peninsula as proposed by Lin (1994), based on his mapping of St. Paul Island.

To the southeast of St. Paul Island, a large elliptical and composite-looking anomaly trends northeast, and a smaller circular anomaly occurs farther to the northeast (~ 47.3°N, 59.2°W; Fig. 5). On the first derivative map (Fig. 5), both are characterized by a positive rim and negative core, i.e. they display a halo effect typical of granitic plutons and their adjacent contact metamorphic aureoles (e.g. Cook et al. 2007); the elliptical feature may consist of two separate but overlapping anomalies. The linear anomalies extending from Aspy Bay in Cape Breton Island and the Cape Ray and Isle-aux-Morts faults in Newfoundland are located along the northwestern edge of the elliptical anomaly.

On the total field magnetic map (Fig. 4), the Sydney Basin displays several weak linear anomalies trending toward Newfoundland. These linear trends are much more apparent on the first derivative map (Fig. 5), indicating that their sources are relatively shallow under low-magnetic Carboniferous sedimentary cover. These moderate to strong positive elongate anomalies are broken up into smaller sections and appear to form the background for elliptical anomalies associated with the Burgeo Intrusive Suite that characterize nearshore and onshore Newfoundland.

Prominent gravity lows of –20 to –100 mGal characterize the Magdalen Basin in the Cabot Strait area, coinciding with an area of thick evaporite rocks and salt tectonics (Langdon and Hall 1994; Langdon 1996; Hayward et al. 2014). The Sydney Basin also shows areas of low gravity anomalies (0 to –80 mGal), one in the Cabot Strait area and one farther south offshore from the Mira terrane; these anomalies are superimposed on the faint trace of the wide, northwest-trending Laurentian Channel.

