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Preliminary report on the structural geology of the Clarence Stream–Moores Mills area, southwestern New Brunswick: implications for gold exploration[1]

Sébastien Castonguay, Sheila Watters, and Jean-François Ravenelle

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Abstract: Significant gold occurrences located in proximity to Devonian granitoid intrusions have been recently discovered in the Clarence Stream area of southwestern New Brunswick. The area straddles the Ordovician St. Croix Terrane and Silurian Mascarene Belt, which are variously affected by four phases of regional deformation. The St. David antiform is interpreted as a megascopic F_2-F_3 fold-interference structure, the southeastern limb of which is cut by the late-D_3, dextral Sawyer Brook Fault. Mineralized quartz veins and breccia units within the Ordovician Cookson Group are structurally associated with thrust-related D_2 high-strain zones and folds. Southward, the occurrence of mineralized quartz veins in the Silurian Waweig Formation is influenced by the competency of gabbroic bodies, whereas late-D_3 high-strain zones control their present geometry. The distinct lithostratigraphic assemblages and the nature and location of structures hosting the gold mineralization indicate that exploration strategies should not be restricted only to the proximity of specific intrusions or shear zones.

Résumé : D'importantes minéralisations aurifères se situant à proximité d'intrusions granitiques du Dévonien ont été découvertes récemment dans la région du ruisseau Clarence, dans le sud-ouest du Nouveau-Brunswick. La région chevauche le terrane de St. Croix de l'Ordovicien et la ceinture de Mascarene du Silurien, lesquels sont affectés à divers degrés par quatre phases de déformation régionale. L'antiforme de St. David est interprété comme une structure d'interférence mégascopique de plis P_2-P_3, dont le flanc sud-est est recoupé par la faille de Sawyer Brook, une structure dextre liée aux épisodes tardifs de la déformation D_3. Des veines de quartz et des brèches minéralisées au sein du Groupe de Cookson sont structuralement associées à des zones d'intense déformation et à des plis liés à la déformation par chevauchement D_2. Vers le sud, la présence de veines de quartz minéralisées dans la Formation de Waweig du Silurien est influencée par la compétence de corps gabbroïques, tandis que des zones d'intense déformation liées aux épisodes tardifs de la déformation D_3 contrôlent leur géométrie actuelle. Les différents assemblages lithostratigraphiques, ainsi que la nature et la position des structures hôtes de la minéralisation aurifère démontrent que les stratégies d'exploration ne devraient pas seulement se restreindre à la proximité d'intrusions ou de zones de cisaillement spécifiques.

[1] Contribution to the Targeted Geoscience Initiative (TGI) 2000–2003.

INTRODUCTION

Although better known for its volcanogenic, massive Cu-Pb-Zn sulphide deposits and granite-related Sn-W-Mo-Sb deposits, parts of New Brunswick have recently been the focus of exploration for gold (*see* compilation in McLeod and Fyffe, 2002). Significant occurrences of gold mineralization have recently been discovered in the Clarence Stream area of southwestern New Brunswick (Fig. 1). The number of gold occurrences, their significant grade, and the diversity of their geological setting potentially make the area an emerging gold belt, and emphasize the need to better understand the geological architecture of this complex and poorly exposed region. The purpose of the present study, part of the Targeted Geoscience Initiative (TGI) project 'Metallogeny of intrusion-related gold systems in southwestern New Brunswick', is to describe the regional structural framework and document the different generations of structures. This study complements various ongoing, deposit-scale, thematic metallogenic studies (e.g. Thorne et al., 2002; Chi, 2002; Watters and Castonguay, work in progress, 2003) and extensive exploration programs, mostly by Freewest Resources Canada Inc., in attempting to better understand the nature, setting, and controls of gold mineralization.

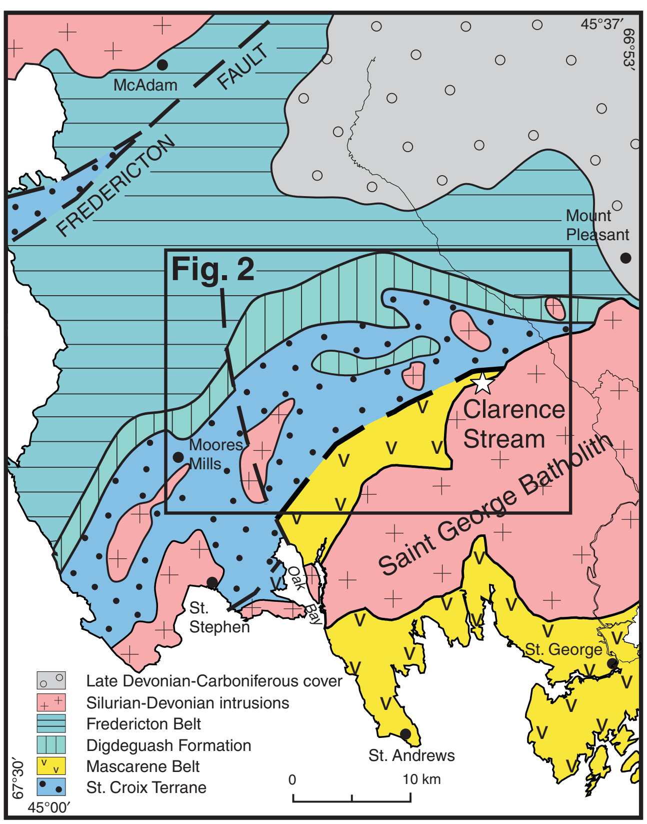


Figure 1. *Geotectonic map of southwestern New Brunswick (*modified from *Fyffe and Riva, 2001).*

With the help of recently updated geological maps (Fyffe, 1997; McLeod et al., 1998) and vintage structural studies (e.g. Ruitenberg, 1967), limited fieldwork targeted on the Clarence Stream–Moores Mills area was effective in refining the overall picture of the regional structure. Although exposure is scarce in the area, a few key outcrops showing interference fold patterns or cleavage relationships have permitted regional distinctions and correlations between regional- and deposit-scale structures, thereby providing an assessment of the regional structural evolution and some indication of the setting and controls of gold mineralization. A parallel, TGI-funded, deposit-scale study (Watters and Castonguay, work in progress, 2003) focuses on characterizing the nature and distribution of hydrothermal alteration, veining, and geochemical signatures of recently discovered mineralized zones, and their local structural controls.

