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Introduction

A regional bedrock mapping program by the Ontario Geological Survey of the northeastern Central Metasedimentary Belt of the Grenville Orogen near Renfrew (Figure 1) started in 2011 and has continued into the 2014 field season. This presentation focuses on the results obtained from a 1:50 000 scale mapping study of the Ontario portion of the Cobden NTS 31F/10 map area, north of Renfrew. All UTM co-ordinates cited are in NAD 83, Zone 18.

Abstract

The Cobden area lies approximately 80 km NNW of Ottawa and straddles the Central Metasedimentary Belt Boundary tectonic zone (CMBBTz) of the Grenville Orogen in Ontario (Figure 1). New 1:50 000 scale mapping and new high-resolution (200-m line-spacing) aeromagnetic data shown in this presentation (Figure 4) aid in mineral resource assessment and indicate a more complex geological history than previously thought. Although the presence of several northwest-trending subvertical faults that result in the local preservation of middle to upper Ordovician limestone (Photo 2) in the area was previously known, a major north-trending fault, the Ross fault, was previously unrecognized (Figure 2, 3, 4). The Ross fault divides the Cobden area into 2 roughly equal-sized domains: 1) an eastern domain (Ross subdomain, Figure 2) underlain by lower amphibolite facies calcite and dolomite marbles with relic primary features (Photo 9, 10, 11) cut by the Chenaux gabbro (ca. 1231 Ma) (Photo 13); and 2) a western domain (Bromley subdomain, Figure 2) underlain by a complex of marble tectonic breccia (Photo 6, 7) and syenite intrusions (ca. 1030 Ma) (Photo 4, 5) and metasomatic rocks (Photo 7, 8) that abut and intrude thin-layered, highly strained upper amphibolite gneisses of the CMBBTz (Photo 3). Older low-resolution (800-m line spacing) aeromagnetic data suggested that the Ross fault was near vertical; however, the high-resolution data show that the Ross fault is a shallow, east-dipping thrust fault (compare Figures 3 and 4). The Ottawa River is also oriented N-S rather than WNW in the Cobden area, but does not directly follow any known faults. The new aeromagnetic and geological data also indicate that upper amphibolite facies gneisses along the Ottawa River, including the host rocks to the former Calumet Zn (Pb-Ag-Au) mine (Rocher-Fendu subdomain, Figure 2), are in thrust contact with the underlying eastern domain marbles. The new aeromagnetic data also reveal the presence of 3 main west-trending zones, spaced at roughly 10 km intervals, of Grenville swarm (circa 590 Ma) diabase dikes (Figure 4). Most of these dikes occur beneath middle to upper Ordovician limestones. Implications for mineral exploration are a) exploration for high-quality marble is restricted to the eastern domain, b) exploration for U-Th-REE mineralization is restricted to the western domain (Table 1, Photo 5), and c) host rocks for the former Calumet mine have limited extent in Ontario, although the presence of cordierite in these rocks suggests that the deposit may result from hydrothermal alteration in a VMS-environment, rather than a SEDEX-system.