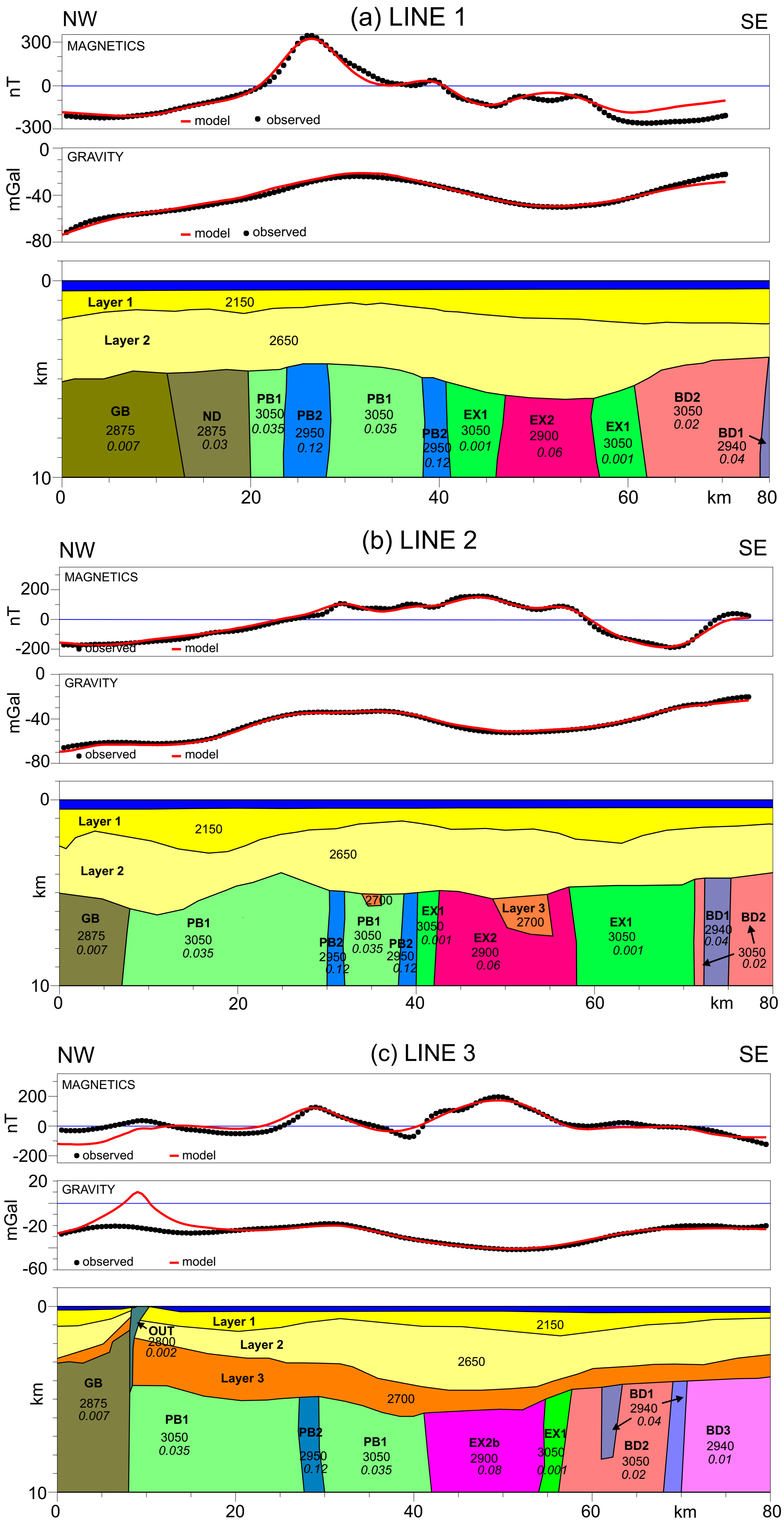


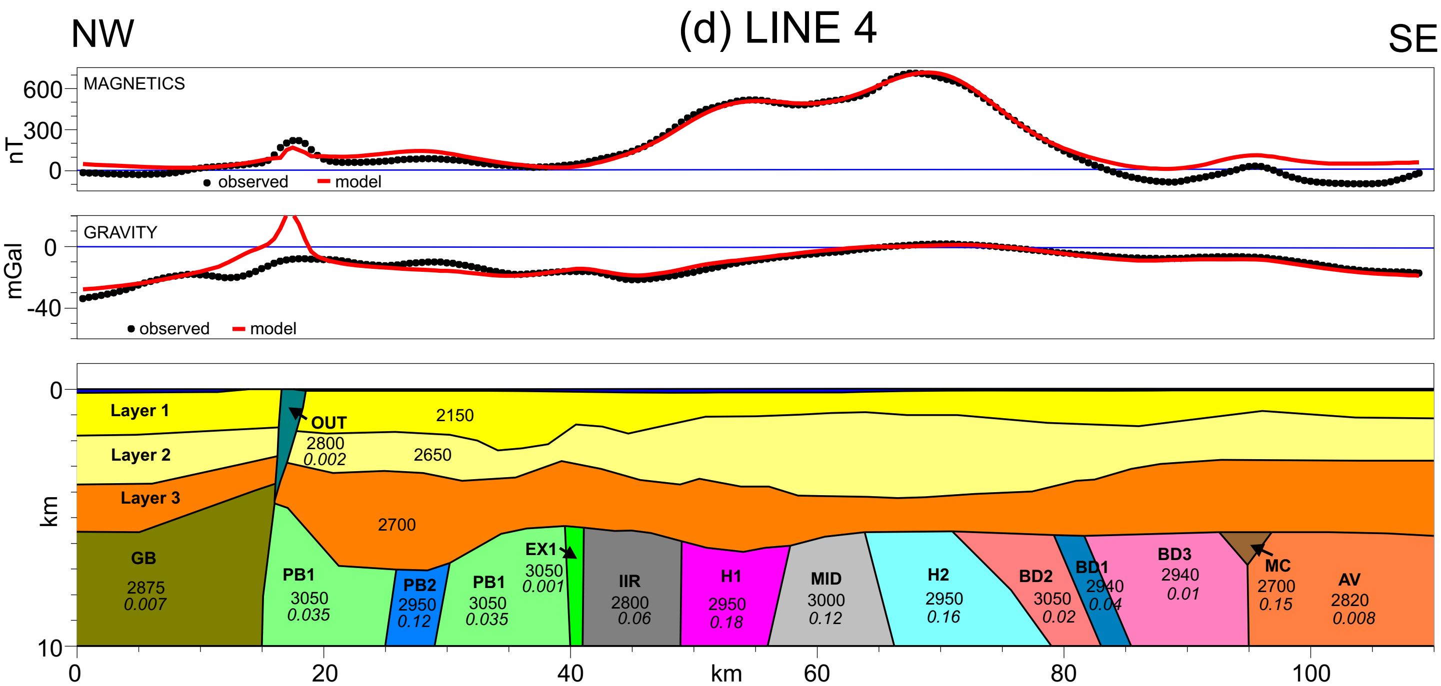

**Figure 8.** **(*on this and the following page*)** Forward models for (a) line 1, (b) line 2, (c) line 3, (d) line 4, and (e) line 5. Layers 1, 2, and 3 correspond to the Pictou + Morien, Windsor + Mabou, and Horton groups, respectively. Density values assigned to each source are in kg/m$^3$. Susceptibility values (in italics) are in SI units. Interpretations of rock units and key to abbreviations are summarized in Figure 9.

## POTENTIAL FIELD MODELS

Two-dimensional models were prepared along 4 northwest – southeast profiles in the Cabot Strait and a single northeast – southwest profile near Cape Breton Island (Fig. 3). The goal of the modeling was to correlate geologic units and boundaries across the offshore realm, and provide linkages to geologic units mapped onshore. The models (Fig. 8a-e) are by nature somewhat simplified, as few constraints are available for thicknesses of sub-sedimentary units, and the emphasis is on determining relationships between units, as needed to provide a good first-order fit to the observed data. As such, the recognition of units with consistent properties on multiple lines, and their contrasts with adjacent units, allowed correlations to be made and extended across the region. The process was iterative, as the model predictions were tested against geologic information and other constraints and adjusted until a 'best fit' product was derived. Figure 9 provides a key to the naming of the model units; pre-Carboniferous units were assigned names based on the terranes inferred to be present at surface, or in some cases arbitrary letter designations.

### Line 1

Line 1 extends from the Magdalen Basin northwest of the Cabot – Long Range Fault to the Sydney Basin in the southeast (Fig. 8a). The line crosses two linear magnetic anomalies continuing offshore from the Notre Dame and Port aux Basques subzones, and a circular halo anomaly to the south (Fig. 10), all of which are apparent on the



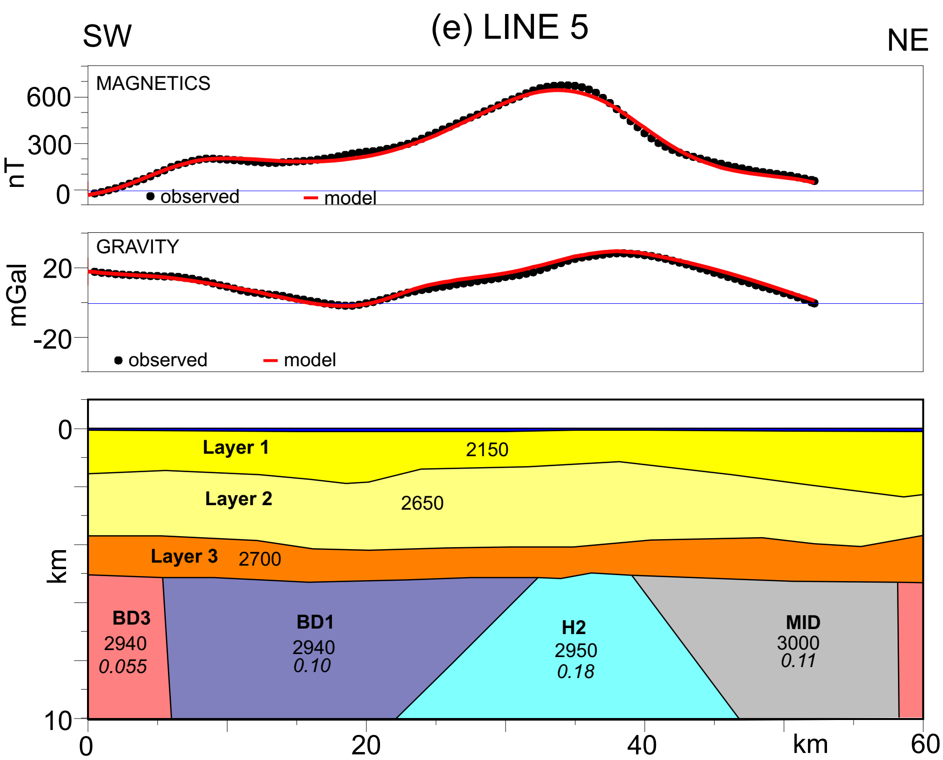




**Figure 8.** (*continued*).

magnetic profile.