GEOLOGICAL AND STRATIGRAPHIC SETTING

The study area straddles three tectonostratigraphic packages (Fig. 1; Williams, 1995). The Ordovician St. Croix Terrane (Rollingdam Belt), traditionally assigned to the Gander Zone, is flanked on both sides, along unconformable and/or faulted contacts, by Silurian–Early Devonian cover sequences: the Fredericton Belt, to the northwest, and the Mascarene Belt (Oak Bay Subbelt), southeast of the Sawyer Brook Fault. The Sawyer Brook Fault is interpreted as the surficial boundary between the St. Croix and Avalonian terranes (Fyffe et al., 1999). Several generations of Late Silurian to Devonian granitoid intrusions occur in the area (Fig. 1, 2; Ruitenberg, 1967; McLeod et al., 1994; Fyffe, 1997; McLeod et al., 1998), including the Silurian-Devonian Saint George Batholith (comprising the 396 Ma Magaguadavic Granite; McLeod et al., 1994) and satellite stocks of the Pomeroy Intrusive Suite, and are commonly in close spatial relationship with the gold occurrences. In addition, gabbroic bodies of the East Branch Brook Intrusion (Thorne and Lentz, in press) crop out within the Silurian Oak Bay package in the Clarence Stream area, and had some influence on the setting of gold mineralization. Regional metamorphic grade is low in the study area, generally lower greenschist facies (chlorite zone). Although local extensive recrystallization and contact metamorphism (up to sillimanite grade) have occurred around intrusions, primary or relict sedimentary features are generally well preserved.

The St. Croix Terrane is underlain by the Ordovician Cookson Group (Ruitenberg, 1967; Ludman, 1987, 1991). In southwestern New Brunswick, it comprises three formations (Fig. 1, 2): a black shale–dominated sequence, with subordinate mafic volcanic rocks (Calais Formation) at the base; followed by feldspathic wacke and minor thin-bedded dark shale (Woodland Formation); and, finally, an interbedded quartz arenite and silty shale sequence (Kendall Mountain Formation). To the northwest, the early Late Ordovician Kendall Mountain Formation (Fyffe and Riva, 1990) is in gradational stratigraphic contact with the lithologically similar Early Silurian Digdeguash Formation, which consists of

