

Preliminary Stratigraphy and Structure of the Scotsburn Anticline Area, Pictou County, Nova Scotia

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Introduction

The Scotsburn Anticline is an ENE-trending upright fold structure that deforms Devonian-Carboniferous strata exposed in the easternmost part of the Cobequid Highlands in Pictou County, Nova Scotia (Fig. 1). The Scotsburn Anticline area was targeted for new mapping in 2012 for two reasons. First, after several years of study, Trevor MacHattie and Chris White of the Nova Scotia Department of Natural Resources are close to completing a revised map interpretation of the

Eastern Cobequid Highlands; a revised map of the Scotsburn Anticline area was seen to be an important complement to their work. Second, a revised map of the Scotsburn Anticline area provided the opportunity to revisit some of the outstanding stratigraphic and structural uncertainties brought to light by previous mapping projects.

The geological map plotted in Figure 1 represents a standard interpretation of the Scotsburn Anticline area prior to the work described here;

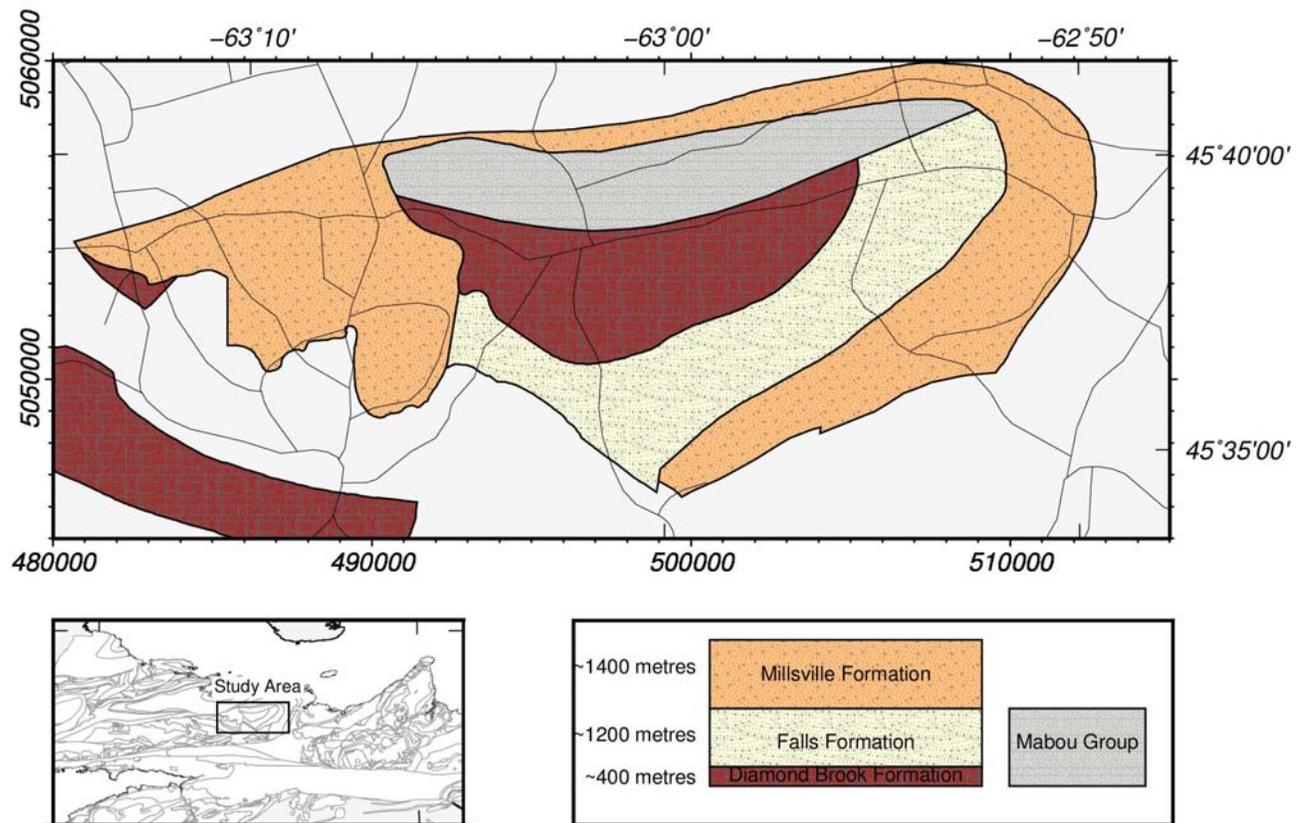


Figure 1. Map showing an interpretation of the Scotsburn Anticline based on the work of Donohoe and Wallace (1982).

lithostratigraphic polygons in Figure 1 are taken from the most recent provincial geology map of Nova Scotia (Fisher and Poole, 2006) and largely follows the work of Donohoe and Wallace (1982). An alternative interpretation of the Scotsburn Anticline area was also part of the Cobequid Highland mapping conducted by Pe-Piper and Piper (2002). For the Scotsburn Anticline area, the main difference between the maps of Donohoe and Wallace (1982) versus Pe-Piper and Piper (2002) was the recognition and inclusion by Pe-Piper and Piper (2002) of a transitional unit between the Diamond Brook Formation and the overlying Falls Formation conglomerate. Fine-grained clastics of the Diamond Brook Formation are seen to interfinger with Falls Formation conglomerate across their conformable contact, which potentially justifies the approach taken by Pe-Piper and Piper (2002) in further refining the stratigraphic relationships in the area.