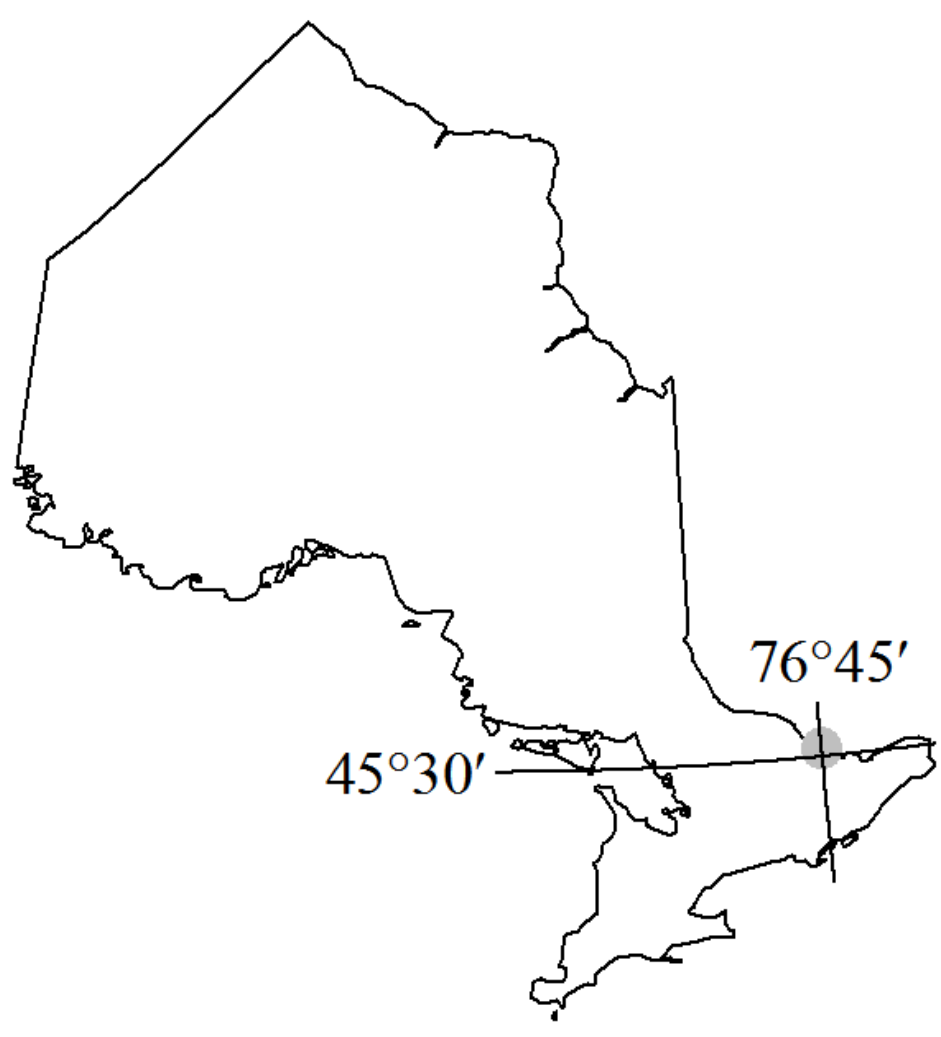


Photo 1. The author beside an artist's conception of the Muskkrat Lake monster which inhabits the central part of the Cobden map area.

PHANEROZOIC ROCKS



Photo 2. Limestone of the Bobcaygeon Formation, Ottawa Group (Upper Ordovician) exposed on Highway 17. Locally the preserved Paleozoic strata are sufficiently thick to subdue the magnetic signal from underlying basement rocks, suggesting thicknesses on the order of 400 metres. Hammer handle is 33 cm long. UTM 344576E 5066110N.

CMBBTZ ROCKS



Photo 3. Folded, compositionally heterogeneous, straight gneiss of the Central Metasedimentary Belt boundary tectonic zone (CMBBTz). UTM 339303E 5070028N.

Table 1: Rare earth element data for selected Late Syenite Suite rocks in the Cobden area (from Easton 2014).						
Sample	Total REE (in ppm)	Y (in ppm)	Rock Type or Mineral	Easting Zone 18	Northing NAD 83	Comment
Syenite						
13RME-0068	1512	22	syenite	352019	5048726	medium-grained red syenite, reported as 1044 ppm total REE in Easton (2013b)
13RME-0072	1457	58	syenite	350711	5050016	medium-grained red syenite, reported as 1062 ppm total REE in Easton (2013b)
13RME-0259	2095	222	syenite	353928	5053929	fine-grained, scapolitized syenite, Highway 17 just south of Cobden
13RME-0404	750	52	syenite	350967	5052930	medium-grained syenite, Cobden road
Marble						
13RME-0216	216	32	calcite marble	353916	5053575	matrix, marble breccia
13RME-0255	638	59	calcite marble	357859	5048933	matrix, marble breccia, Highway 17
13RME-0262	689	43	calcite marble	357541	5049284	matrix, marble breccia, Highway 17
Minerals						
13RME-0139	1569	161	calcite	354459	5050976	from vein cutting varitextured and varigained syenite, host syenite 381 ppm
13RME-0140	1647	154	calcite	354470	5050932	from vein cutting varitextured and varigained syenite
13RME-0141	2280	80	apatite	354470	5050932	from vein cutting varitextured and varigained syenite