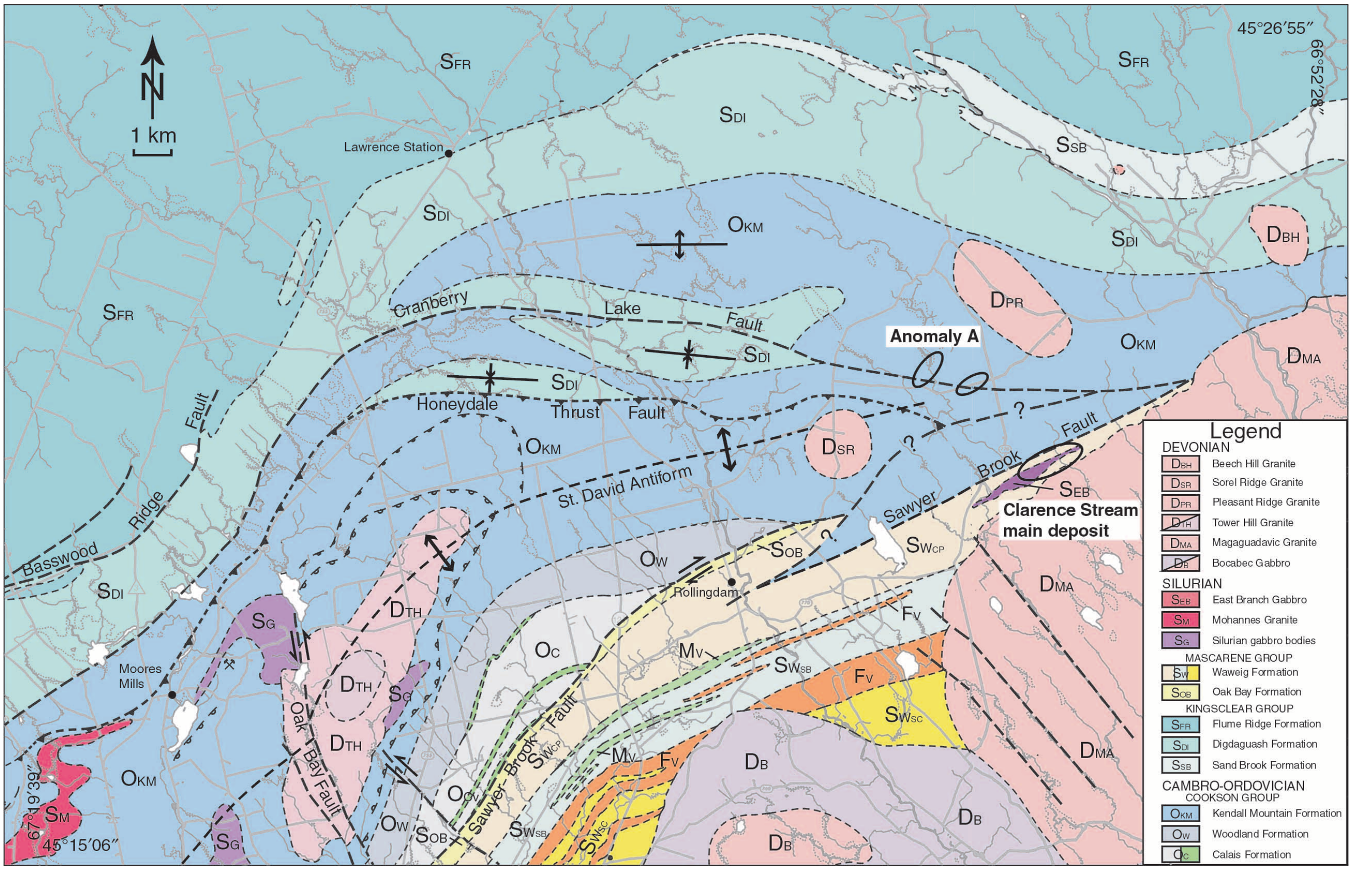


Figure 2. *Geology of the Clarence Stream–Moores Mills area (*modified from *Fyffe, 1997; McLeod et al., 1998). See Figure 1 for location of map area. Note the location of the Clarence Stream main deposit, Anomaly A, and the Moores Mills quarry (identified with the usual symbol). Abbreviations: Ocv, mafic volcanic rocks; Swcp, volcaniclastic sandstone and lapilli tuff; Swsb, shale and feldspathic sandstone; Swsc, siltstone and calcareous sandstone; Fv, felsic volcanic rocks and tuff; Mv, mafic volcanic rocks and tuff.*

interbedded lithic and feldspathic wacke and shale (Fyffe, 1997; Fyffe and Riva, 2001). The Digdeguash Formation has been assigned to the Kingsclear Group of the Fredericton Belt (Ludman, 1991; Fyffe, 1997; Fyffe and Riva, 2001) based on recent biostratigraphic evidence, which better constrains the age of the Kendall Mountain and Digdeguash formations (suggesting a slight unconformable gap), and on an apparent contrast in deformation style and intensity (Ludman, 1991; *see* below). The stratigraphic contact between these units can thus be considered as the boundary between the Ordovician St. Croix Terrane and the Silurian Fredericton Belt. Previous interpretations, which had the Digdeguash Formation as part of the Cookson Group, regarded the Basswood Ridge Fault (Fig. 2) as representing such a boundary (e.g. Fyffe and Riva, 1990).

Southeast of the St. Croix Terrane, the Oak Bay Subbelt consists of the apparently homoclinal sedimentary and volcanic sequence of the Mascarene Group, encompassing the Oak Bay and Waweig formations (Fig. 1, 2; Ruitenberg, 1967; Fyffe et al., 1999). Commonly marking the hanging wall of the Sawyer Brook Fault in the study area, the Oak Bay Formation is roughly 200 m thick and comprises thick-bedded polymictic conglomerate intercalated with coarse sandstone (Fyffe, 1997). It is interpreted as having been deposited along a steep fault scarp during the Late Silurian (Fyffe et al., 1999). Cleaved slabs of shale, probably derived from the underlying Calais Formation, have been found in the conglomerate (Fyffe et al., 1999), suggesting that parts of the St. Croix Terrane were a sedimentary source that had been deformed to some extent prior to erosion. The conformably overlying Waweig Formation consists of a thick succession of interstratified volcaniclastic and siliciclastic sedimentary and volcanic rocks (Fyffe 1997; Fyffe et al., 1999).

REGIONAL STRUCTURAL GEOLOGY

The pioneering studies of Ruitenberg (e.g. 1967, 1972) provide the most detailed regional-scale structural analysis in the Moores Mills–Clarence Stream area. More recent geological mapping (Fyffe, 1997, McLeod et al., 1998), various structural studies, and field trip guidebook descriptions of the Oak Bay area and surrounding regions of Maine (e.g. Ruitenberg and Ludman, 1978; Stringer and Burke, 1985; Fyffe et al., 1991) have broadened the understanding of the structural setting. Although comprehensive in depicting the individual deformation phases, most of these studies lack extensive descriptions of polyphase structures and interference fold patterns, so that the overall understanding of the structural architecture has been limited.

The structural geology of the area is characterized by four main phases of regional deformation (Ruitenberg, 1967), each of which varies in style and intensity due to differences of rock competency, anisotropy, and bedding thickness, and the presence of magmatic bodies within the rock package. As well as often lacking distinctive styles, the most conspicuous folding phases (D_2 and D_3; *see* below) are apparently coaxial, do not systematically display axial-planar cleavage, and are most frequently observed affecting only bedding or a single bedding-parallel cleavage. The incidence (or intensity) of the different fold generations commonly occurs in domains, most probably related to position in the principal regional-scale structure, the St. David antiform (*see* below). In addition, the different faulting events have segmented the area into blocks or zones that display different imprints of the regional structural evolution. The four phases (D_1 to D_4) described below mesoscopically resemble, to a certain extent, those documented by Ruitenberg (1967); however, their significance and correlation with regional structures are reinterpreted based on key outcrops that show interference fold patterns or clear cleavage relationships.

The D_1 deformation is dominantly recognized in the Rollingdam Belt (Cookson Group), although ambiguous evidence of intrafolial F_1 folds in the Digdeguash and Flume Ridge formations suggests that it might be present in the Fredericton Belt to the north. In the Cookson Group, S_1 is essentially a composite bedding-parallel slaty cleavage, except when it is axial planar to isoclinal, mostly intrafolial F_1 folds, often with sheared limbs (Fig. 3A, B). Multilayered F_1 and F_1-F_2 interference patterns are only rarely observed in areas of limited D_3 overprint (Fig. 3C); for example, they are most prominent (or less overprinted) in the core of the St. David antiform, west of the Tower Hill Granite (Fig. 2). The F_1 folds have been interpreted by Ruitenberg (1967) as originating from a 'composite main phase', whereas Fyffe et al. (1991), based on regional geometric correlations, have introduced 'F_0' for folds that apparently predated D_1. As is frequently the case in polydeformed terrains, D_1 structures are complex and strongly overprinted, and mostly lie subparallel to lithological layering; as such, their tectonic significance and influence on the regional structure are difficult to ascertain.