The model for this profile shows two sedimentary layers 1 and 2, interpreted to correspond to the Pictou + Morien and Windsor + Mabou groups, respectively, based on published interpretations of seismic reflection profiles in the area (Langdon and Hall 1994). Thickness of sedimentary layer 1 ranges from 300 m to 2650 m along the profile, increasing into the Magdalen Basin to the north and Sydney Basin to the south. Layer 2 is thicker, varying between 1800 m and 5700 m, and thins to the south. Horton Group rocks may be present in the lower part of Layer 2 but could not be conclusively identified on the models or seismic interpretations. They appear only as a thin unit on the seismic interpretation of Langdon and Hall (1994). Faults are not identified in these layers because of the lack of physical property contrasts, but seismic interpretations indicate that they are present (e.g. Langdon and Hall 1994).

Pre-Carboniferous rocks (subsequently referred to as 'basement') lie at depths of approximately 4 to 6 km below the sea floor. The central positive magnetic anomaly is inferred to reflect basement sources PB1 and PB2 (Figs. 8a, 10); PB2 is interpreted as plutonic rock that intrudes PB1 in two locations. These plutons are represented by the two most northwestern anomaly peaks in the profile. The lower magnitude but wider anomaly to the southeast represents the smaller magnetic halo in the Cabot Strait (Fig. 10), as shown in the model by basement source EX2, which is inferred to have intruded a less magnetic unit than PB1, identified as EX1. The positive gravity anomaly in the profile is attributed to a combination of PB1 and PB2. Lower gravity values are seen over unit EX2, which is interpreted as an intrusive unit.

Northwest of PB1, less mag-

| | | | | | |
|---|---|---|---|---|---|
| Water: 1026, 0 | Water | PB1 (PAB): 3050, 0.035 | Metavolcanic and metasedimentary rocks | MID (intrusion): 3000, 0.12 | Granitoid pluton (IMA) |
| Layer 1 (sed): 2150, 0 | Pictou+Morien groups | PB2 (PAB): 2950, 0.12 | Margaree orthogneiss & equivalent | BD1 (Bras d'Or): 2940, 0.04 | Granitoid pluton |
| Layer 2 (sed): 2650, 0 | Windsor+Mabou groups | OUT (outcrop): 2800, 0.002 | Metavolcanic and metasedimentary rocks | BD2 (Bras d'Or): 3050, 0.02 | Granitoid pluton |
| Layer 3 (sed): 2700, 0 | Horton Group | ND (Notre Dame): 2875, 0.03 | Meta-igneous and metasedimentary rocks | BD3 (Bras d'Or): 2940, 0.01 | Granitoid pluton |
| EX2b (Exploits): 2900, 0.08 | Granitoid pluton | IIR (rhyolite): 2800, 0.08 | Ingonish Island rhyolite | MC (sed): 2700, 0.015 | McAdams Lake Fm, minor syenite |
| EX2 (Exploits): 2900, 0.06 | Granitoid pluton | H1 (intrusion): 2950, 0.18 | Granitoid pluton (IMA) | AV (Avalon): 2820, 0.008 | Meta-igneous and metasedimentary rocks |
| EX1 (Exploits): 3050, 0.001 | Metavolcanic and metasedimentary rocks | H2 (intrusion): 2950, 0.16 | Granitoid pluton (IMA) | GB (Grenville): 2875, 0.007 | Gneiss, anorthosite, syenite |

**Figure 9**. Summary of density and magnetic susceptibility values for units depicted in the forward-modeling profiles, and an interpretation of their geological significance. Density units are kg/m$^3$ and magnetic susceptibilities are in SI units. Magnetic highs H1, H2, and MID are inferred sources of the Ingonish magnetic anomaly (IMA).

netic sources are interpreted to represent Notre Dame subzone basement (ND), and Grenville basement (GB). ND basement has density similar to GB but slightly higher susceptibility. The contact between GB and ND is suggested in the model to be a steep, south-dipping fault, which coincides with the Cabot Fault as interpreted by Langdon and Hall (1994) on Seismic Line 81-1103. The nearly vertical boundary between basements ND and PB1 is inferred to be the offshore extension of the Cape Ray Fault (Fig. 10).

The near-vertical boundary between basement sources PB2 and EX1 is inferred to be the offshore extension of the Isle-aux-Morts Fault Zone, which onshore also separates more magnetic rocks of the Port-aux-Basques subzone from less magnetic rocks of the Exploits subzone (Fig. 4). At the southeastern end of the line, rising gravity and magnetic signatures are inferred to be associated with basement sources designated BD1 and BD2. As discussed below, BD1 and BD2 are interpreted to represent components of the Bras d'Or terrane.