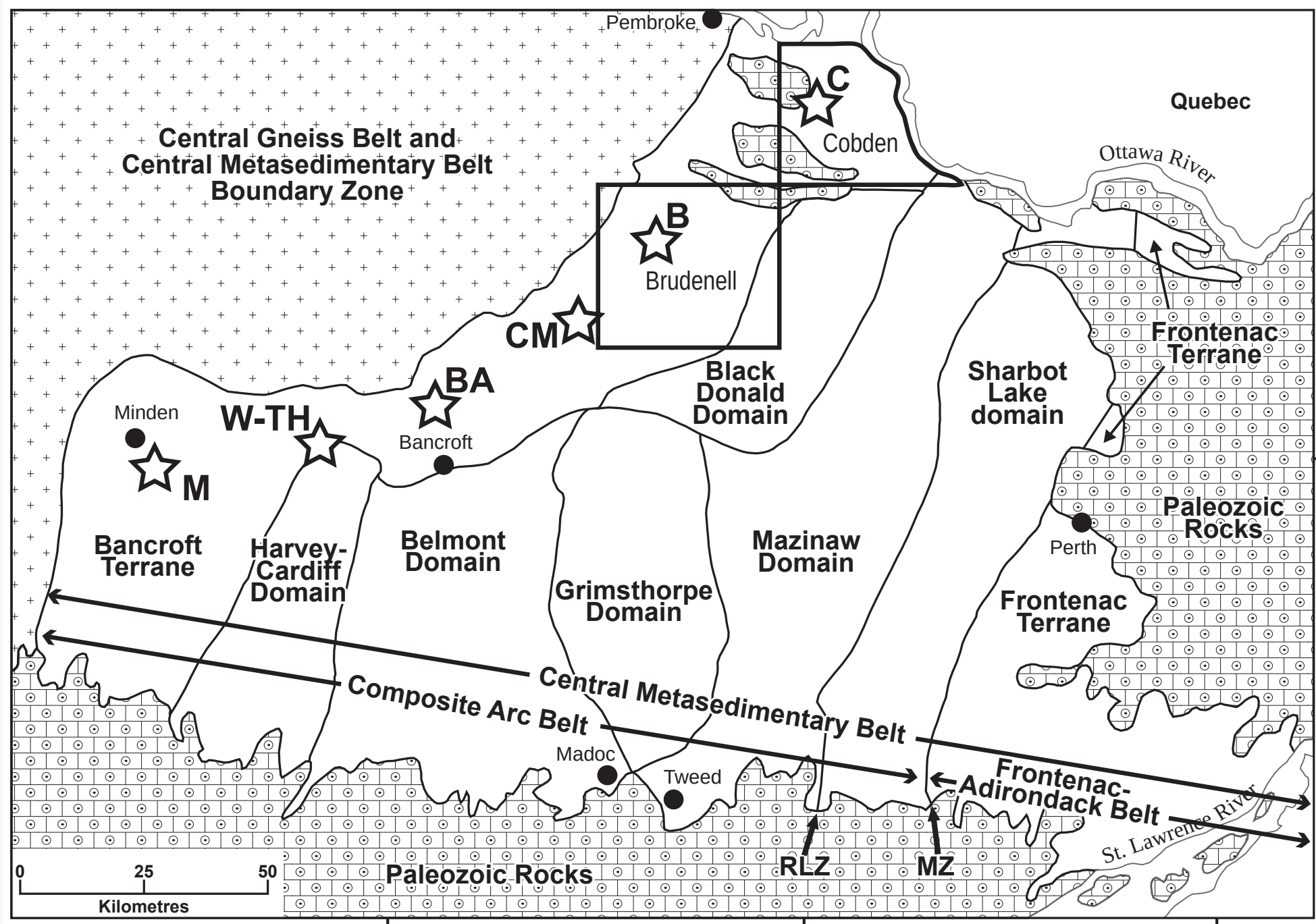


Figure 1. Project location in Ontario. Terrane and domain subdivision of the Central Metasedimentary Belt (from Easton (1992) and Carr et al. (2000)) showing the location of the Brudenell and Cobden study areas, and the location of major subareas of the Late Syenite suite belt within the Bancroft terrane. Abbreviations: B, Brudenell subarea; BA, Bancroft subarea; C Cobden subarea; CM, Craigmont subarea; M, Minden subarea; W – TH Wilberforce – Tory Hill subarea; MZ, Maberly shear zone; RLZ, Robertson Lake mylonite zone.

