Geology of the Weymouth - Church Point Area (NTS 21A/05 and 21B/08), Southwest Nova Scotia

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Introduction

Bedrock mapping in the Weymouth - Church Point area (Fig. 1a) was conducted during the 1999 field season. This mapping project is part of a regional program by the Nova Scotia Department of Natural Resources to produce 1:50 000 scale bedrock maps of the lower to middle Paleozoic rocks in the Digby-Yarmouth-Shelburne area (Fig. 1b). An overview of the mapping program, as well as the results of mapping in the Digby area (NTS map area 21A/12, Fig. 1a), is provided in White *et al.* (1999).

Outcrop exposure in the Weymouth - Church Point area is generally poor. Most of the area has a low topographic relief and is covered by glacial deposits (Stea *et al.*, 1992; Finck *et al.*, 1992). Areas of good exposure are limited to the Sissiboo River and a few coastal sections along St. Marys Bay (Fig. 2).

Cambrian-Devonian Metamorphic Rocks

Introduction

Metamorphic units include, from oldest to youngest, the Meguma Group, comprising the Goldenville and Halifax formations, the White Rock Formation and the Torbrook Formation (Fig. 2). This sequence is apparently conformable and has been folded into regional-scale, north-northeast-trending folds (Fig. 2). Field work in 1999 has resulted in significant changes to previous maps, most notably re-assignment of some units, subdivision of the Halifax Formation into three members, and recognition of a regional-scale shear zone overprinting regional folds. The interpretation presented here accounts, in the simplest way, for the distribution of the units identified, where the distribution of the Halifax, White Rock and Torbrook formations represents an extension of the Bear River Syncline defined northeast of the current study area (NTS map area 21A/12, Fig. 1; White *et al.*, 1999). The syncline plunges moderately to the northeast in the northeast part of the map area, with the distribution of stratigraphic units consistent with a change in structural level (Fig. 2). The area of White Rock Formation (Taylor, 1969) or White Rock - Kentville Formation rocks (MacDonald and Ham, 1994) exposed in the upper reaches of the Sissiboo River is interpreted here as Halifax Formation (Sissiboo member, see below), locally with thick (up to approximately 50 m) mafic sills.

Map Units

Goldenville Formation

The Goldenville Formation is the most extensive unit mapped, underlying the western part of the study area (Fig. 2). Exposure, is limited, however, and the following discussion largely reflects the cross-section exposed along Sissiboo River and in coastal exposures along St. Marys Bay.

The Goldenville Formation consists mainly of medium- to thick-bedded metasandstone, lesser green metasiltstone, and rare black slate, similar to the Goldenville Formation elsewhere in the Meguma Terrane (e.g. Schenk, 1995). Proportions of metasandstone and metasiltstone are highly variable. Typically this unit is characterized by regularly interbedded metasandstone and thin metasiltstone beds (Fig. 3a); however, sections of up to 50 m consisting mainly of metasiltstone, and extensive sections (hundreds of metres) where metasiltstone beds are rare and thin (~1-5 cm) occur. The lack of along-strike exposure and distinct marker horizons, combined with structural repetition by folding, makes determination of any stratigraphic significance in variation in the ratio of metasandstone vs. metasiltstone difficult.

Metasandstone beds are typically massive, although sedimentary structures occur locally, including planar laminations, cross bedding and cross-trough stratification. Grain size is often difficult to determine in the field, although the rock generally appears to consist of fine to medium sand. However, local lenses of coarse sand to fine-grained conglomerate (Fig. 3b) occur in coastal exposures south of Gilberts Cove, Cape Firmain and Little Brook (Fig. 2). These occurrences of relatively coarse sediment lie along a strike-parallel trend and likely represent the same stratigraphic level; conceivably they may define a useful