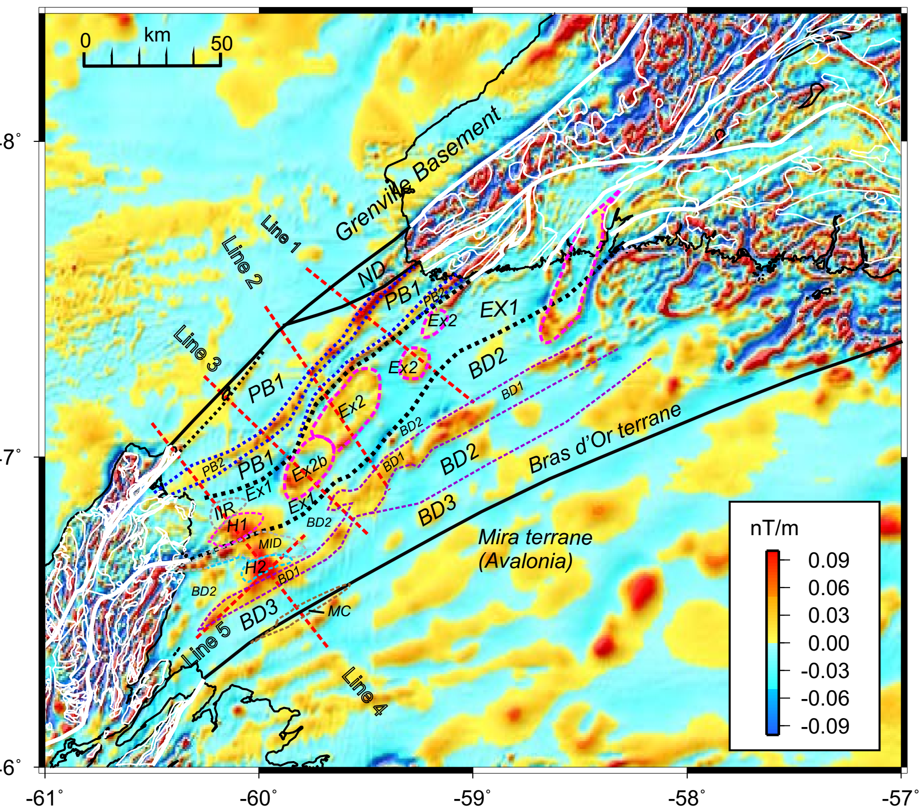



**Figure 10.** First vertical derivative of the total field magnetic anomaly map of the Cabot Strait study area (as in Figure 5), overlain by the inferred offshore extent of faults, terrane boundaries, and rock units. White lines onshore are the geological map unit boundaries from Figure 2. Red dashed lines indicate locations for model profiles, also shown in Figure 3.

## Line 2

Line 2 crosses from the Magdalen Basin at the northwestern end to the Sydney Basin at the southeastern end; like line 1, it includes both linear magnetic anomalies in the central part of the Cabot Strait, but also crosses the northeastern part of the large, northeast-trending elliptical anomaly in the central part of the Cabot Strait (Figs. 3, 4, 8b, 10). As on the model for line 1, sedimentary layers 1 and 2 vary in thickness – layer 1 from 600 m to 3 km and layer 2 from 2 km to 4 km. Layer 3 (Horton Group?) appears in this model but only in two small graben (Fig. 8b), similar to the interpretation of Langdon and Hall (1984) for nearby seismic lines.

The basement in the central part of the model is composed of PB1 and PB2, with PB2 again interpreted to have intruded into basement PB1, as seen on the model for line 1. Basement source PB2 is related to the two magnetic peaks in the central part of the profile; these peaks coincide with the linear magnetic anomalies extending from southwestern Newfoundland toward Cape Breton Island. The large positive magnetic anomaly in the central part of the profile is caused by source EX2, interpreted to be plutonic as on line 1 because of the halo effect seen on the map and profile. However, the EX2 body in line 2 is separate from the EX2 source in line 1 because their magnetic anomalies are separate in map view (e.g. Fig. 10). The northwestern part of line 2 does not include the ND basement source seen on the line 1 model, and instead shows PB1 basement juxtaposed against Grenville basement (GB) at a steeply north-dipping fault inferred to be the Cabot Fault as seen in map view (Fig. 10).

The positive gravity anomaly in the profile is attributed to basement sources PB1 and PB2, with additional contributions from thinner sedimentary layers, whereas the relative gravity low in the southeastern part of the profile is related to source EX2, as also seen on line 1. As on line 1, increasing magnetic and gravity trends are attributed to basement sources BD1 and BD2.

### Line 3

Line 3 (Fig. 8c) crosses St. Paul Island, the linear magnetic anomaly southeast of the island, the southwestern part of the large elliptical halo anomaly in Cabot Strait, and a linear anomaly east of the Ingonish magnetic anomaly (Figs. 3, 10). In contrast to lines 1 and 2, three sedimentary layers are identified on the model for line 3, consistent with seismic interpretations in the region (e.g. Pascucci et al. 2000). The maximum sediment thickness on the model is ~5.7 km in the central part of the profile, and the total thickness of sedimentary layers decreases toward the south. Sediment thickness is less to the northwest of St. Paul Island compared to the southeast, but increases rapidly into the Magdalen Basin, especially the thickness of layer 2, which contains halite west of the Cabot Fault. In the same area, depth to the top of the underlying Grenville basement source (GB) varies from about 1.3 to over 3 km.

To explain St. Paul Island, a basement source termed OUT is brought to the surface in a schematic representation of a positive flower structure (Fig. 8c), consistent with seismic interpretations offshore (Langdon and Hall 1994). Source OUT has been assigned density and susceptibility values to represent the rocks on St. Paul Island but the values are only loosely constrained. Few gravity and magnetic anomaly measurements have been made over the island, and the model does not provide a good match to this feature. Geological mapping has shown that the rocks on St. Paul Island correlate with those of the Money Point and Cape North groups of the Aspy terrane (Lin 1994).

As on lines 1 and 2, the linear magnetic anomaly southeast of St. Paul Island is associated with basement source PB2, but unlike the other lines, only one anomaly and hence one PB2 source is present. The elliptical, halo-type magnetic anomaly to the southeast is associated with a basement source identified as EX2b because it has the same density as source EX2 but slightly higher magnetic susceptibility. Like EX2 on lines 1 and 2, source EX2b is responsible for the negative gravity anomaly in this part of the profile. These basement sources are at a similar depth as on profiles 1 and 2.

Line 3 crosses inferred basement sources BD1 and BD2 seen on lines 1 and 2, but also passes over a somewhat different source, identified as BD3, which is associated with a gravity anomaly similar to BD1 and BD2, but a negative magnetic anomaly, an effect explained in the model by decreasing sediment thickness and lower magnetic susceptibility in BD3.

### Line 4

Line 4 (Fig. 8d) extends from northwest of Money Point to the southeast across the Ingonish magnetic anomaly and the inferred position of the boundary between the Bras d'Or and Mira terranes (Fig. 10). On this model the thickness of layer 1 varies from 1 km to almost 3 km. Layer 2 also varies from 480 m to 3.4 km, the thickest part lying over the central part of the profile. Layer 3 is thickest in Aspy Bay and in the southeastern part of the model. All three layers thicken to the northwest toward the Magdalen Basin.