BROMLEY SUBDOMAIN ROCKS

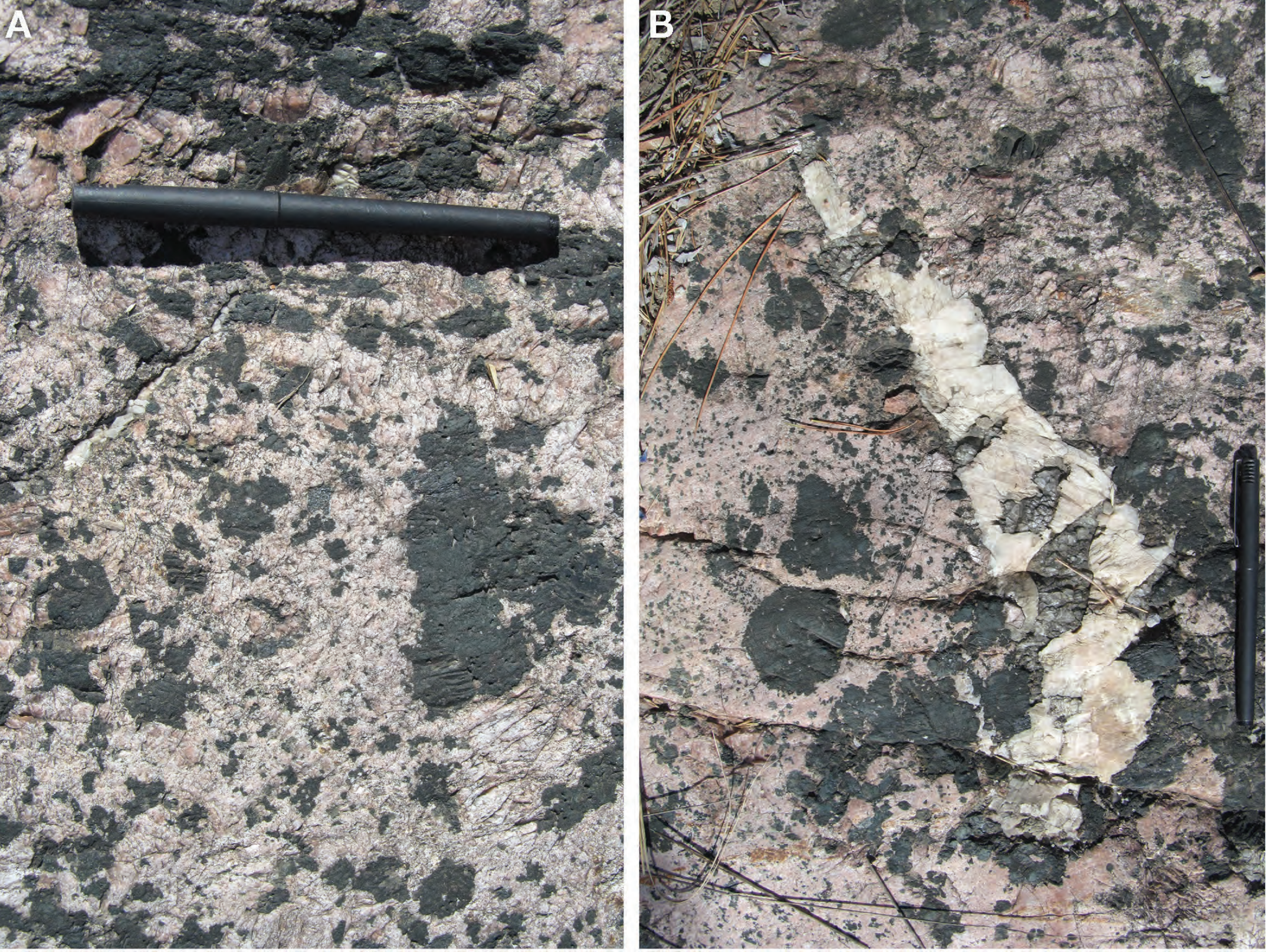


Photo 4. Examples of Lake Clear type syenite from the Bromley subdomain. A) Typical varitextured and varigained pyroxene syenite. B) Lake Clear type syenite with a discrete calcite pod. Pods such as these are common in the late syenite suite rocks, and may result from crystallization from a CO₂-rich immiscible liquid co-existing with the syenite magma. Pen in both images is 14 cm long. UTM 354285E 5053553N.



Photo 5. A) Fine- to medium-grained syenite of the Bromley subdomain, which is more likely to host rare earth element mineralization. Sample 13RME-0072 (see Table 1). B) Varitextured and varigained syenite typical of the Bromley subdomain, which is less likely to host rare earth element mineralization. Hammer handle is 33 cm long. UTM 350711E 5050016N and 353735E 5054135N, respectively.