In both the Donohoe and Wallace (1982) and Pe-Piper and Piper (2002) maps, however, the stratigraphic relationship between the northern and southern limbs of the Scotsburn Anticline remained unclear. Donohoe and Wallace (1982) interpreted a “faulted facies change???” across their interpreted hinge line; Pe-Piper and Piper (2002) did not interpret the northern limb of the Scotsburn anticline. The “faulted facies change???” of Donohoe and Wallace (1982) was inferred to separate supposed Mabou Group correlatives in the northern limb (i.e. an unnamed local formation) from possible Horton Group correlatives in the southern limb (i.e. the Diamond Brook Formation) (Donohoe and Wallace, 1982; Fig. 1). The uncertainty in the stratigraphic relationships across the hinge of the anticlinal structure meant further that the relationship of these basal rocks with the overlying Falls Formation was also unclear: the Falls Formation may be both unconformable and conformable with Diamond Brook Formation and Mabou Group rocks of the Scotsburn Anticline core (Fig. 1).

The northern part of the northern limb of the Scotsburn Anticline was also visited during a mapping project for the Cumberland Basin to the north (Ryan and Boehner, 1994). Critically, Ryan and Boehner (1994) reported considerable

structural complexity in the northernmost part of the Scotsburn Anticline where bedding appeared to be overturned and folded about steeply plunging fold axes. The relationship of the predominantly clastic strata of the Scotsburn Anticline to basement units to the west and south was also unclear. The present mapping project was designed to address these uncertainties.

New Interpretation of the Scotsburn Anticline

A synthesis of previous and new map data suggests the following interpretation for the stratigraphy and structure of the Scotsburn Anticline. Overall, the Scotsburn Anticline appears to be a doubly plunging, upright fold structure that expresses a saddle geometry in the west and a domal geometry in the east (Fig. 2). A number of smaller folds, parasitic to the main structure of the Scotsburn Anticline, can be interpreted within this overall context (Fig. 2). Specifically, the presence of overturned bedding and steeply plunging fold axes are confirmed in the northern limits of the northern limb of the Scotsburn Anticline. These structures potentially reflect a more intense expression of the doubly plunging geometry of folding that is interpreted regionally, and/or are associated with proximity to a buried shear zone. Further analysis is needed to distinguish between these possibilities.