In the northwestern part of line 4, the basement is interpreted to be Grenville, as on lines 1, 2, and 3. The basement source termed OUT, introduced in line 3 at St. Paul Island, is brought again to the surface in a schematic representation of a positive flower structure (Fig. 8d). Source OUT represents the rocks on the Money Point peninsula but the match between predicted and observed anomalies is poor and the area remains a challenge to model. The northern margin of OUT is the Wilkie Brook Fault and the southern margin is the Aspy Fault (Fig. 3); the two faults appear to merge at depth in the model.

The basement sources under Aspy Bay to the south of the merged fault are interpreted to be PB1 and PB2, as also seen on models 1, 2, and 3. Basement source EX1 and a lower density source IIR (Ingonish Island rhyolite) are also present on line 4, the latter contributing to the flank of the large Ingonish magnetic anomaly. However, the bulk of the large positive magnetic anomaly is associated with basement sources H1, MID, and H2, which, like the Ingonish Island rhyolite, are not seen on profiles 1, 2, or 3. Lower susceptibility but higher density unit MID separates the higher susceptibility and lower density H1 and H2 sources. These basement sources are located at depths of about 5.5 to 7 km below sea level and together extend about 25 km along line 4.

Basement sources BD1, BD2 and BD3 to the southeast are associated with low to negative magnetic anomalies and slightly negative gravity anomalies. At about 95 km along the profile, basement source AV is interpreted as the Mira terrane (Avalonia), characterized in this area by lower density than the adjacent Bras d'Or terrane units. A small inlier (MC) overlying the boundary is interpreted to schematically represent the McAdam Lake Formation, known to overlie the terrane boundary onshore (King 2002). Predicted magnetic anomalies are, on average, 100 nT higher than observed values at this end of the line; an improved fit would require either thicker sedimentary layers or increased susceptibility in the basement units, neither of which seems a suitable interpretation based on seismic and other constraints.

### Line 5

Profile 5 (Fig. 8e) extends northeast from the Kellys Mountain area to cross profile 4 at right angles (Figs. 3, 10). Total thickness of layers 1, 2, and 3 is about 5 km and varies only slightly along the model, to a maximum of about 5.5 km in the central part. Thicknesses of individual layers 1, 2, and 3 do not vary significantly in this model, although layer 2 is slightly thicker than the others. The basement source responsible for the Ingonish magnetic anomaly on this profile is H2, which is again flanked by MID. The latter source produces much of the locally high gravity anomaly. A contact that appears to dip to the south or southwest is interpreted between H2 and adjacent unit BD1. A small amount of BD2 may be present between the two units, but this could not be clearly determined. Much of the line is underlain by basement source BD1, which generates a strong positive magnetic anomaly relative to source BD3 at the southwestern end of the model (Fig. 8e). Basement sources MID and H2 are inferred to have intruded Bras d'Or terrane sources (BD1 and 3), as also shown on line 4.

## DISCUSSION

### Correlation of Major Faults and Terrane Boundaries Across the Cabot Strait

Both the Blair River Inlier and Laurentian margin are underlain by Grenvillian rocks, the southeastern margins of which are marked by the Wilkie Brook and Cabot – Long Range faults, respectively (Fig. 2). Models 1, 2, 3, and 4 enable the edge of Grenvillian basement, and hence the coincident Cabot – Long Range Fault, to be traced from southwestern Newfoundland to the Wilkie Brook Fault, more or less as interpreted by Langdon and Hall (1994) based on seismic data. One significant implication from the models not apparent from the work of Loncarevic et al. (1989) is that Grenvillian basement in the Blair River Inlier may extend to a depth of at least 10 km.

Also clear from the magnetic maps, as well as a comparison of models 1 and 2, is the fact that the Notre Dame subzone does not extend far into the Cabot Strait. It is likely that the Cape Ray Fault merges with the Cabot – Long Range Fault to cut off the Notre Dame subzone north of the location of line 2 (Fig. 10), and hence not as far south as shown in the interpretation of Hibbard et al. (2006).

The Isle-aux-Morts Fault separates the Port aux Basques subzone from the Exploits subzone onshore in southwestern Newfoundland. The Port aux Basques subzone is an area of varied and complex geology dominated by metamorphic rocks (e.g. Schofield et al. 1993, 1998; Valverde-Vaquero et al. 2000) and is generally considered to be part of the Gander Zone based on its metasedimentary components (Hibbard et al. 2006). Although Silurian – Devonian metamorphic history shows similarities to that of the Aspy terrane (Burgess et al. 1995; Barr et al. 1998), rock types such as the ca. 475 Ma Margaree orthogneiss are not present in the Aspy terrane, and the two areas have not been directly correlated in previous studies (Barr et al. 1998). Instead, Aspy terrane rocks have been correlated with those in the La Poile Group and Cinq-Cerf block (Barr and Jamieson 1991; Barr et al. 1998; Lin et al. 2007). Based on models 1 through 3, the boundary between the Port-aux-Basques and Exploits subzones can be traced southwest to within 30 km of the Aspy terrane (Fig. 10). The boundary position on line 4 is suggested to swing more east-west but cannot be traced onshore because it is obscured by the Black Brook Granitic Suite.

The boundary seen on lines 1, 2, and 3 between EX1 and BD2 is inferred to represent the boundary between the Exploits subzone and older rocks represented onshore by the Bras d'Or terrane in Cape Breton Island and the Cinq-Cerf block in southwestern Newfoundland. The continuation of this boundary into southwestern Newfoundland is not clear because the elliptical anomaly extending offshore from the La Poile Granite occurs in the critical area. One possible connection, as shown on Figure 10, is with the Cinq-Cerf Fault Zone, which separates the Silurian La Poile Group from the mainly Neoproterozoic rocks of the Cinq-Cerf block (Fig. 2), although in places the Silurian rocks sit unconformably on the older rocks (e.g. Lin et al. 2007). Hence the boundary might connect instead with the Bay d'Est Fault Zone, which separates the La Poile Group on the southeast from the Bay du Nord Group, a unit characteristic of the Exploits subzone in the area. A third alternative, based on the observation that the muted magnetic signature of EX1 in the offshore is similar to that of the Harbour le Cou Group, is a connection with the Bay le Moine Shear Zone (Fig. 2), implying that the Exploits subzone rocks exposed onshore in southwestern Newfoundland overlie BD sources and that those 'cover rocks' are not present in the offshore.