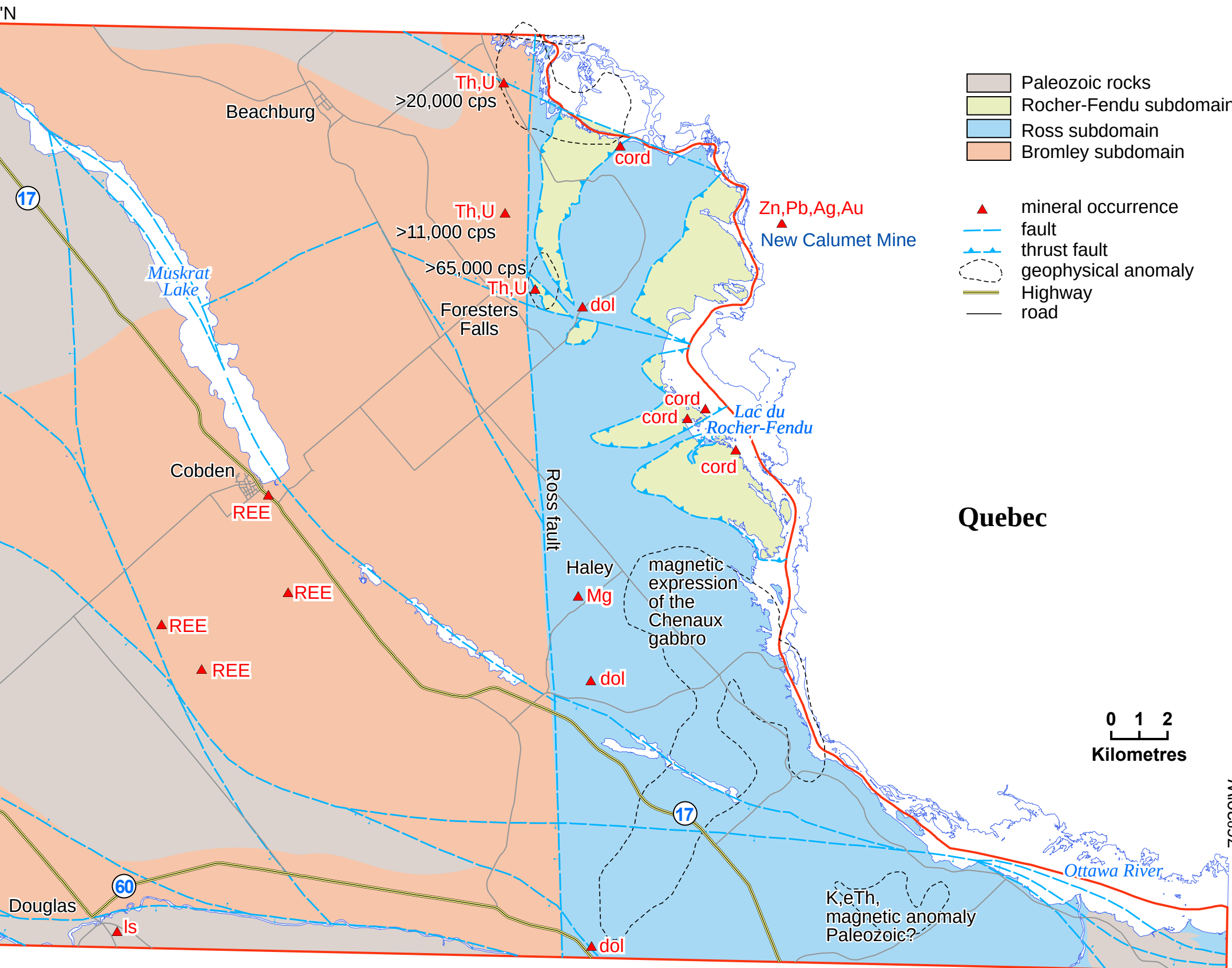


Figure 2. Simplified geological map of the Cobden area showing the location of subdomains, major faults, and significant mineral occurrences. Abbreviations: Ag – silver, Au – gold, cord – cordierite, cps – counts per second, dol – dolomite, eTh – equivalent Thorium, ls – limestone, Mg – magnesium, Mo – molybdenum, Pb – lead, REE – rare earth elements, Th – thorium, U – uranium, Zn – zinc, K – Potassium



Photo 6. Typical marble tectonic breccia with white calcite matrix and altered fragments from the Bromley subdomain. UTM 352020E 5048730N.