When differentiated from D_1, D_2 is associated with close to tight F_2 folds (Fig. 3D, E) that locally become isoclinal with thickened fold hinges (i.e. similar folds) in the proximity of D_2 high-strain zones (Fig. 3F). In the study area, axes of F_2 folds are mostly gently plunging to the northeast (Fig. 4A). Axial-planar S_2 dips shallowly to the northwest (Fig. 4B) and varies from a spaced-fracture or dissolution cleavage to a crenulation, depending on rock competency, imprint of S_1, and intensity of D_2. The structural style of this second deformation phase is nicely displayed in a small quarry near Moores Mills (Fig. 1, 2, 3F), where thick-bedded quartz arenite and interstratified black carbonaceous slate of the Kendall Mountain Formation are deformed into a series of moderately inclined, isoclinal F_2 folds. These folds have their lower inverted limbs cut by faults, commonly along arenite-slate contacts, thus creating 'piggy-back' or duplex-like geometry. The faults are typically marked by 2 to 5 cm of cataclastic breccia and gouge. Quartz-carbonate veins and stockworks have been noted at this locality (Fyffe, 1997). At the regional-scale, late-D_2 high-strain zones are often nearly coincident with change in asymmetry of mesoscopic F_2 folds, thus reinforcing the genetic link as fault-related folds. For example, synformal keels of the Digdeguash Formation occur infolded within the Kendall Mountain Formation in the footwall of the D_2 Honeydale Fault (Fig. 2; Ruitenberg, 1967). Following Ruitenberg and Ludman (1978) and Ludman (1991), it is suggested that D_1 and D_2 have been part of a protracted compressive stage, which evolved during the northwest-directed thrusting of the St. Croix Terrane onto the Fredericton Belt in Salinian or early Acadian time.

The third phase of deformation (D_3) is seemingly complex (Ruitenberg, 1967) and has a profound influence on the regional structural map pattern, although the S_3 fabric is rarely penetrative northwest of the Sawyer Brook Fault (i.e. in the Cookson Group; Fig. 2). When present, however, the steeply dipping S_3 fracture to crenulation cleavage (Fig. 4C) is axial planar to open to tight F_3 folds (Fig. 3G, H), with axes plunging moderately to the east-northeast or southwest (Fig. 4B), depending of the area. The 'St. David Dome' has been characterized by Ruitenberg (1967) as an early structure, connecting the Silurian belts on both sides of the St. Croix Terrane, which was subsequently domed up and flattened during granitic intrusion. Thrust faults and folds attributed to D_2 (e.g. Honeydale Fault), however, appear to be folded by this antiformal structure (Ruitenberg, 1967; Fyffe, 1997), whereas the likely trace of its axial plane appears to be only slightly arched by later events (*see* below). As such, the St. David antiform can be better described as culminating from a megascopic F_3 fold, which produced a coaxial F_2-F_3 interference pattern. Such a pattern may be distinguished on aeromagnetic anomaly maps (i.e. magnetic first vertical derivative, Fig. 5; Kiss et al., 2002), and is observed at mesoscopic scale (Fig 3G). As tentatively suggested by Ludman (1991) in Maine, the surface expression of this megascopic structure, which exposes the northwesterly younging Cookson Group, can be described as the normal limb of an $F_{1\text{-}2}$ fold, coaxially folded into an F_3 antiform.

The Sawyer Brook Fault is interpreted as an inherited, late-D_3, dextral strike-slip fault cutting the southeastern limb of the St. David antiform, possibly in late Acadian time. Shallowly dipping D_2 structures of the St. Croix Terrane are apparently cut by the Sawyer Brook Fault, and have not been observed south of it in study area. The D_3 structures are dominant in the Silurian Oak Bay Subbelt, particularly in the vicinity of the Sawyer Brook Fault, where lithological layering is mostly subparallel to S_3, which dips steeply to the northwest or southeast (Fig. 4C) and locally evolves into a mylonitic fabric (Fig. 6B; *see* below). This fabric, herein ascribed to the regional S_3, is the equivalent of the S_1 depicted by Stringer and Burke (1985, p.18) and Fyffe et al. (1999) for the Silurian rocks in the Oak Bay area.

Finally, megascopic deflection of the St. David antiform (from northeast to east trending) is thought to be related to D_4, although the intrusion of granitic bodies may have also played a role (Ruitenberg, 1967). The effect of F_4 folding is also thought to mark local change of regional orientation and increase or decrease of dip (or plunge) of pre-existing structures. At the mesoscopic scale, F_4 are upright north-northwest-trending chevron folds, with gently plunging axes. These structures appear to, in part, correspond to the minor, northwest-trending, conjugate set of F_3 folds described by