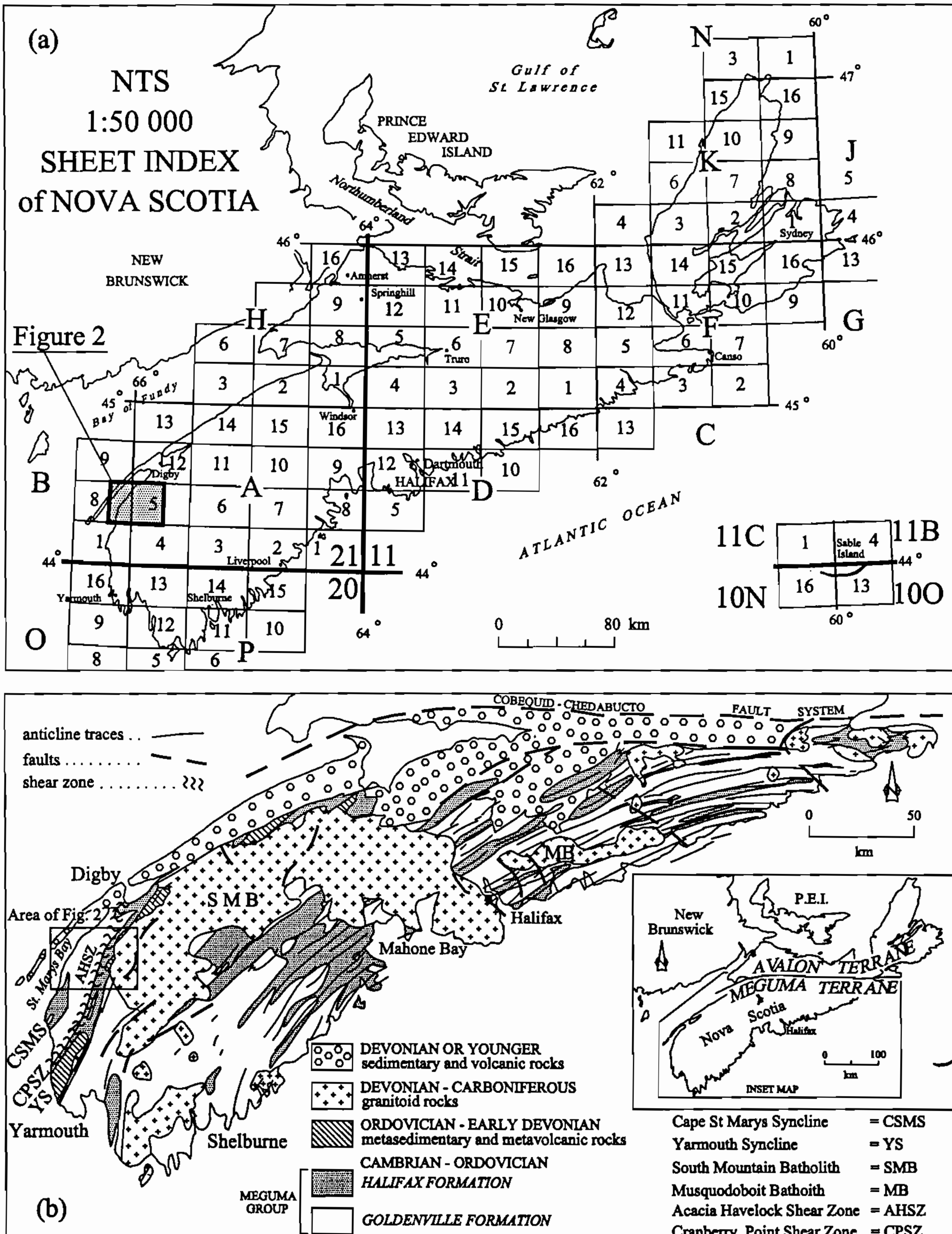


Figure 1. (a) NTS index map of Nova Scotia showing the boundary of the map area. (b) Simplified geology map of the Meguma Terrane showing the location of the map area.

marker horizon in an otherwise monotonous sequence. Metasiltstone beds are typically greenish and massive to very thinly bedded.

Concretions are abundant in metasandstone layers and occur throughout the entire section. There is no apparent variation in abundance of concretions within any part of the stratigraphy. It is possible that this reflects fold repetition of a thin stratigraphic section where concretions are abundant; however, up to 1 km of continuous strata are exposed on some fold limbs along the Sissiboo River. Concretions vary widely in shape, the most common occurring as bedding-parallel sheets with abrupt lateral terminations, and as cylinder-shaped or football-shaped concretions with their long axes within the bedding plane and parallel to the fold hinge (Figs. 3c, d). The composition and origin of the concretions are not known, although many are calcareous. Concretion boundaries cross-cut sedimentary structures and they are cleaved, suggesting a probable pre-tectonic, diagenetic origin.

Halifax Formation

The Halifax Formation in the map area has been subdivided into three lithologically distinct, conformable units, described below from oldest to youngest.

Bloomfield Member

The Bloomfield member is the lowermost unit of the Halifax Formation and is exposed along the western margin of the Bear River Syncline in the southern part of the map area. The Bloomfield member is also represented by clasts in till in the northern part of the map area (Fig. 2). This unit is not exposed, but inferred along the eastern margin of the Bear River Syncline in the southern portion of the map area (Fig. 2). The contact with the underlying Goldenville Formation is not exposed, but it is assumed to be gradational.

Till clasts in the north consist of distinct maroon and green, locally variegated, thinly bedded metasiltstone, similar to exposures of the Bloomfield member found along strike in the Digby area (White *et al.*, 1999). Exposures of this unit in the south part of the map area consist of green, very thinly to thinly bedded metasiltstone, similar to the green portion of this unit in the north part of the area.

Cunard Member

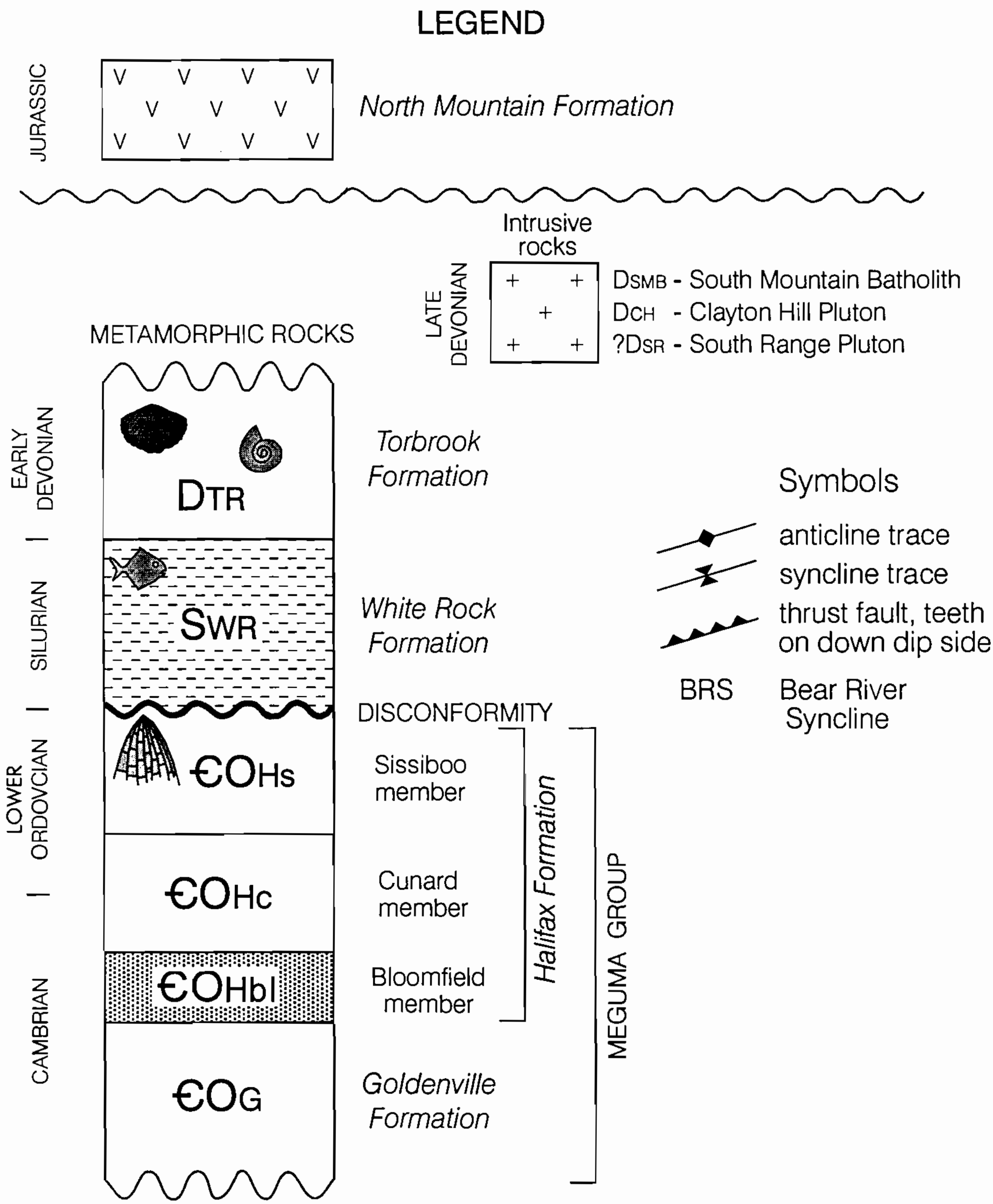
The Cunard member occurs along the entire length of the Bear River Syncline in the map area, although it varies in distribution depending on the structural level of exposure. The Cunard member is the dominant unit of the Bear River Syncline in the south, where the structural level is lower and the syncline is subhorizontal. However, this unit is restricted to the margins of the syncline at higher structural levels in the north, where the syncline plunges moderately to the northeast (Fig. 2). The Cunard member occurs above the Bloomfield member and a conformable relationship is assumed. The Cunard member consists of mainly dark (black), very thinly bedded slate and lesser thin- to medium-bedded metasandstone. Sulphide minerals (pyrite, pyrrhotite) are common to locally abundant.