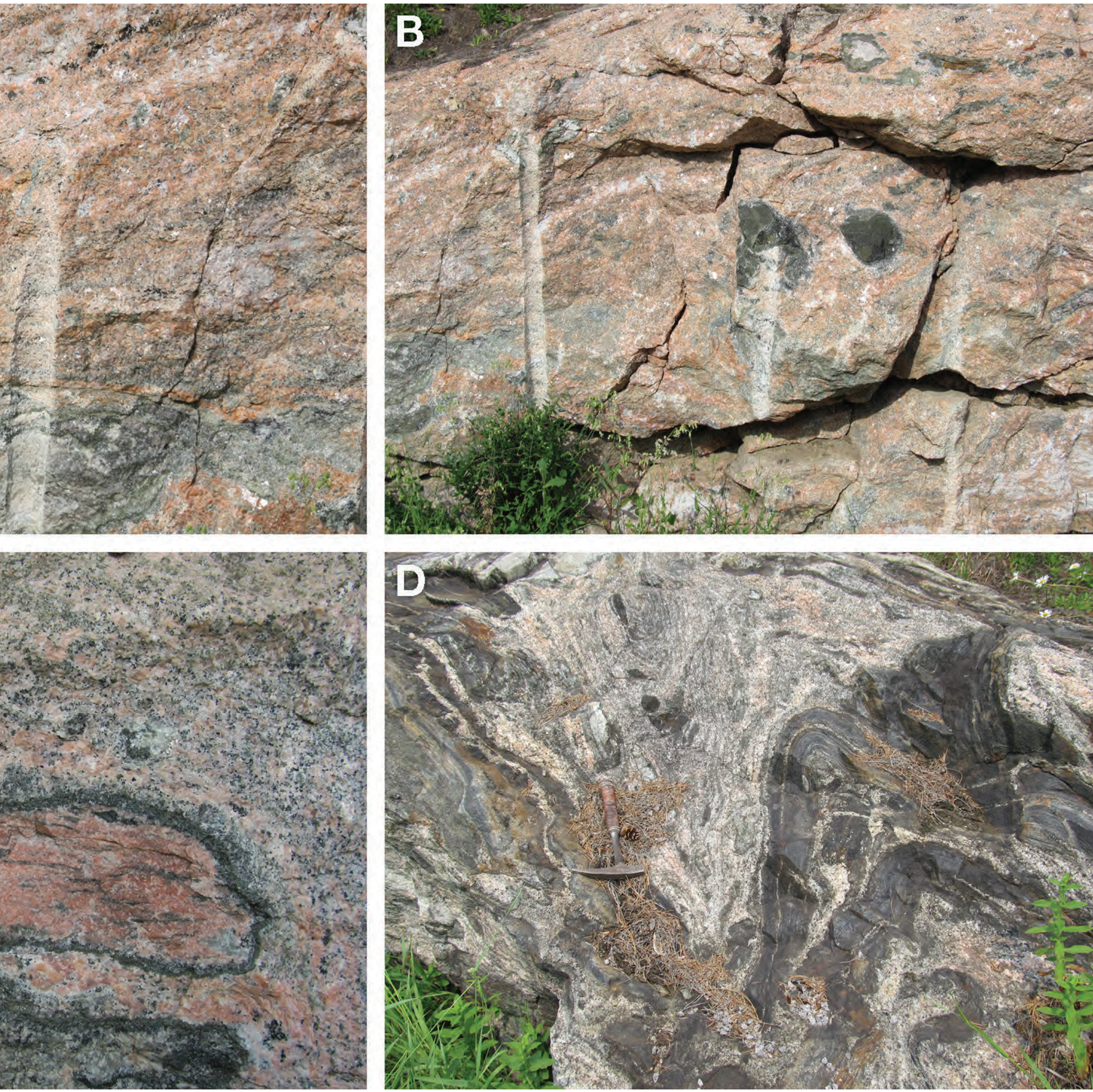


Photo 7. Examples of pink metasomatic carbonate rocks that are widespread in the Bromley subdomain in the Cobden map area. A) Typical massive, coarse-grained, pink calcite rock. The pink calcite forms as a result of metasomatism of an originally white-coloured marble. B) Similar to Photo 7-A, but containing dark-coloured fragments, which are diopside-rich fragments derived from metasomatism of pre-existing silicate fragments. The presence of these fragments indicates that the protolith was a marble tectonic breccia. C) Syenite fragment with dark diopside alteration rim. The presence of syenite fragments indicates that deformation was occurring during and post-syenite intrusion and metasomatism. Photos A, B, C UTM 344426E 5045006N. D) Folded mafic gneiss layers within pink-grey, partly metasomatized marble breccia. UTM 358640E 5048120N.

COBDEN AREA GEOPHYSICAL DATA

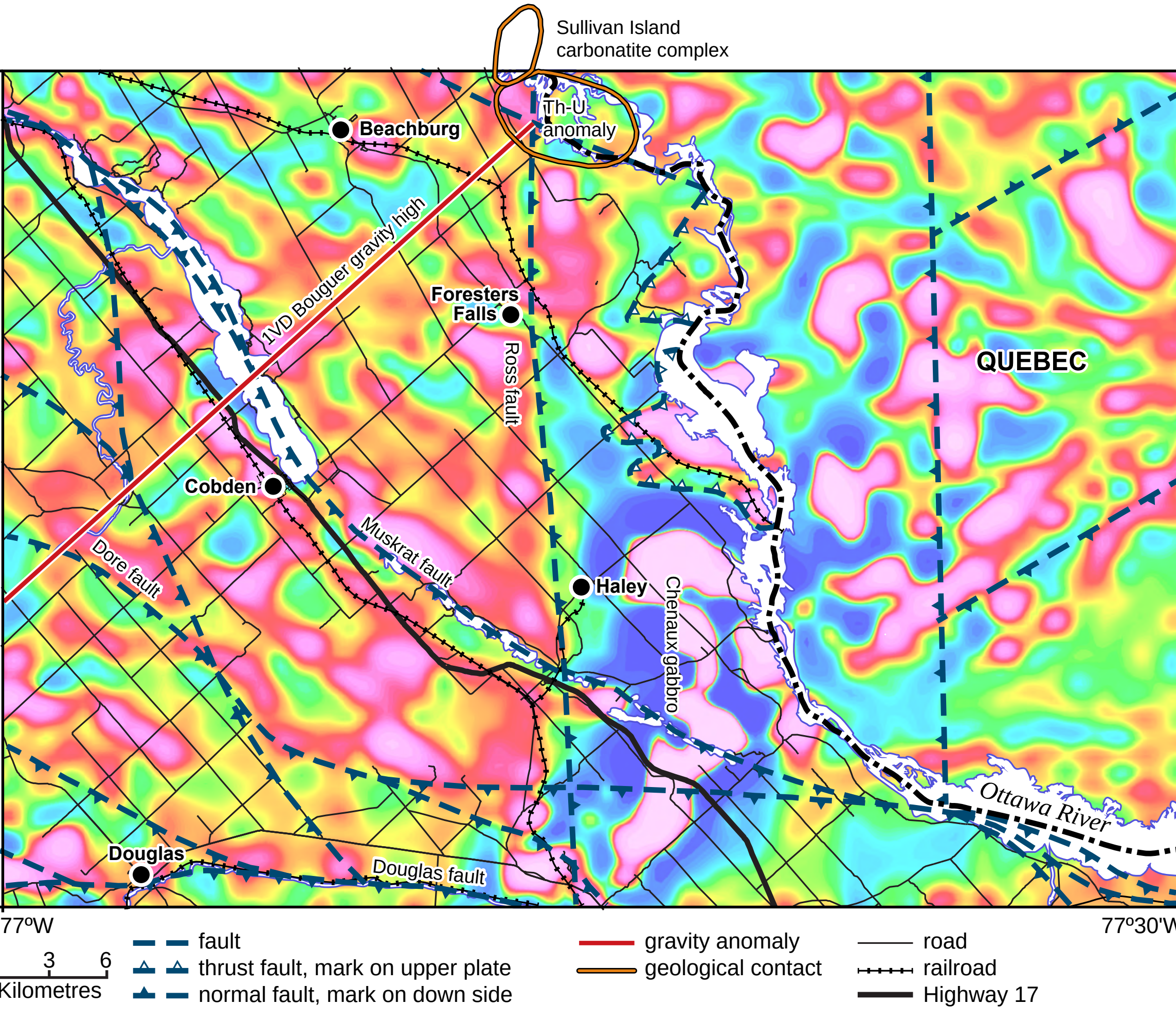


Figure 3. Map of the Cobden area showing the first vertical derivative (1VD) of the magnetic field based on historic publicly available data. Red colours indicate highs, blue colours lows. Also shown are major faults in the area. The north-trending Ross fault follows a prominent break in the magnetic field, which also corresponds to a major change in the bedrock geology. Magnetic data at 800 m line-spacing are from Ontario Geological Survey (1999).