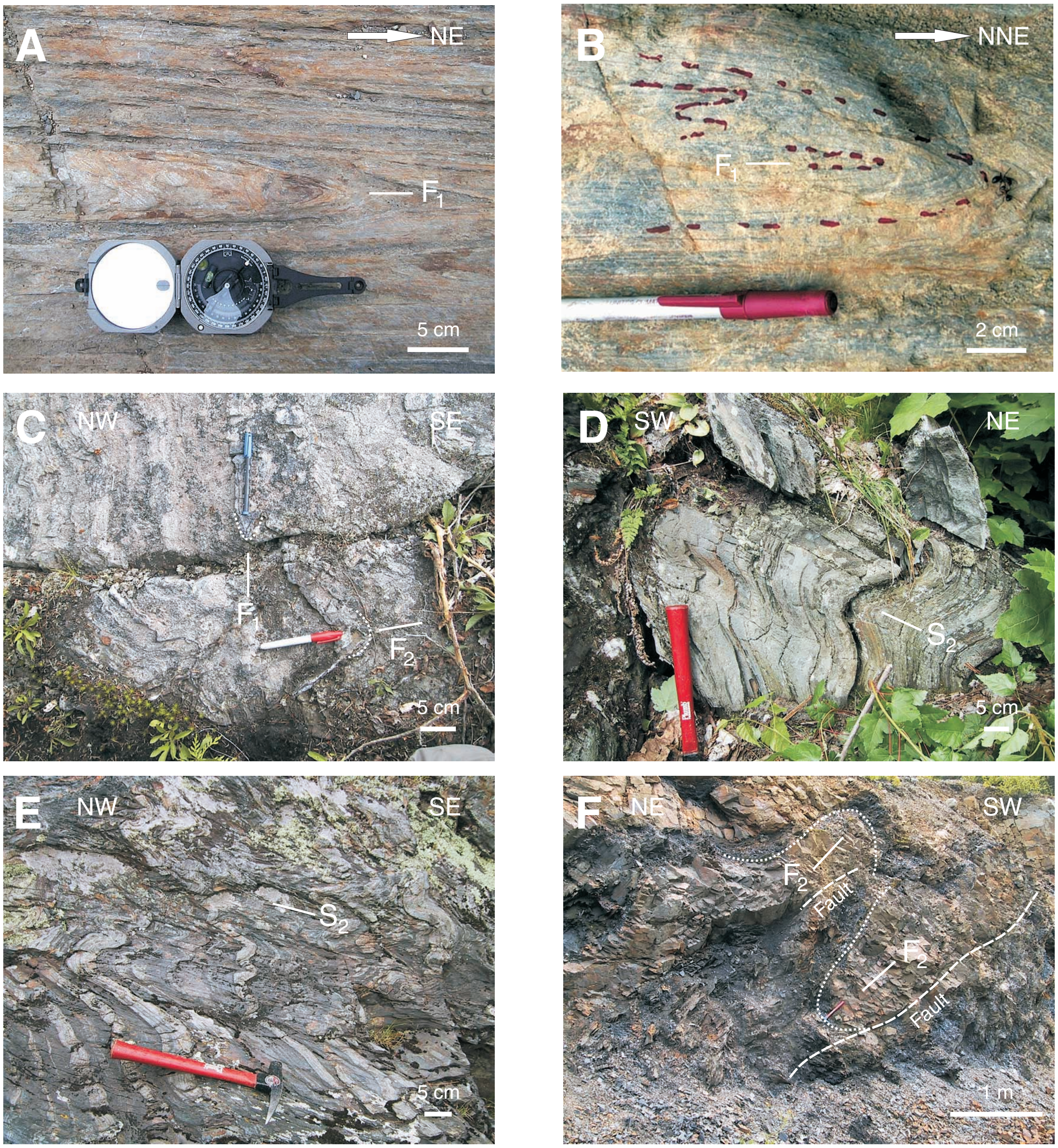


Figure 3. *Representative mesoscopic structural features:* ***A)*** *axial-planar S_{1B} delineating the sheared limbs of an isoclinal intrafolial F_1 fold affecting S_{1A} in metamorphosed silty slates of Kendall Mountain Formation, southwest of Moores Mills;* ***B)*** *isoclinal F_1 folds taken near photo A;* ***C)*** *F_1-F_2 interference pattern, consisting of a close F_2 fold with a gently inclined axial plane affecting the hinge zone of an upright isoclinal F_1, taken near photo A; note the asymmetric F_1 fold along southeastern limb;* ***D)*** *open F_2 fold in the Digdeguash Formation on road 127, south of Lawrence Station;* ***E)*** *F_2 gently plunging to the northeast with shallow, southeast-dipping, axial-planar S_2 in Woodland Formation along the Digdeguash River, Rollingdam area;* ***F)*** *series of moderately inclined, isoclinal F_2 folds with lower limb faulted, Moores Mills quarry.*

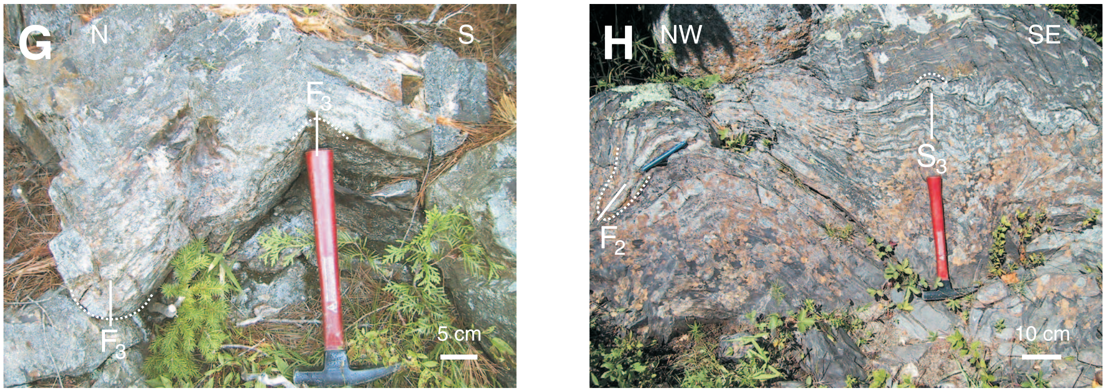


Figure 3. G) *upright F_3 chevron fold, with axis moderately plunging to the east, in the Kendall Mountain Formation along the Digdeguash River, Rollingdam area;* ***H)*** *F_2-F_3 interference pattern, consisting of isoclinal F_2 fold, gently plunging to the northeast, refolded by steeply inclined, open F_3 folds moderately plunging to the northeast in Kendall Mountain Formation along the Digdeguash River, Rollingdam area.*