The Cunard member occupies the same stratigraphic position as the Acacia Brook member in the Digby area (White *et al.*, 1999), which mainly consists of very thinly bedded grey slate. We interpret the Cunard member to represent a lateral facies equivalent of the Acacia Brook member. This unit is typical of the Cunard member elsewhere in the Meguma Group (e.g. Waldron, 1992; Schenk, 1995).

Sissiboo Member

The Sissiboo member is exposed along the upper section of the Sissiboo River, and occupies the core of the Bear River Syncline at this structural level (Fig. 2). Our interpretation in this area is markedly different from that shown on previous maps, which show White Rock Formation rocks along the Sissiboo River in the area east of 'The Bend' (Fig. 2; Taylor, 1969; MacDonald and Ham, 1994). The current interpretation is based on the fact that structural continuity across the syncline demands stratigraphic repetition (in Taylor's interpretation White Rock Formation is shown on the east limb and Halifax Formation on the west limb of the syncline) and a lack of variation in lithology. Exposure east of 'The Bend', previously assigned as White Rock Formation, is limited to only a few outcrops of mafic sills (noted by Taylor, 1969) and metasiltstone within the contact aureole of the South Mountain Batholith (see below). This makes differentiation of these rocks as belonging to the White Rock Formation based on lithology difficult. Taylor also reported mafic volcanic rocks in this area; however, our mapping shows these rocks are actually mafic sills.

The Sissiboo member consists of planar stratified, interbedded, very thin to thin bedded grey slate and pale grey metasiltstone beds, resulting in a distinct colour banding (Fig. 4a). Metasiltstone beds generally are characterized by cross-bedded sedimentary structures (Fig. 4a), whereas slate is planar laminated. Although the Sissiboo member is distinct from the Bear River member described in the Digby area (White *et al.*, 1999), the two units are lithologically and sedimentologically similar (e.g. interbedded slate - metasiltstone; thin cross-bedded metasiltstone) and


LEGEND
JURASSIC
North Mountain Formation
Intrusive rocks
LATE DEVONIAN
DSMB - South Mountain Batholith
DCH - Clayton Hill Pluton
?DSR - South Range Pluton
METAMORPHIC ROCKS
EARLY DEVONIAN
DTR
Torbrook Formation
Symbols
anticline trace
syncline trace
thrust fault, teeth on down dip side
SILURIAN
SWR
White Rock Formation
BRS
Bear River Syncline
DISCONFORMITY
LOWER ORDOVICIAN
€OHs
Sissiboo member
€OHc
Cunard member
Halifax Formation
MEGUMA GROUP
CAMBRIAN
€OHbl
Bloomfield member
€OG
Goldenville Formation