ROSS SUBDOMAIN ROCKS

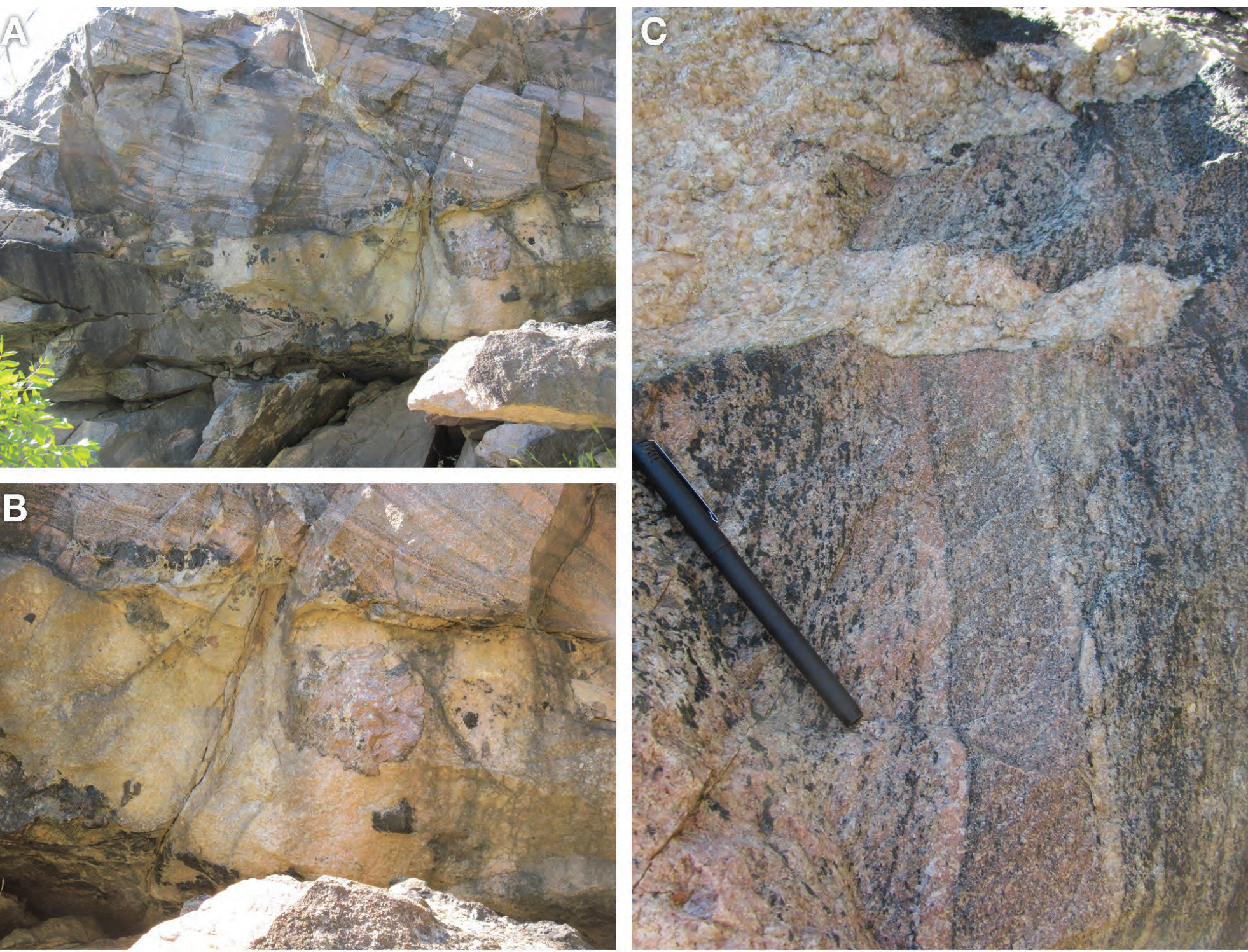


Photo 8. Relationship between Late Syenite suite and associated rocks and gneiss of the Central Metasedimentary Belt boundary tectonic zone (CMBBTz). A) Sub-horizontal white calcite-fluorite-apatite vein (fluorite and apatite are only visible on fresh broken surfaces) in lower half of image cuts the gneissosity in the host granitoid gneiss at a high angle. B) Close-up of vein shown in Photo 8-A. Note large block of syenite in the vein, as well as the development of coarse diopside and amphibole crystals in the adjacent gneiss along the vein contact. C) Close-up of margin of calcite vein showing that it cuts the gneissosity in the host gneiss. UTM 344426E 5045006N.



Photo 11. Typical layered calcite marble of the Ross subdomain. Compare and contrast with Photos 6 and 7. Pen is 14 cm long. UTM 370895E 5040173N.