The strata underlying the Scotsburn Anticline include at least four units (Fig. 3): (1) a basal sequence comprising primarily silt- and sand-sized calcareous clastics and capped by a ca. 2-30 m basalt flow, (2) a middle sequence consisting primarily of calcareous clastics in the north and a clast-supported conglomerate in the west and south with modest sorting and rounding of clasts, and (3) a top sequence consisting primarily of a clast-supported conglomerate, which exhibits poor sorting and very angular clasts. The basal sequence is identified informally as the Mackay Brook formation here (since the Mackay Brook exposes the best section of this sequence in outcrop), and the capping basalt is called the Diamond Brook member (it is exposed on the Mackay Brook, Diamond Brook and West Branch River John). The middle sequence is identified informally as the

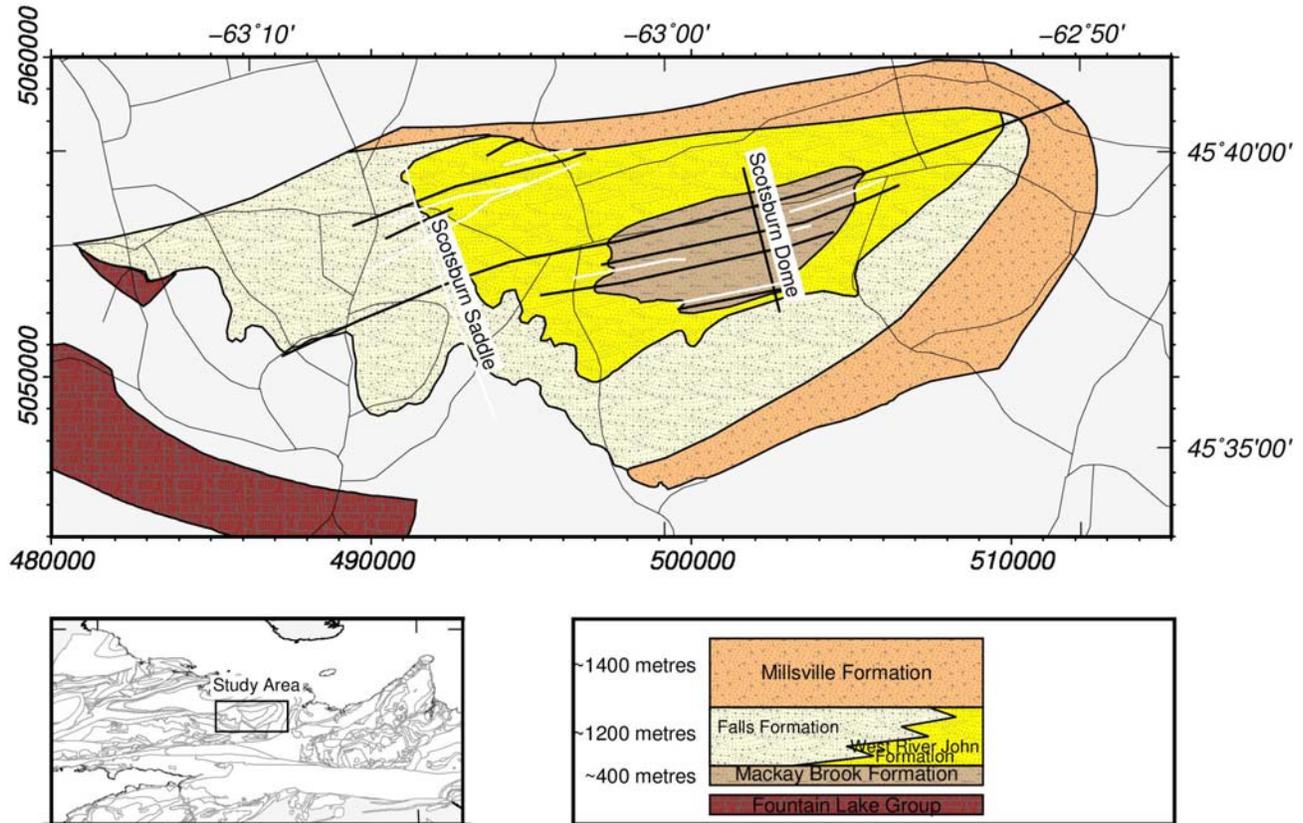


Figure 2. Preliminary interpretation of the Scotsburn Anticline based on this study.