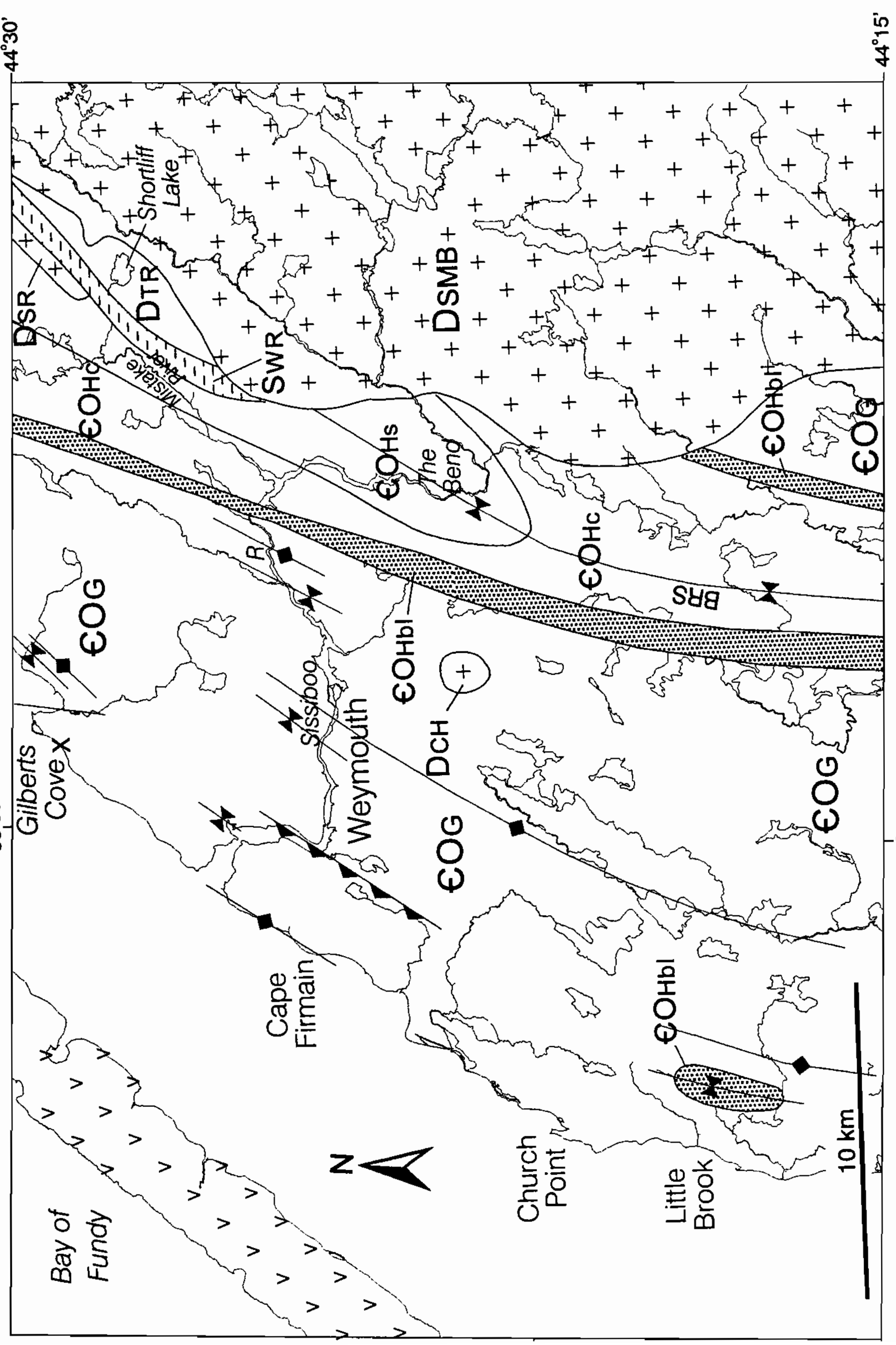


Figure 2. Simplified geology map of the Weymouth - Church Point area.

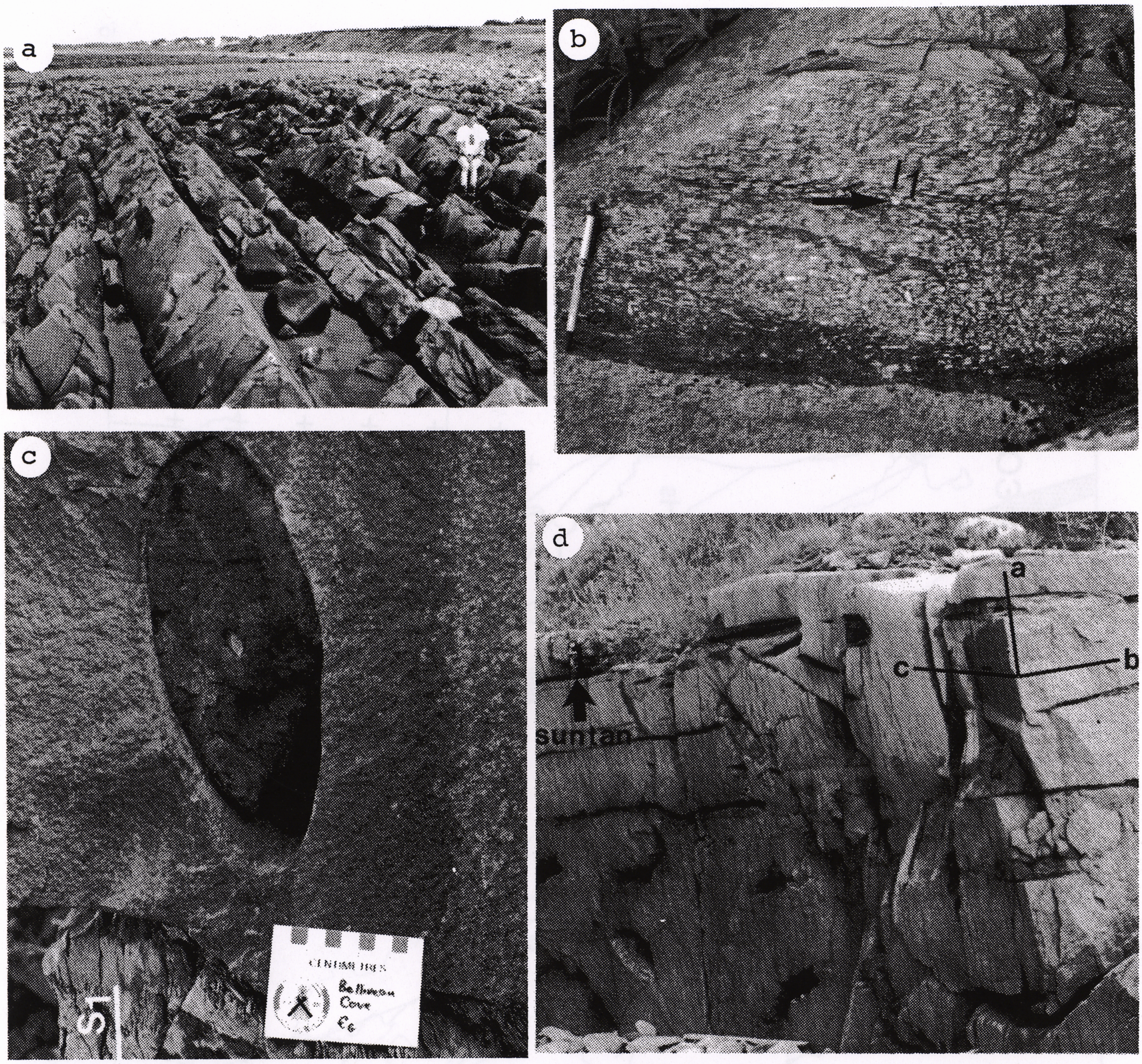


Figure 3. (a) Photograph of an outcrop of typical Goldenville Formation rocks, consisting of medium- to very thick-bedded metasandstone and interbedded thin- to medium-bedded metasiltstone. (b) Photograph of mud chip metaconglomerate in the Goldenville Formation. Mud chips are stretched parallel to the fold hinge (arrow, l_1). (c) Photograph of concretion in fold profile view showing the apparent flattening parallel to fold-related cleavage (S_1). (d) Photograph of Goldenville Formation outcrop showing several concretions. Fold axis indicated, with a-c defining the fold profile and a-b the axial plane (here parallel to cleavage, S_1); bottle of suntan lotion for scale.

occur at the same stratigraphic position. Thus, we interpret them to represent facies variations of the same stratigraphic unit.