On model lines 1, 2, and 3, the EX1 – BD2 boundary can be traced to the southwest as far as the Ingonish magnetic anomaly, where it is obscured by the source(s) of that feature and cannot be identified. On Figure 10 it is inferred to follow the boundary between H1 and MID into the Middle Head area to connect with the southern margin of the Cameron Brook Granodiorite and Clyburn Brook Formation (Fig. 3). The magnetic and gravity maps indicate that the boundary between Aspy and Bras d'Or terranes is located just north of Middle Head, placing both the Clyburn Brook Formation and the Cameron Brook Granodiorite in Aspy terrane (Fig. 2). This position is consistent with interpretations based on geological maps of the area, but those studies also suggest that the original position of the boundary was through the Black Brook Granite Suite (Yaowanoiyothin and Barr 1991), or along the northern margin of the Cameron Brook Granodiorite following the Eastern Highlands Shear Zone (Figs. 2, 3; Lin 1995). The Ingonish Island rhyolite crops out only on Ingonish Island, but we postulate that a similar highly magnetic but low-density body may occur farther offshore, composing basement source IIR (Ingonish Island rhyolite) on model 4 and contributing to the low gravity anomaly associated with the northern edge of the Ingonish magnetic anomaly (Fig. 8d).

On the Newfoundland side of the Cabot Strait, it is difficult to trace the Bras d'Or terrane onshore because of abundant plutons that extend into the offshore from the Burgeo Intrusive Suite. As noted above, the boundary with the Exploits subzone is inferred to connect onshore with the Cinq-Cerf Fault Zone, because the Cinq-Cerf block contains rocks of Precambrian – Early Paleozoic age similar to those of the Bras d'Or terrane (O'Brien et al. 1991; Barr et al. 1998). Farther to the east in the area south of the Grey River Enclave, the elliptical shapes of plutons in the offshore extension of the Burgeo Intrusive Suite change to more linear shapes typical of Bras d'Or terrane units, suggesting that the Bras d'Or terrane extends into that area (Fig. 10).

The contact between the Bras d'Or and Mira terranes is crossed only on line 4, where it appears as an almost vertical boundary between higher density basement source BD3 and lower density basement source AV (Fig. 8d). In map view, this location is marked by subtle changes in magnetic signature that are most apparent on the second derivative map (Figs. 6, 10). This result is not consistent with that of King (2002) who modeled the boundary in the Boisdale Hills onshore as steeply north dipping, with near-surface Mira units having higher density (2820–2840 kg/m$^3$) than Bras d'Or terrane units (2710–2720 kg/m$^3$) and lower magnetic susceptibility based on measured values. Based on the models of King (2002), deeper parts of the Mira terrane (down to 5 km) also have higher density and lower susceptibility than equivalent basement in the Bras d'Or terrane.

### Pre-Carboniferous Basement Units on Profile Models

Models derived for magnetic and gravity anomalies on profiles 1, 2, 3, and 4 all show Grenville basement (GB) northwest of the inferred location of the Cabot – Long Range – Wilkie Brook faults (Fig. 8a-d). In the models, GB is assigned a density of 2875 kg/m$^3$ and magnetic susceptibility of 7 x 10$^{-3}$ SI units (Fig. 9), consistent with the rock types likely to be present based on exposed Grenvillian units in western Newfoundland and the Blair River Inlier, and with measured susceptibility (Appendix A). Southeast of the fault, PB1, having a density of 3050 kg/m$^3$ and susceptibility of 35 x 10$^{-3}$ SI units, is the dominant basement source. The relatively high density (and susceptibility) suggests an abundance of mafic metavolcanic rocks (e.g. Tenzer et al. 2011). This basement source broadly represents the metamorphic rocks (both metasedimentary and meta-igneous) of the Port aux Basques subzone in southwestern Newfoundland. It is not clear from the geophysical maps that any of these rocks continue into Cape Breton Island and, as yet, none have been specifically recognized (Barr and Jamieson 1991; Barr et al. 1998; Lin et al. 2007)

On line 3, unit OUT with density 2800 kg/m$^3$ and susceptibility 2 x 10$^{-3}$ SI units represents the rocks exposed on St. Paul Island. Details of the complex geology, including a positive flower structure based on the seismic interpretation of Langdon and Hall (1994), cannot be resolved at the scale of the modeling. The match between observed and calculated anomalies in this part of profile 3 is poor, and better constraints are needed, including more gravity data and rock property measurements for Money Point and St. Paul Island and the nearby surrounding areas, so that gravity errors in the models can be better constrained and reduced. OUT (part of the Cape North and Money Point groups) could be a component in PB1, or an unrelated rock assemblage.

Unit PB2, having a density of 2950 kg/m$^3$ and susceptibility of 120 x 10$^{-3}$ SI units, is interpreted to consist of plutonic rocks in PB1 basement. The northern band of PB1 is cut off by the Cape Ray Fault before it reaches southwestern Newfoundland, but the southern belt appears to continue onshore from line 1 into the Margaree orthogneiss (Fig. 10). The latter is a composite unit consisting of amphibolite, dioritic orthogneiss, tonalitic orthogneiss with mafic enclaves, granitic orthogneiss, and minor ultramafic rocks (Valverde-Vaquero et al. 2000), and is associated with a strong positive magnetic signature onshore (Fig. 4). To the southeast, the PB2 anomaly is truncated at the inferred Port aux Basques – Exploits boundary (Fig. 10).

Basement source EX1 has relatively high density of 3050 kg/m$^3$ but very low susceptibility of 1 x 10$^{-3}$ SI units. The low susceptibility is consistent with the low-level anomalies associated with EX1 in the offshore, and in its inferred continuation onshore in the Harbour le Cou and Bay du Nord groups. Miller et al. (1990) reported a comparable average susceptibility of 2.7 x 10$^{-3}$ SI units for 7 samples from the Bay du Nord Group. As noted in the previous section, it is not clear that any units of EX1 are exposed in Cape Breton Island, although they may very well continue under younger units in the eastern part of the Aspy terrane. The Clyburn Brook Formation and other units assigned to the Money Point Group appear to be too young (Silurian) to be correlative with the Ordovician Harbour le Cou and Bay du Nord groups, although age constraints are limited. Units such as the undated, more magnetic body of Money Point Group west and northwest of the Black Brook Granitic Suite (Fig. 3) could be part of EX1, and ghostly and unexplained east-southeast magnetic trends in the pluton could represent relict EX1 in the subsurface. The Black Brook Granitic Suite has a magnetic signature in map view similar to that of the Rose Blanche Granite in Newfoundland (Fig. 2), but their different ages (ca. 420 – 414 vs. 373 Ma) preclude their correlation.