West Branch River John formation (northern clastics) and the Falls formation (western and southern conglomerate), which are confirmed to interfinger with one another from the southwest to the northeast. The proportion of conglomerate in the middle sequence increases from northeast to southwest and is the dominant lithology in the western and southern parts of the Scotsburn Anticline. The top sequence is identified as the Millsville Formation conglomerate. The terms Mackay Brook formation, Diamond Brook member, and West Branch River John formation are all new here; the terms Falls Formation and Millsville Formation follow the definitions of Donohoe and Wallace (1982). Informally here, these three sequences comprising five formations are referred to as the Scotsburn group for convenience.

The Scotsburn group appears to unconformably overlie basement strata at its western boundary, which approximately follows present topographic contours (Fig. 4). The Scotsburn group appears to

be in faulted contact with basement rocks at its southern boundary (Fig. 2). A magnetic anomaly high is revealed in the total field data beneath the core of the Scotsburn Dome (King, 2005a; Fig. 5).

Discussion

The principal conclusion from the new map interpretation is that the previously proposed Diamond Brook Formation (Donohoe and Wallace, 1982) is misnamed. The Diamond Brook Formation has been defined as a mafic volcanic and clastic sequence, exposed in both the eastern to central Cobequid Highlands (MacHattie, 2010) and in the southern limb of the Scotsburn Anticline (Donohoe and Wallace, 1982; Pe-Piper and Piper, 2002). It is supposed here that the Diamond Brook Formation was named after the section exposed on Diamond Brook in the Scotsburn Anticline area (Fig. 2). Several kilometres of basalt are also exposed along West Branch River John. It is supposed here that previous mappers interpreted