White Rock Formation

The White Rock Formation is exposed along Mill Brook (which flows west from Shortliff Lake, Fig. 2) where it is represented by thick (several metres), massive quartzite beds, characteristic of this unit, and interbedded metasiltstone and marly metasiltstone. Recognition of the White Rock Formation in this area is consistent with along-strike extension of this unit from the Bear River area to the northeast (White *et al.*, 1999). The relationship with the Sissiboo member is unknown, although a disconformity between the Halifax and White Rock formations was proposed in the Bear River area (White *et al.*, 1999; Horne *et al.*, 2000).

Torbrook Formation

The Torbrook Formation occurs in the northeast part of the map area, underlying the area south of the White Rock Formation. A single outcrop of Torbrook Formation rocks occurs on the south side of Shortliff Lake (Fig. 2) and this unit was intersected in diamond-drill holes on the north and south sides of Shortliff Lake (Dakers, 1982). Abundant angular boulders of this unit occur along the road southwest of Shortliff Lake. In the map area, the Torbrook Formation consists of metasiltstone, locally characterized by beds with abundant well preserved macrofossils, including brachiopods, pelecypods, gastropods, crinoids and other shell fragments (Fig. 4b). Fossils are typically well preserved, displaying only minor strain. As with the White Rock Formation, the distribution of the Torbrook Formation is consistent with along-strike continuity of this unit from the Bear River area (White *et al.*, 1999).

Intrusive Rocks

South Mountain Batholith

The South Mountain Batholith in the study area has been mapped by MacDonald and Ham (1994) and was not systematically addressed during this study. However, some mapping was conducted along new logging roads and generally supported the distribution of units (biotite monzogranite and granodiorite) shown by MacDonald and Ham (1994).

Clayton Hill Pluton (Leucomonzogranite)

The Clayton Hill pluton consists of a small intrusion south of Weymouth Falls (Fig. 2). There is no exposure of the pluton; however, its distribution is reasonably well constrained by till clasts (Fig. 5a, Table 1; Finck *et al.*, 1994). Exposure of granite till is particularly well presented along a new woods road on the west side of Highway 340, which cuts across the proposed limits of the pluton, and in gravel pits on the north side of the road to Danvers, just east of Highway 340 (Fig. 5a). The pluton was also outlined on the basis of boulder distribution by Dakers (1982). The Clayton Hill pluton, as defined by till clasts and boulders in this study, occurs in an area of low response in the aeromagnetic data (Fig. 5b).

The Clayton Hill pluton consists of massive, medium-grained, equigranular leucomonzogranite. The term leucomonzogranite is adopted from MacDonald *et al.* (1992) and indicates a granite-syenogranite composition with 4-6% mafic minerals. The Clayton Hill pluton is comparable to medium-grained leucomonzogranite units in the South Mountain Batholith. Small (typically 2-10 mm) miarolitic cavities occur throughout the intrusion, locally accounting for a few percent by volume. Oxidation stains around the miarolitic cavities resulted from weathering of sulphide minerals (pyrite, chalcopyrite) within the cavities. Pegmatite dykes and quartz veins are common in the leucomonzogranite boulders throughout the area, the latter often containing coarse sulphides (see below for details). The abundant miarolitic cavities, pegmatite and quartz veins in this intrusion indicate it was relatively fluid-rich at the time of crystallization. Certainly the abundance of miarolitic cavities, veins and pegmatite dykes is high in comparison to most fine- to medium-grained leucomonzogranite units in the South Mountain Batholith (R. J. Horne, personal observation). The age of the Clayton Hill pluton is unknown; however, the pluton is similar to rocks of the South Mountain Batholith and it may have a similar Devonian-Carboniferous age.

South Range Pluton (Diorite)

Outcrop of a medium-grained mafic intrusive rock occurs just north of Shortliff Lake. The composition of this unit has not been determined, although Dakers (1982) reported the occurrence of olivine diabase and amygdaloidal basalt in this area. Dakers (1982) suggested the diabase reflects a sill and interpreted the basalt to represent the White Rock Formation. MacDonald and Ham (1994) show a mafic intrusion in the area, indicating the presence of gabbro, quartz gabbro and peridotite boulders.

The relationship between the mafic intrusive rocks and the Torbrook and White Rock formations is unknown. However, the outcrop of mafic intrusive rock observed is characterized by abundant slickensided fractures, commonly coated with epidote, suggesting a possible fault contact. This could explain the apparent strike-parallel contact of this intrusive unit.

Mafic Sills

A few mafic sills occur within the map area, but they are notably less common than in the Bear River area where they are abundant (White *et al.*, 1999). Thick, medium to coarse sills are exposed in the Sissiboo member along the Sissiboo River east of 'The Bend'. These sills are locally foliated and highly fractured, possibly reflecting a north-northeast-trending fault along this segment of the river, as proposed by MacDonald and Ham (1994).