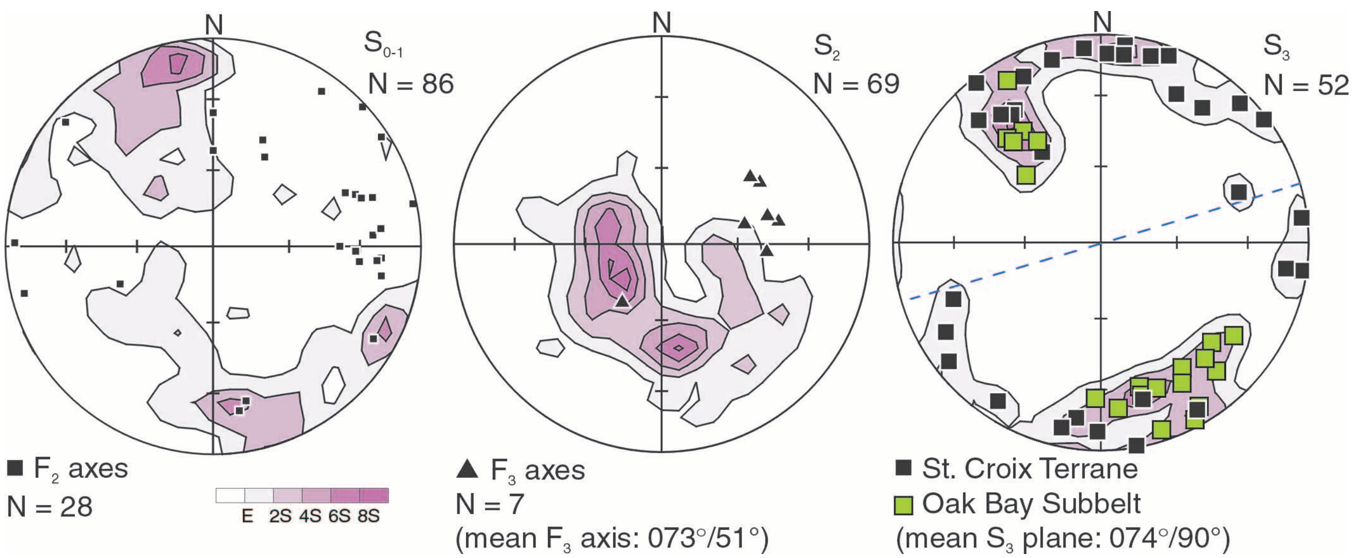


Figure 4. *Stereographic projections (lower hemisphere) of mesoscopic structural elements of the Clarence Stream–Moores Mills area; contours at 2, 4, 6, and 8 standard deviations. See text for discussion. Abbreviation: N, number of data points.*

Ruitenberg (1967), although their documented plunges markedly differ. Consequently, the late kink bands, which are conspicuous in the laminated rock units of the Fredericton Belt (e.g. Flume Ridge Formation; Ruitenberg, 1967) would be considered herein as D_5 structures. The D_4 structures are geometrically compatible, and possibly coeval, with numerous north-northwest-trending late transverse structures, such as the Oak Bay Fault, main displacement on which has been interpreted as Early Jurassic in age (cf. Fyffe et al., 1999).

CLARENCE STREAM GOLD OCCURRENCES

Several gold occurrences, showing a spatial relationship with Devonian granitoid intrusions, have recently been discovered in southwestern New Brunswick (Fig. 1, 2; McLeod and Fyffe, 2002). The Ordovician Kendall Mountain Formation hosts mineralization in several zones of Anomaly A (Hoy, unpub. rept., 2002; Watters and Castonguay, work in progress, 2003). Other showings have also been found near the