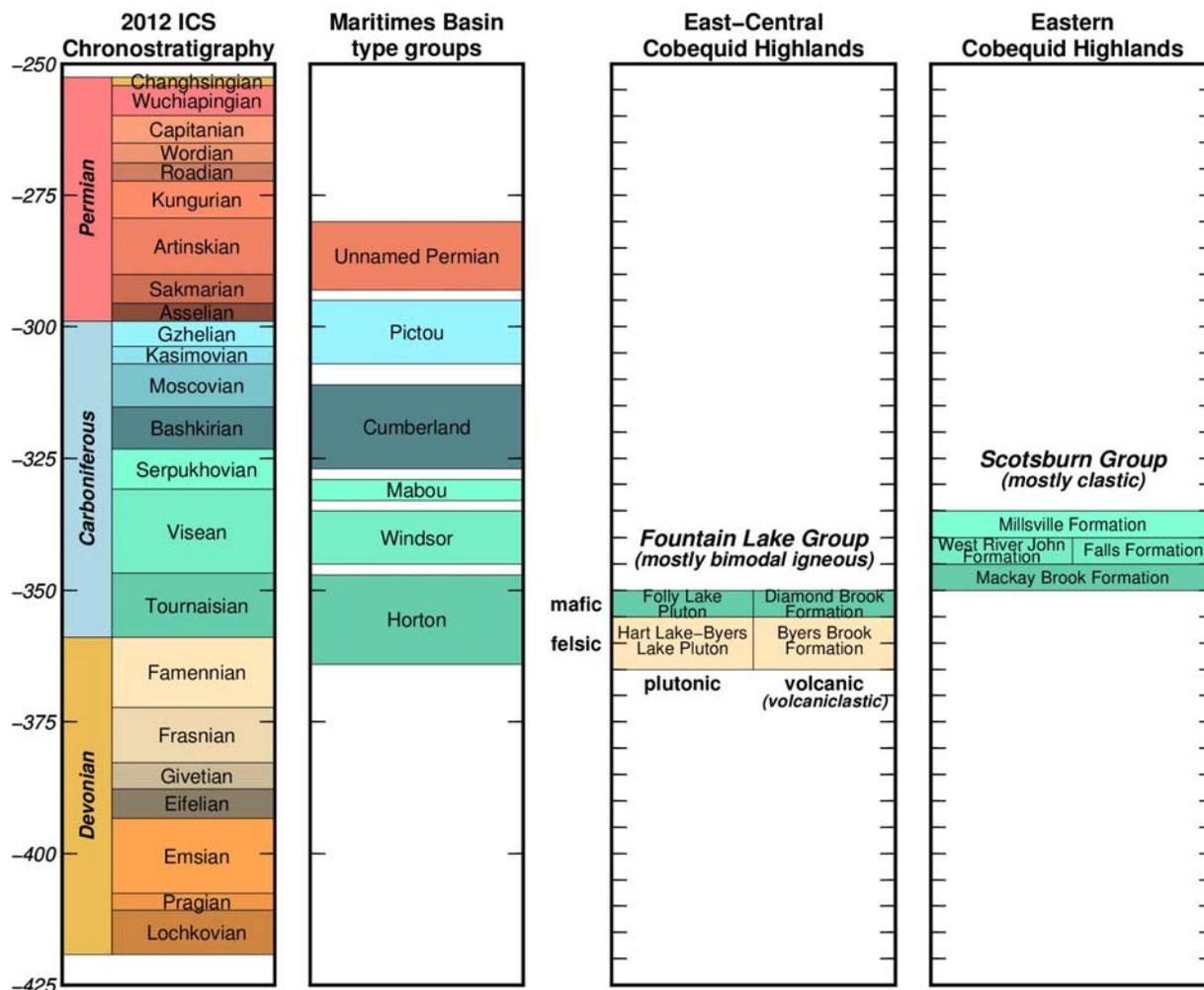


Figure 3. Tentative chronostratigraphic relationships for the Fountain Lake Group of the eastern-central Cobequid Highlands (after MacHattie, 2010) and the informal Scotsburn Group (introduced here), in the context of the regional Maritimes Basin type sections (after Gibling et al., 2008) and global chronostratigraphic classification scheme (after Cohen et al., 2012).

the different basalt outcrops as a single sequence of many basalt flows, and that this inferred pattern justified the definition of the Diamond Brook Formation and its correlation with similar outcrops in the eastern and central Cobequid Highlands. However, previous mapping projects probably recorded outcrops only every ca. 100-500m, a resolution that would have been too coarse to identify the local changes in bedding which indicate the basalt outcrops may all correspond to a single basalt horizon. Local changes in bedding appear to be primarily due to parasitic folding related to the regional Scotsburn anticline. Diamond Brook, in particular, gently cuts up and down section exposing this basalt, and clastic strata immediately

above or below it, repeatedly. As interpreted here, Diamond Brook may only expose a single basalt horizon. Consequently, this section is interpreted to be the type area of a Diamond Brook Basalt Member of the MacKay Brook Formation, where the Mackay Brook exposes both this basalt and a more extensive section of underlying clastics in the core of the Scotsburn Dome.

With this re-interpretation, the correlation between the rocks exposed on Mackay Brook (i.e. the proposed Mackay Brook formation) and the mafic volcanic sequence in the eastern and central Cobequid Highlands (MacHattie, 2011), which were previously identified as Diamond Brook