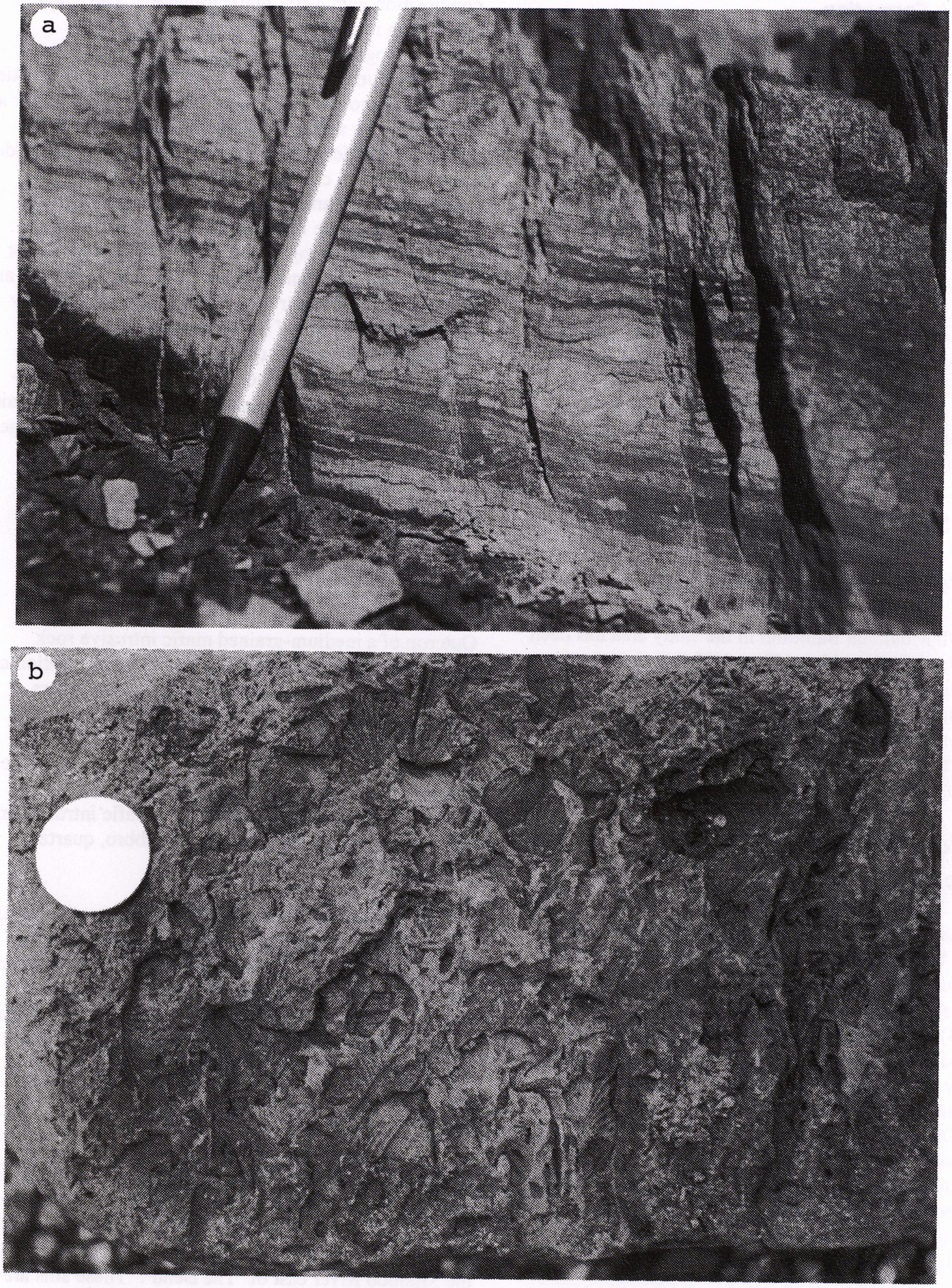


Figure 4. (a) Photograph of outcrop of the Sissiboo member, Halifax Formation, showing typical colour-banding defined by interbedded dark slate and pale coloured metasiltstone layers, the latter with features which may reflect wavy and ripple-bedded forms and bioturbation (R. Naylor, personal communication, 1999). (b) Photograph of bedding surface on fossiliferous rock of the Torbrook Formation (quarter for scale).