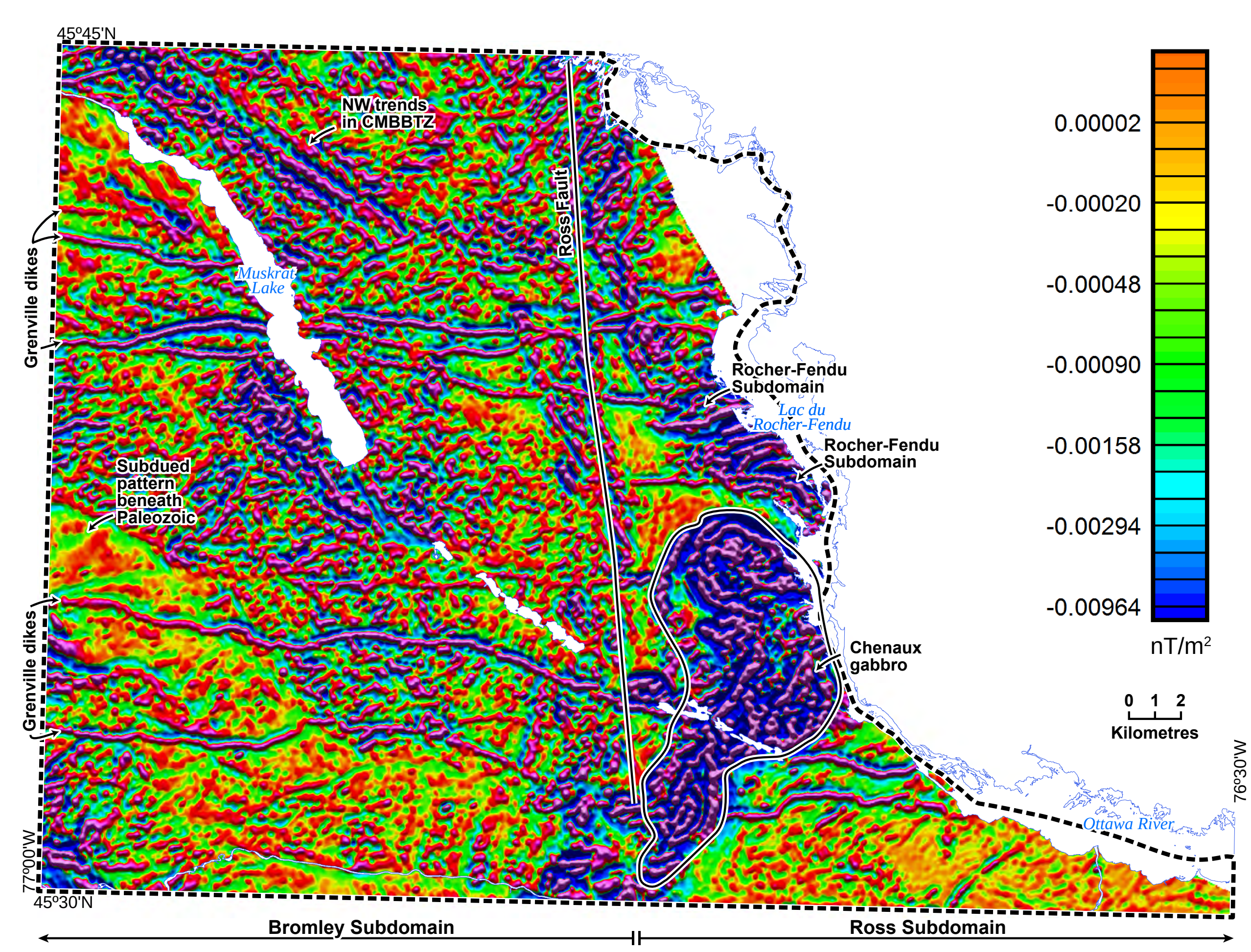


Figure 4. Map showing the second vertical derivative (2VD) of the magnetic field for the Cobden area of Ontario, with key features indicated. Note presence of Grenville dikes, which are not evident in the lower resolution data set (see Figure 3). Magnetic data at 200 m line-spacing are from Ontario Geological Survey (2014). Abbreviation: CMBBTz, Central Metasedimentary Belt boundary tectonic zone.



Photo 9. Typical layered calcite marble of the Ross subdomain. Compare and contrast with Photos 6 and 7. UTM 363000E 5047854N.



Photo 10. Typical layered calcite marble of the Ross subdomain. Compare and contrast with Photos 6 and 7. UTM 370698E 5040151N.



Photo 12. Cross-bedded metasandstone, possible Flinton Group strata, within Ross subdomain. Knife is 9 cm long. UTM 373900E 5042731N.

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— — — 2014. Ontario airborne geophysical surveys, magnetic and gamma-ray spectrometric data, grid and profile data (ASCII and Geosoft® formats) and vector data, Renfrew area; Ontario Geological Survey, Geophysical Data Set 1074.

Photo 13. Chenaux metagabbro. A) Primary igneous layering within the Chenaux gabbro; hammer points south and is 32 cm long. UTM 365219E 5044804N. B) Contact between the Chenaux gabbro and calcite marble displaying disharmonic folding; hammer points south and is 32 cm long. UTM 364907E 5045299N. C) Close-up view of varitextured and varigained Chenaux gabbro, looking south. UTM 365842E 5043799N. D) Very coarse grained and strongly amphibole altered melanocratic Chenaux gabbro, view to the southwest. UTM 365909E 5043753N. E) Homogeneous and weakly foliated, medium-grained mesocratic Chenaux gabbro, view to the north. UTM 365956E 5044413N. F) Lineated and foliated Chenaux gabbro, view to the north. UTM 364941E 5045302N. From Azar and Easton (2013).