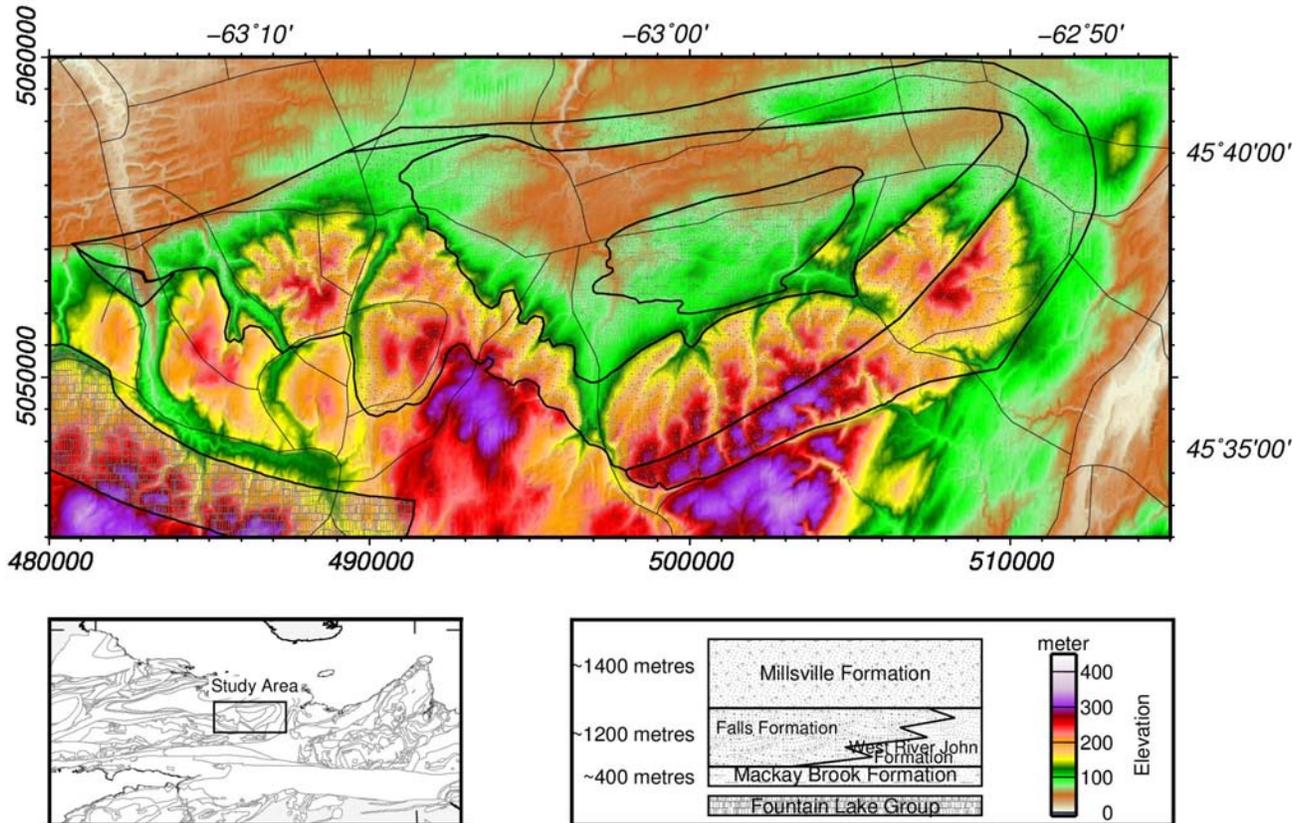


Figure 4. Elevation data for the Scotsburn Anticline area overlain by new interpretations of lithological contacts for the informal Scotsburn group.

Formation (Donohoe and Wallace, 1982), is brought into question. Tentatively, it is conjectured that the Mackay Brook formation strata exposed in the core of the Scotsburn Dome immediately overlie the mafic volcanic section exposed in the eastern and central Cobequid Highlands. This conjecture is based on the magnetic high anomaly preserved under both the eastern and central Cobequid Highlands (King, 2005b; Fig. 5) and the Scotsburn Dome (King, 2005a; Fig. 4). If this conjecture is correct, untapped mineral potential equivalent to that identified in the eastern and central Cobequid Highlands in recent years (e.g., MacHattie 2011; Fig. 6) may underlie the Scotsburn Dome. For example, Figure 6 illustrates that active mineral exploration claims are staked all along the eastern and central Cobequid Highlands, but no active claims are staked over the Scotsburn Dome. Validation of the proposed correlation and the depth at which elevated geochemical anomalies may occur will be important next steps.