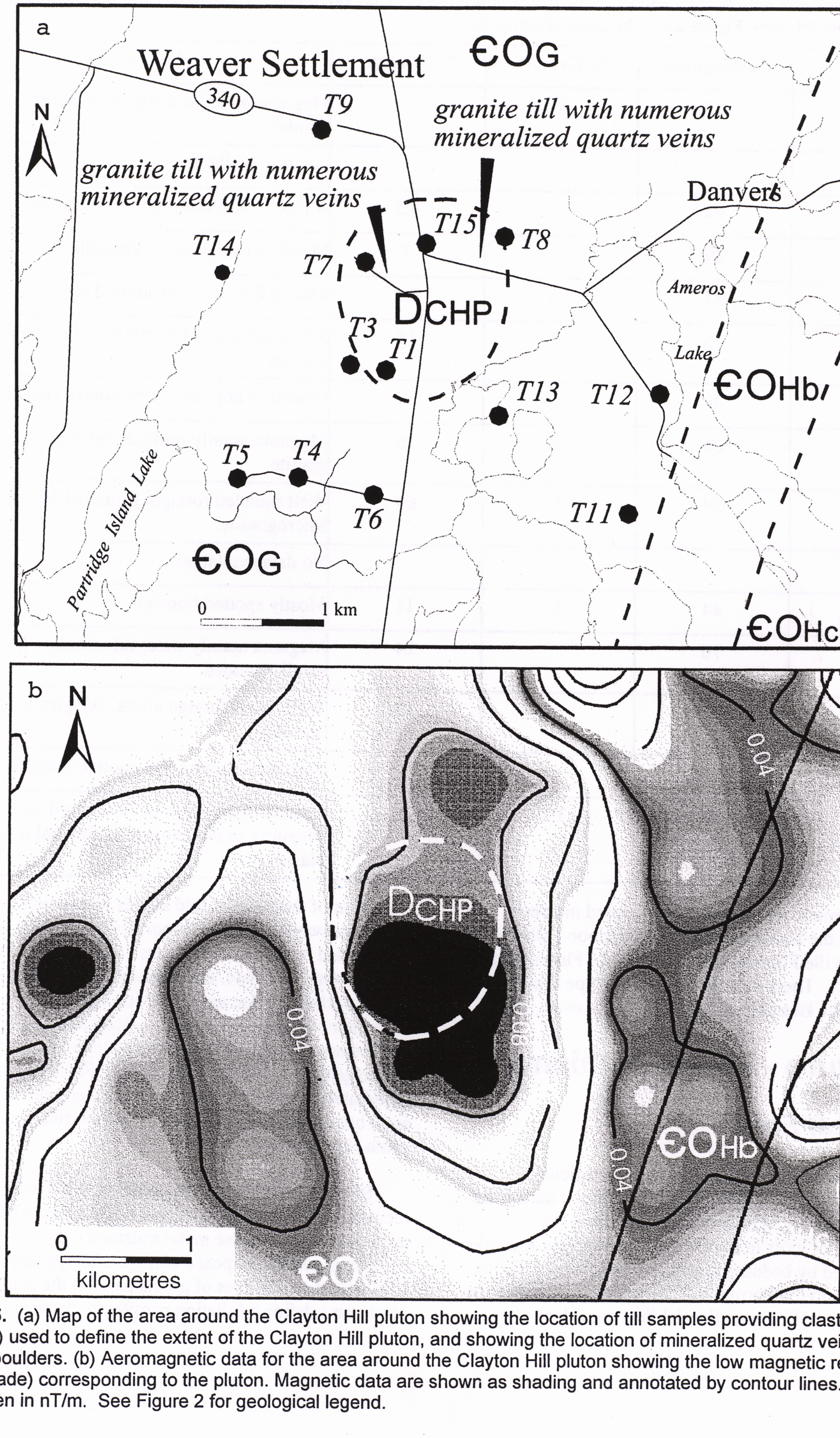


Figure 5. (a) Map of the area around the Clayton Hill pluton showing the location of till samples providing clast lithology (Table 1) used to define the extent of the Clayton Hill pluton, and showing the location of mineralized quartz veins cutting granite boulders. (b) Aeromagnetic data for the area around the Clayton Hill pluton showing the low magnetic response (dark shade) corresponding to the pluton. Magnetic data are shown as shading and annotated by contour lines. Contour data given in nT/m. See Figure 2 for geological legend.

Table 1. Results of pebble clast counts for till samples around the Clayton Hill Pluton. Values given as a percentage of total clast content. See Figure 5a for location of samples.

	% Meguma	% Granite	% Foreign	Comments
T1	55	45		Meguma includes abundant hornfels. Angular granite.
T2				No data available.
T3	92	3.5	4.5	Almost completely spotted hornfels.
T4	89	4	7	Mainly subangular Goldenville.
T5	87	4.5	8.5	Mainly hornfels and some skarn.
T6	75	11	14	Abundant spotted hornfels. Granite is angular.
T7	6	94		Granite is angular. Nine quartz vein clasts.
T8	66	18	16	Meguma mainly spotted hornfels. Angular granite.
T9	29	2	69	Well rounded foreign. Rounded Meguma. Microgranite.
T10				No data available.
T11	84	5	11	Mostly spotted hornfels.
T12	76		24	Meguma mainly slate, subrounded. Foreign small, rounded.
T13	7		93	Well round foreign clasts. Meguma is spotted hornfels.
T14	100			Angular Meguma, not spotted hornfels.
T15	63	33	4	Granite highly altered, hematized, chloritized. Meguma spotted hornfels. Several quartz vein clasts.

A few mafic sills occur in the Cunard member exposed on the Sissiboo River near Sissiboo Falls and in the Goldenville Formation exposed in the Firmain Point area (Fig. 2). These sills are similar to Type II sills defined in the Bear River area (e.g. White *et al.*, 1999).

Structure - Metamorphism

Regional Folds

The dominant structures of the area are regional, kilometre-scale folds (Figs. 2, 6a) developed during the Acadian Orogeny. Folds are apparent from the distribution of units in the Bear River Syncline and have been defined by bedding and cleavage data (Fig. 6b, c) in the Goldenville Formation. However, poor exposure in the Goldenville Formation inhibits confident extension of the trace of fold hinges in this unit. Axial planar cleavage trends north-northeast (Fig. 6b) and is represented by a fine, continuous cleavage in metasiltstone and slate, and a spaced cleavage in metasandstone. Cleavage refraction occurs between slate intervals, where cleavage is steep and axial planar, and metasandstone beds, where cleavage defines a convergent fan about the axial plane. Folds plunge moderately to the northeast in the northern part of the area, but are shallow plunging to subhorizontal in the south (Fig. 6a, b).

Significant hinge-parallel extension is locally recorded by stretched quartz and feldspar grains and mud chips in the coarse metasandstone - metaconglomerate exposed along St. Marys Bay (Fig. 3b); the long axes of grains parallel the fold hinge. Mud chips define a foliation parallel to cleavage,