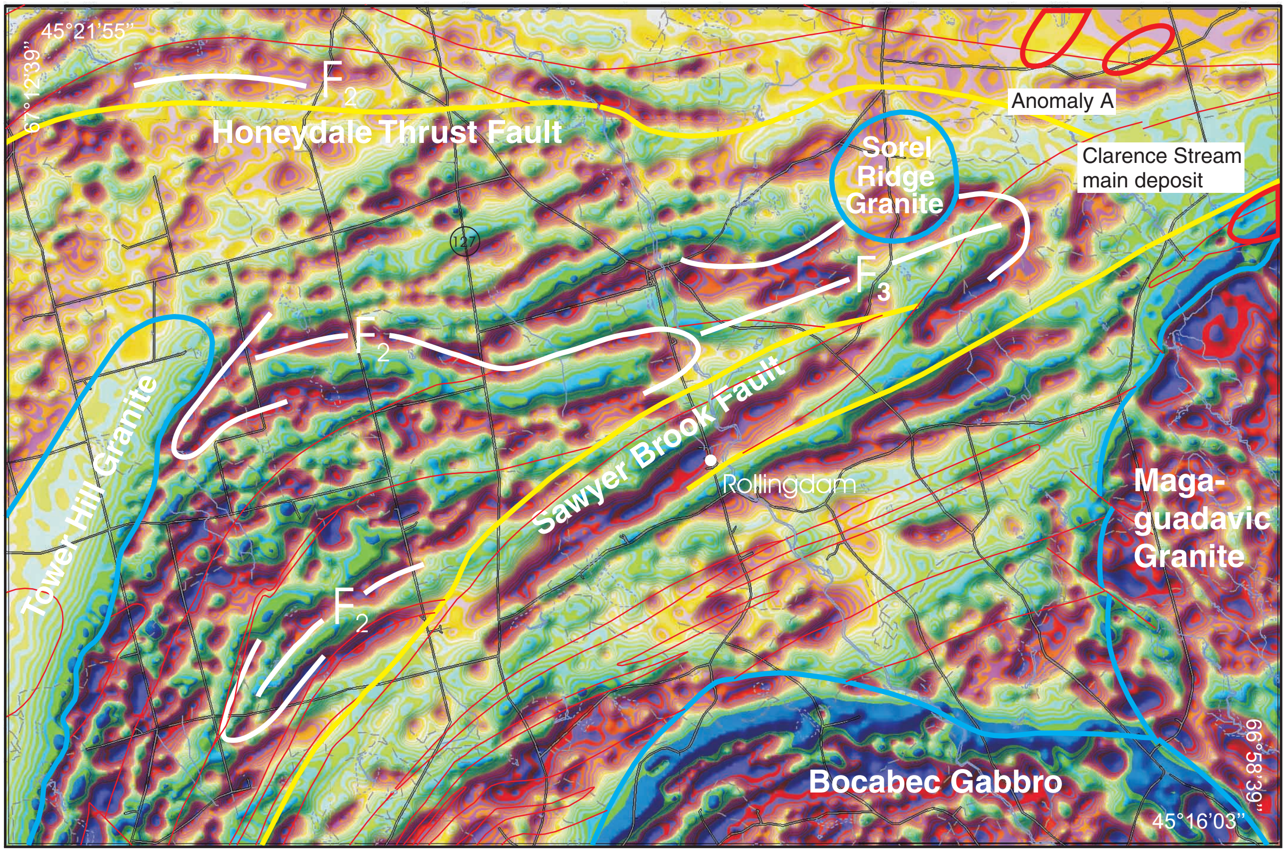


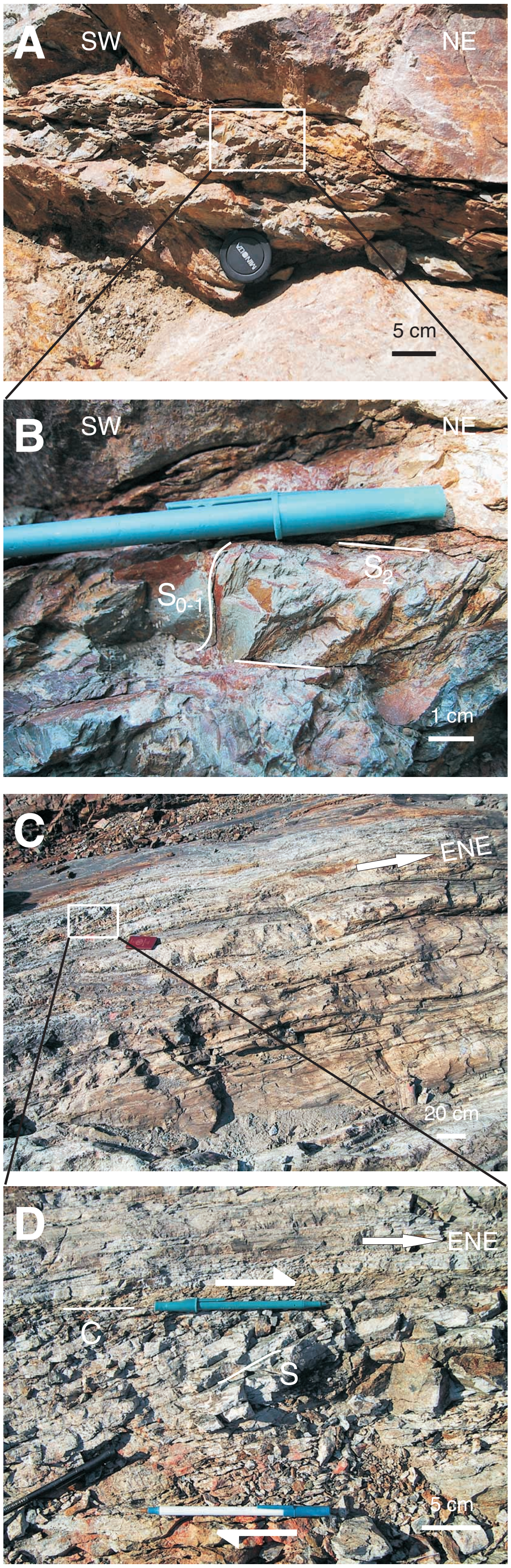
Figure 5. *Aeromagnetic first vertical derivative map of parts of the study area, with outline of possible fold closures showing indication of a coaxial fold interference pattern within the Cookson Group (*modified from *Kiss et al., 2002; geology* modified from *Fyffe, 1997). The first vertical derivative has the effect of accentuating the shorter wavelength (shallower source) components of the magnetic field. See text for discussion.*

contact between the Calais and Woodland formations east of the Tower Hill Granite (Ravenelle, unpub. rept., 2002). South of the Sawyer Brook Fault, gold mineralization occurs in the Silurian Waweig Formation, fringing and within the contact aureole of the Magaguadavic Granite, along the West, Central, and East zones of the Clarence Steam main deposit (Thorne and Lentz, 2001; Thorne et al., 2002).

Anomaly A: mineralization and structural controls

Mineralization in the Anomaly A zones is mostly hosted by stockwork and massive quartz-sulphide veins and hydrothermal breccia units in interstratified argillite and wacke of the Kendall Mountain Formation (Fig. 2). No intrusive rocks have been yet described at Anomaly A. Gold is mainly hosted by quartz-sulphide veins; other minerals include mainly pyrrhotite, arsenopyrite, pyrite, and stibnite (Watters and Castonguay, work in progress, 2003). Stratigraphic top reversals and fold crests that have been observed in many drill-core sections (Lutes, unpub. rep., 2002; Watters and Castonguay, work in progress, 2003) are interpreted to be the result of superposed (?)F_1 and/or F_2 isoclinal folds with moderately inclined, north-dipping axial surfaces.