Aside from the simplification in the stratigraphic and structural interpretation of the Scotsburn Anticline just discussed, a key possibility is that the informal Scotsburn group may be broadly Viséan in age. If so, the Scotsburn group may be broadly correlative with Windsor Group rocks elsewhere in the Maritimes Basin (Gibling et al., 2008; Fig. 3). Alternatively, the informal Mackay Brook formation may be correlative with the upper Horton Group, and the Millsville Formation conglomerate may be correlative with the Mabou Group. A series of palynological samples have been taken and sent for analysis to hopefully address the time of deposition of the Scotsburn group rocks.

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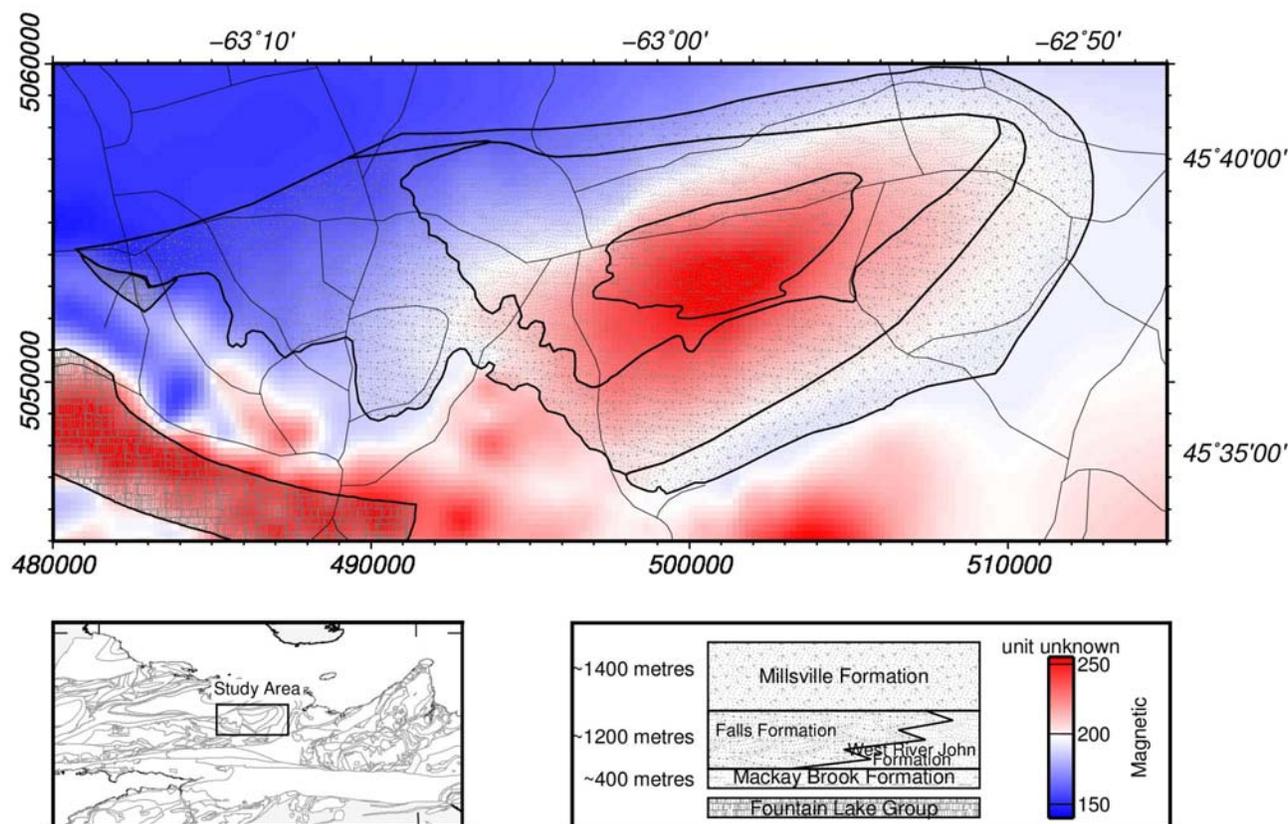


Figure 5. Total magnetic field data for the Scotsburn anticline area (King, 2005a, b) overlain by new interpretations of lithological contacts for the informal Scotsburn group.