Basement sources EX2 and EX2b, with density of 2900 kg/m$^3$ and susceptibility of 60–80 x 10$^{-3}$ SI units, are considered to represent Silurian – Devonian plutons equivalent to components of the Burgeo Intrusive Suite and/or the La Poile Granite, both of which exhibit halo anomalies of similar size and shape onshore and offshore in the Hermitage Flexure area (Fig. 10). These units extend as far as line 3 but do not appear to continue to line 4 or to Cape Breton Island (Fig. 10). This termination is consistent with the lack of plutons having ages of 429 – 414 Ma in the Aspy terrane (Lin et al. 2007). In contrast, the Aspy terrane is characterized by abundant ca. 400 – 365 Ma plutons (e.g. Cameron Brook, Black Brook, Park Spur, Salmon Pool, Margaree) which appear to be lacking in southwestern Newfoundland. These

Middle and Late Devonian plutons are associated with co-magmatic bimodal volcanic rocks (Fisset Brook Formation; Fig. 3), and appear to be related to widespread extension; this extension culminated in the formation of the Magdalen Basin (e.g. Dunning et al. 2002), but apparently had much less effect in southwestern Newfoundland.

Basement sources BD1, BD2, and BD3 represent a composite basement that is dominated by plutonic rocks but likely also includes metasedimentary rocks such as the McMillan Flowage Formation (r = 2810 kg/m$^3$; k = 2.10 x $10^{-3}$ SI units) and Kellys Mountain Gneiss (r = 2810 kg/m$^3$; k = 3.47 x $10^{-3}$ SI units). In the models, these sources have been assigned densities of 2940, 3050, and 2940 kg/m$^3$, respectively, and susceptibilities of 40, 20, and 10 x $10^{-3}$ SI units, similar to measured values in onshore plutonic units such as Kellys Mountain Diorite and Indian Brook Granodiorite. Unit BD1 is associated with a strong quasi-linear anomaly that extends across the strait and may be linked to the strong anomaly at the intersection of profiles 4 and 5 (Fig. 10). It cannot be traced into a specific map unit onshore, but could match plutonic belts in the Boisdale Hills (Fig. 10).

On models generated for lines 4 and 5, basement sources H1, MID and H2 are linked to the large Ingonish magnetic anomaly seen on the total field map (Fig. 4). H1 is interpreted to be north of the Bras d'Or – Exploits boundary but has density and susceptibility consistent with various plutonic units of the Bras d'Or terrane, and could have been emplaced after terrane juxtaposition. Basement source H2 could be a pluton like the Kellys Mountain Diorite. MID is associated with a lower magnetic anomaly and higher density; its modeled susceptibility (12 x $10^{-3}$ SI) is comparable to values measured in the plutonic units of the eastern Bras d'Or terrane such as the Indian brook Granodiorite (14.99 x $10^{-3}$ SI) and Birch Plain Granite (12.07 x $10^{-3}$ SI).

Basement source BD2, considered to be a composite unit representing plutonic and metamorphic units of the Bras d'Or terrane, is in contact near the southeastern end of profile 4 with slightly different basement source BD3. The latter is postulated to represent plutonic units of the Boisdale Hills pluton (r = 2820 kg/m$^3$; k = 8.21 x $10^{-3}$ SI units) based on projections of geophysical trends in these rocks into the offshore (Fig. 10). Source BD3 is in contact across the postulated continuation of the McIntosh Brook – Georges River Fault with basement source AV, considered to represent the Avalonian Mira terrane in that area.

## CONCLUSIONS AND CAVEATS

The geophysical models presented here support correlation of major faults and orogen components between Newfoundland and Cape Breton Island across the Cabot Strait. The Cabot – Long Range Fault can be traced to the Wilkie Brook Fault in Cape Breton Island and separates Grenvillian basement to the northwest from peri-Gondwanan basement to the southeast. The Cape Ray Fault/Red Indian Line merges offshore with the Cabot – Long Range Fault and hence Notre Dame subzone rocks do not extend across the Cabot Strait. The Port aux Basques – Exploits boundary crosses the strait but appears to be buried by younger rocks onshore in Cape Breton Island. Magnetic halos in the Exploits subzone are likely caused by Silurian – Devonian plutons like those in the Burgeo Intrusive Suite. The Bras d'Or terrane can be traced to the Cinq-Cerf block and Grey River areas in southern Newfoundland, and hence Bras d'Or terrane 'basement' may underlie all of Exploits subzone.

However, these geological interpretations are limited by a lack of constraints from high-quality deep seismic reflection data in the Cabot Strait area. Such data would help to resolve pre-Carboniferous units, the nature and orientation of their contacts, and their depth extent, as has been done in Newfoundland as a result of the Lithoprobe East project (e.g. van der Velden et al. 2004). Currently available seismic data enable mapping of Carboniferous units to a depth of only 3.5 to 4.0 s (e.g. Pascucci et al. 2000). Deeper Carboniferous units are more difficult to interpret, limiting the ability to constrain the shape of the underlying basement bodies. Seismic data with higher resolution images at the Carboniferous and pre-Carboniferous boundary would provide better constraints on the basement. Another limiting factor in the study is the potential field database. Although magnetic data are quite detailed, gravity data are relatively sparse, and a more detailed database would allow better resolution in the models. In much of the study area, both onshore and offshore, gravity data were collected at too large a line spacing and hence were gridded too coarsely for high-resolution interpretations. The models are by necessity simplified to make best possible use of available geophysical constraints and geologic information; it should be recognized that depth and thickness variations may trade-off against other parameters such as density and susceptibility, so the models are not unique.

Finally, the modeling procedure relies on the availability of magnetic susceptibility and density data for rock units in the study area. Such data are very scarce for units in southwestern Newfoundland. The database for magnetic susceptibility in Cape Breton Island is relatively good, but density data are limited. Furthermore, at the scale of the modeling, only large units could be included, most of which are composite, and the averages obtained from the susceptibility measurements may not be representative of the whole unit. Problems such as those encountered in trying to model the St. Paul Island area demonstrate the scale problem.