Mineralization is commonly structurally controlled by gently to moderately north-dipping brittle fault zones (Fig. 6A, B) that are locally coincident with the argillite-wacke interface and most probably intersect lower limbs of genetically related F_2 folds. These high-strain zones may be associated with regional structures, such as the Honeydale or Cranberry Lake faults, that are interpreted to occur in the vicinity of Anomaly A (Fig. 2; Fyffe, 1997, McLeod et al., 1998). In addition, Anomaly A is nearly coincident with the extension of the axial trace of the F_3 St. David antiform (Fig. 2). Locally at Anomaly A, a subvertical spaced cleavage, tentatively correlated to S_3, is subperpendicular with an earlier bedding-parallel fabric, thus indicating that the area could be located near the hinge of an F_3 structure. The overall structural style of mineralized zones at Anomaly A is interpreted to be compatible with D_2 thrust-related deformation documented regionally and observed at mesoscopic scale in some localities (e.g. Moores Mills quarry; Fig. 2, 3F). Mineralization in other showings, such as those reported east of the Tower Hill Granite (Ravenelle, unpub. rept., 2002) and which coincidently occur near the axial region of the St. David antiform, are apparently hosted (or have been remobilized?) in dilatant structures associated with mesoscopic F_3 folds (as suggested by Ruitenberg, 1967, 1972).



Clarence Stream main deposit: mineralization and structural controls

At the Clarence Stream main deposit, gold is associated with arsenopyrite, pyrrhotite, pyrite, and a variety of antimony minerals, which are disseminated throughout the host rocks but occur predominantly in recrystallized quartz veins and locally in pegmatite or aplite dykes (Thorne and Lentz, 2001; Thorne et al., 2002). The occurrence of mineralized quartz veins is influenced by the competency of gabbroic dykes (East Branch Brook suite; Thorne and Lentz, in press) that intrude the Silurian Waweig Formation, whereas the present geometry of quartz veins (commonly boudinaged and transposed) is controlled by dextral, mylonitic, and brittle-ductile shear zones that dip steeply to the north-northwest (Fig. 6C, D; Thorne and Lentz, 2001; Park, unpub. rept., 2001). These high-strain corridors are interpreted as splays genetically related to the late D_3, northeast-trending Sawyer Brook Fault. The Z-folds produced by asymmetric deformation of quartz veins are genetically compatible with the dextral kinematics of these shear zones. This deformation induced remobilization and recrystallization of some mineralization constituents within the veins (Thorne and Lentz, 2001). A locally well developed, down-dip stretching lineation is defined by the alignment of volcanic clasts within agglomeratic units and metamorphic minerals (cordierite and andalusite porphyroblasts; Thorne and Lentz, 2001). The intrusive phase responsible for the metamorphic assemblage has yet to be determined and may be attributed to the local granitic intrusions or widespread gabbroic bodies. Similarly, the relative timing between the dip-slip deformation that induced the lineation and the dextral kinematic indicators expressed by neighbouring shear zones is not clearly understood.

DISCUSSION AND IMPLICATIONS FOR EXPLORATION

Gold occurrences in the Clarence Stream–Moores Mills area are spatially associated with granitic intrusions, and are found in a variety of local tectonomagmatic settings (McLeod and Fyffe, 2002). In the Ordovician Cookson Group of the St.

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Figure 6. *Examples of deformational features having geometric or structural controls on mineralization:* ***A)*** *D_2 brittle shear zone gently to moderately dipping to the west-northwest, associated with brecciated mineralized zone, at the Murphy zone of Anomaly A;* ***B)*** *close-up of photo A, showing bedding-parallel fabric (?)S_{0-1}, overprinted by S_2 or related shear fabric;* ***C)*** *mylonitic D_3 shear zone, dipping steeply to the north-northwest, which contains and deforms mineralized quartz veins in felsic rocks of the Waweig Formation, trench 1 of the Clarence Stream main deposit;* ***D)*** *close-up of photo C, showing a C-S fabric with an apparent dextral shear sense.*

Croix Terrane, gold mineralization occurs in quartz veins and breccia units genetically associated with thrust-related, D_2 brittle shear zones, or possibly remobilized in dilatant structures of F_3 fold hinges. Some of the conspicuous, folded linear anomalies shown on aeromagnetic first vertical derivative maps of the area (Fig. 5; Kiss et al., 2002) may represent mineralized high-strain zones. These zones could represent intraformational faults that are not necessarily delineated by lithological or facies changes.

In the Oak Bay Subbelt, mineralization within the Waweig Formation adjacent to the Sawyer Brook Fault is spatially associated with late-D_3 high-strain zones and often borders or is enclosed within competent tabular gabbro of the East Branch Brook suite. The latter evidently acted as rigid bodies, thus inducing strain shadows favourable for preservation of mineralized quartz veins.

The relative timing between the deformation phases that structurally or geometrically control the mineralization (mostly D_2 and D_3) and the age of the suspected progenitor intrusion (i.e. late Early Devonian Magaguadavic Granite; McLeod et al., 1994; Thorne et al., 2002) is still unresolved. Ruitenberg (1967) stated that D_3 predated or was at least contemporaneous with the intrusion of the Tower Hill Granite (Fig. 2), which is, within analytical error, the same age as the Magaguadavic Granite. Mineralization at Anomaly A, however, is apparently structurally controlled by earlier D_2 structures, whereas mineralized quartz veins and aplitic dykes at the Clarence Stream main deposit appear to have undergone intense D_3 deformation. This suggests that the relative age of the original gold mineralization event has to be not younger than late D_2 in the actual scheme of the regional structure.

Despite evidence for an intrusion-related origin for the gold deposits in the area (*see* discussion in Thorne and Lentz, 2001; Thorne et al., 2002), the distinct stratigraphic assemblages, polyphase nature, and location of structures hosting the gold mineralization imply that exploration strategy should not be merely restricted to the proximity of specific intrusions or shear zones. Lithological and/or structural controls on gold mineralization, as succinctly described above, may also be used as prospecting tools to identify potential targets in surrounding areas.

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