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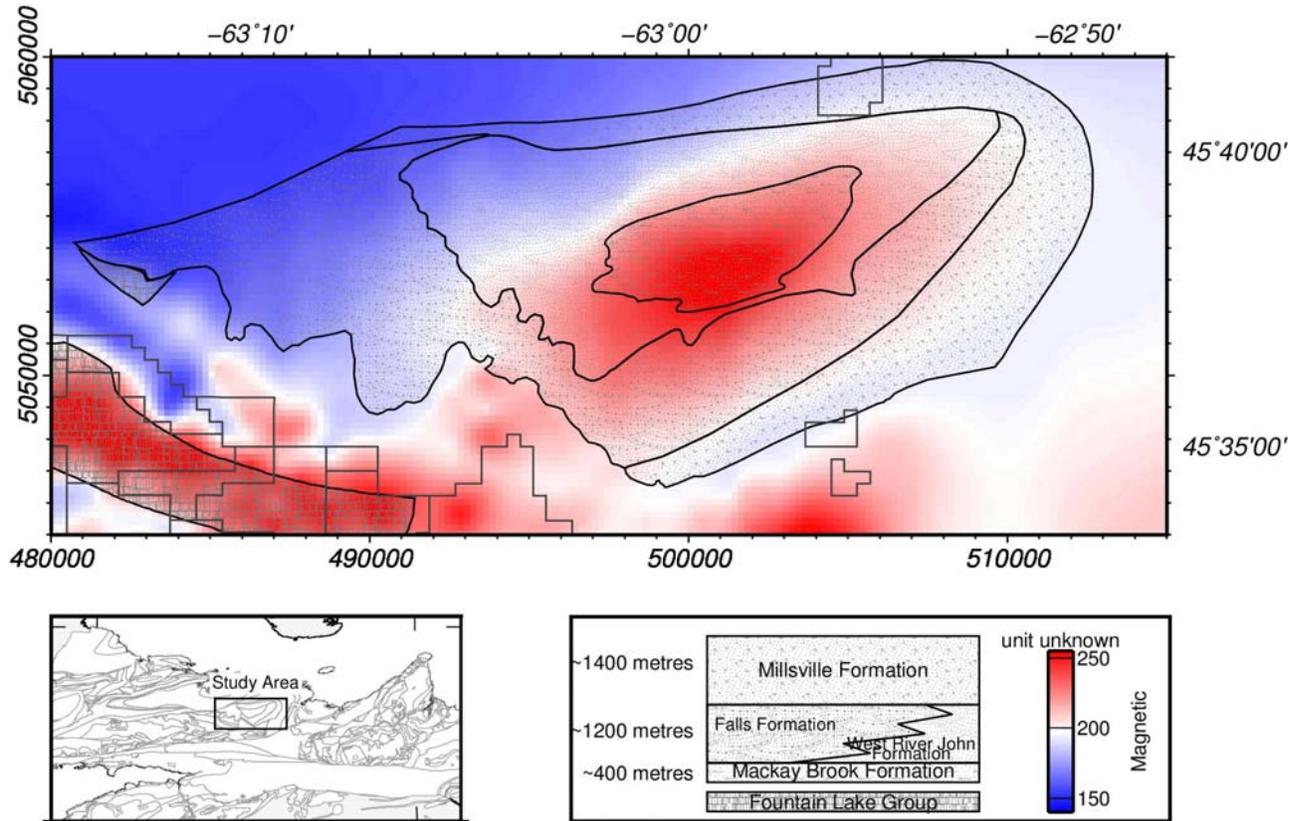


Figure 6. Total magnetic field data for the Scotsburn anticline area (King, 2004a, b) overlain by new interpretations of lithological contacts for the informal Scotsburn Group. Grey boxes outline active claim areas for 2012 (Fisher, 2012).

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