Nonetheless, in spite of these many limitations, at a regional scale the models demonstrate the variations between the disparate geologic units and contribute to ongoing efforts to delineate major units and boundaries in the offshore. They also provide explanations for some of the apparent geological differences between northeastern Cape Breton Island and southwestern Newfoundland, and enhance previous attempts at map-view correlations by providing at least an approximation of the distribution of map units and position of crustal boundaries at depth.

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APPENDIX A: Summary of density and magnetic susceptibility data for selected rock units* in Cape Breton Island.

| | **Density[1] ($g/cm^3$)** | | **Magnetic Susceptibility[2] ($x10^{-3}$ SI units)** | | |
|---|---|---|---|---|---|
| | **Range** | **Avg** | **Range** | **Avg** | **n** |
| **Carboniferous sedimentary units** | | | | | |
| Horton Group | 2.27-2.96 | 2.54 | 0.03-23.5 | 1.17 | - |
| Mabou Group | 2.15-2.68 | 2.47 | 0.14-0.22 | 0.17 | 8 |
| Morien Group | 2.19-2.52 | 2.35 | 0.11-0.29 | 0.17 | 10 |
| Pictou Group | 2.15-2.51 | 2.29 | 0.06-0.14 | 0.08 | 18 |
| Windsor Group | 2.47-2.7 | 2.59 | 0.06-0.09 | 0.07 | 5 |
| **Bras d'Or terrane metamorphic units** | | | | | |
| Barachois River Formation | 1.83-3.15 | 2.81 | 0.1-17.60 | 4.46 | 25 |
| Benacadie Pond Formation | 2.51-3.00 | 2.78 | 0.00-1.42 | 0.31 | 15 |
| Bourinot Belt | 2.41-3.17 | 2.75 | 0.01-44.00 | 5.12 | 56 |
| Frenchvale Road Metamorphic Suite | 2.57-2.78 | 2.66 | 0.01-10.38 | 0.77 | 25 |
| Kellys Mountain Gneiss | 1.83-3.15 | 2.81 | 0.08-12.27 | 3.47 | 7 |
| McMillan Flowage Formation | 1.83-3.15 | 2.81 | 0.01-25.27 | 2.10 | 104 |
| **Bras d'Or terrane plutonic units** | | | | | |
| Birch Plain Granite | 2.33-2.94 | 2.64 | 0.01-46.70 | 12.07 | 47 |
| Boisdale Hills Pluton | 2.44-3.24 | 2.82 | 0.02-72.75 | 8.21 | 114 |
| Cape Smokey Granite | 2.33-2.94 | 2.64 | 0.04-31.83 | 3.16 | 57 |
| Cross Mountain Granite | 2.33-2.94 | 2.64 | 0.02-12.13 | 1.39 | 12 |
| Gisborne Flowage Quartz Diorite | 2.43-3.16 | 2.81 | 0.02-0.14 | 0.06 | 1 |
| Indian Brook Granodiorite | 2.53-2.94 | 2.68 | 0.07-46.27 | 14.99 | 91 |
| Kathy Road Dioritic Suite | 2.43-3.16 | 2.80 | 0.04-25.30 | 3.36 | 29 |
| Kellys Mountain Granite | 2.33-2.94 | 2.64 | 0.06-36.77 | 3.36 | 72 |
| Kellys Mountain Diorite | 2.53-2.94 | 2.80 | 0.12-32.27 | 8.96 | 29 |
| Mount Cameron Syenogranite | 2.49-3.533 | 2.78 | 0.02-20.41 | 2.64 | 15 |
| Shunacadie Pluton | 2.47-3.13 | 2.71 | 0.02-25.95 | 4.27 | 55 |
| Timber Lake Dioritic Suite | 2.43-3.16 | 2.80 | 0.52-59.67 | 17.83 | 4 |
| Wreck Cove Diorite | 2.43-3.16 | 2.80 | 0.05-54.50 | 10.37 | 60 |
| **Aspy terrane metamorphic units** | | | | | |
| Cape North Group | 1.83-3.15 | 2.81 | 0.05-28.00 | 3.58 | 69 |
| Cheticamp Lake Gneiss | 1.83-3.15 | 2.81 | 0.01-33.30 | 1.41 | 43 |
| Clyburn Brook Formation | 2.12-3.10 | 2.73 | 0.01-10.61 | 0.95 | 14 |
| Ingonish Island Rhyolite | 1.36-2.74 | 2.50 | 0.04-40.77 | 8.36 | 9 |
| Money Point Group | 2.12-3.10 | 2.73 | 0.01-63.13 | 1.61 | 116 |
| Sarach Brook Metamorphic Suite | 1.36-2.74 | 2.20 | 0.01-49.53 | 2.73 | 66 |
| **Aspy terrane plutonic units** | | | | | |
| Black Brook Granitic Suite | 2.33-2.94 | 2.64 | 0.01-16.20 | 0.35 | 167 |
| Cameron Brook Granodiorite | 2.53-2.94 | 2.68 | 0.02-36.93 | 3.48 | 29 |
| Glasgow Brook Granodiorite | 2.53-2.94 | 2.68 | 0.02-0.27 | 0.15 | 12 |
| Margaree Pluton (Granite) | 2.33-2.94 | 2.64 | 0.01-22.60 | 2.90 | 34 |
| Neils Harbour Gneiss | 1.83-3.15 | 2.81 | 0.11-16.00 | 0.56 | 34 |
| Wilkie Sugar Loaf Granite | 2.33-2.94 | 2.64 | 0.01-5.65 | 0.72 | 25 |
| **Blair River Inlier** | | | | | |
| Anorthosite, Syenite | 2.44-2.86 | 2.72 | 0.01-50.57 | 6.00 | 49 |
| Gneissic Rocks | 1.83-3.15 | 2.81 | 0.01-47.43 | 12.51 | 38 |

*Units are in alphabetical order by terrane and rock type.

[1]Density estimates are based on similar rock types from Tenzer et al. (2011), in the absence of such data from the study area. In the models, density values were selected within the plausible range for the likely rock types presen

[2]Measured susceptibility data are from Zsámboki (2012).
As noted in the text, most units contain a wide variety of rock types and hence the measurements vary accordingly.
At the scale of the models, the average values are probably reasonably representative of the units.