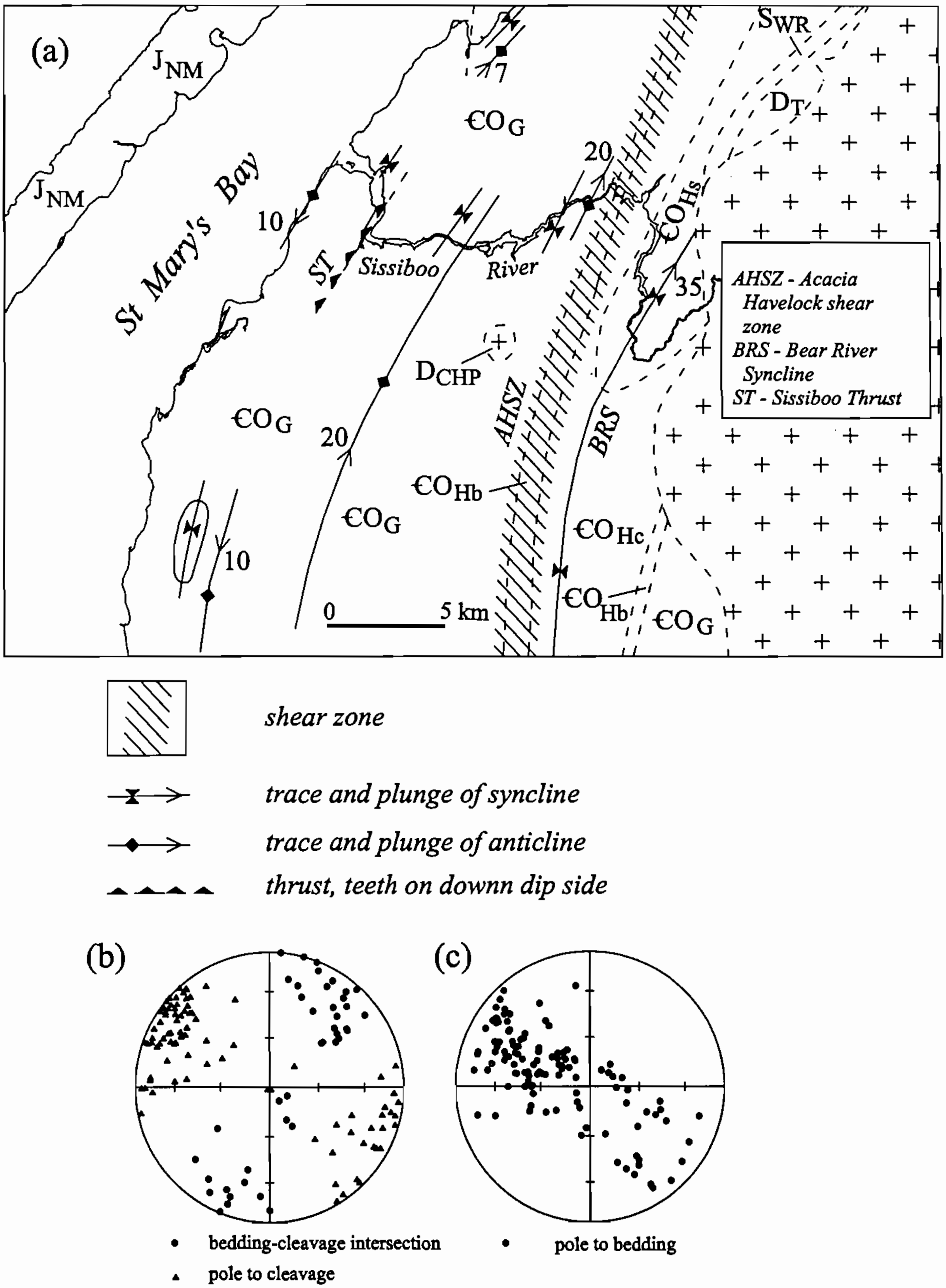


Figure 6. (a) Simplified map of the area showing the distribution of major folds, faults and shear zones. See Figure 2 for legend. (b) Stereoplots of bedding-cleavage intersection and poles to cleavage and (c) poles to bedding for the area. See Figure 2 for legend.

suggesting a fold-related origin for stretching. Concretions in metasandstone beds of the Goldenville Formation also have shapes that are geometrically related to the fold. In profile, concretions commonly have ellipsoid shapes with the long axis parallel to the cleavage plane (Fig. 3d). Many concretions have cylindrical shapes with their long axes parallel the fold hinge; even tabular, bedding-parallel concretions generally have a long axis parallel to the fold hinge (Fig. 3d). These shapes are consistent with fold-related strain, where shortening is perpendicular to cleavage and extension is down-dip and hinge-parallel. Using concretions as strain markers is problematic, as they are highly variable in shape, precluding confident estimates of original shapes. However, consistency in the finite shape of concretions suggests that the apparent flattening and elongation define the axis of fold-related strain.

Metamorphism

Regional metamorphism is within the greenschist or sub-greenschist facies, with cleavage defined by fine-grained mica. Porphyroblasts of biotite, illmenite, magnetite and chlorite overgrow cleavage in metasiltstone and slate throughout the area (Fig. 7a). Pressure shadows on porphyroblasts record variable cleavage-parallel, down-dip strain consistent with folding-related strain. However, the timing of porphyroblast growth with respect to regional deformation and cleavage formation is uncertain.

Well developed contact aureoles occur in the immediate area adjacent to the South Mountain Batholith and the Clayton Hill pluton. These aureoles are defined by biotite±cordierite± andalusite hornfels (Fig. 7b). Similar hornfels zones are locally developed in areas away from the exposed intrusions, notably around Weymouth Falls and Gilberts Cove (Fig. 7c), suggesting buried intrusions in these areas. This interpretation would also provide an explanation for skarns occurring in these areas (see Mineral Occurrences).

Sissiboo Thrust

A thrust fault is proposed in the area west of Weymouth (Fig. 2). The fault is not exposed, but is implied by bedding-cleavage relations in what is interpreted as the hanging wall of the thrust. Specifically, large bedding-cleavage angles (~75°) in slate intervals of the Goldenville Formation are not consistent with the steep dips of bedding in these areas (~75°), but rather imply an origin within a fold hinge. Cleavage is axial planar in slate and metasiltstone intervals of folds in the Meguma Group, generally resulting in small bedding-cleavage angles on fold limbs and large bedding-cleavage angles only in the hinge (e.g. Henderson *et al.*, 1989). This relationship holds even when folds are inclined (e.g. Horne *et al.*, 1998). The bedding-cleavage relations here imply probable thrusting toward the southeast, emplacing a fold hinge area, possibly one exposed to the northwest along St. Marys Bay (Fig. 2), onto a steep fold limb. A similar interpretation was proposed in the Mahone Bay area (Fig. 1) where several thrust sheets representing fold hinge areas are thrust onto the steep limb of the Ovens Anticline (Horne, 1998).

Acacia - Havelock Shear Zone

The Acacia - Havelock shear zone is defined by a wide zone of deformation overprinting the Acadian fold structure. Deformation is characterized by crenulation cleavage (S_2) and minor shear-related folds (F_2) which overprint cleavage (S_1) related to regional folds (F_1). This zone of deformation is confined to the uppermost part of the Goldenville Formation and the lower part of the Halifax Formation (Fig. 2). In the Goldenville Formation shear deformation is restricted to a variably developed crenulation in metasiltstone layers. In the Halifax Formation deformation consists of variably developed crenulation cleavage (S_2), locally defining the principal fabric, and local, minor shear-related folds (F_2; Fig. 8a); S_2 cleavage is axial planar to F_2 folds. The crenulation cleavage and related lineation (L_2; intersection of S_2 and S_1) are regionally constant: S_2 trends north-northwest and dips steeply and L_2 trends south-southeast and plunges steeply (Fig. 8b). Minor F_2 folds plunge steeply, parallel to L_2. The crenulation data and minor fold geometry imply mainly strike-slip faulting with a dextral sense of movement (Fig. 8a, b).

The Acadia - Havelock shear zone is an along-strike extension of similar deformation developed in the uppermost Goldenville Formation and the lower Halifax Formation in the Digby area to the north (Fig. 1; White *et al.*, 1999). The orientations of crenulation data are similar for both areas (compare Fig. 8b here with Fig. 4e of White *et al.*, 1999). The southern projection of the shear zone along the boundary of the Goldenville and Halifax formations extends into the Cranberry Point shear zone of Culshaw and Liesa (1997; Fig. 1b) which is defined by similar features. Culshaw and Liesa (1997) defined several other similar shear zones within the Yarmouth and Cape St. Marys synclines (Fig. 1b) and Culshaw and Reynolds (1997) assigned a middle Carboniferous age (ca. 320 Ma) for this deformation. Recognition of shear zones in the Weymouth (this study) and Digby (White *et al.*, 1999) areas confirms the suggestion of Culshaw and Liesa (1997) of widespread

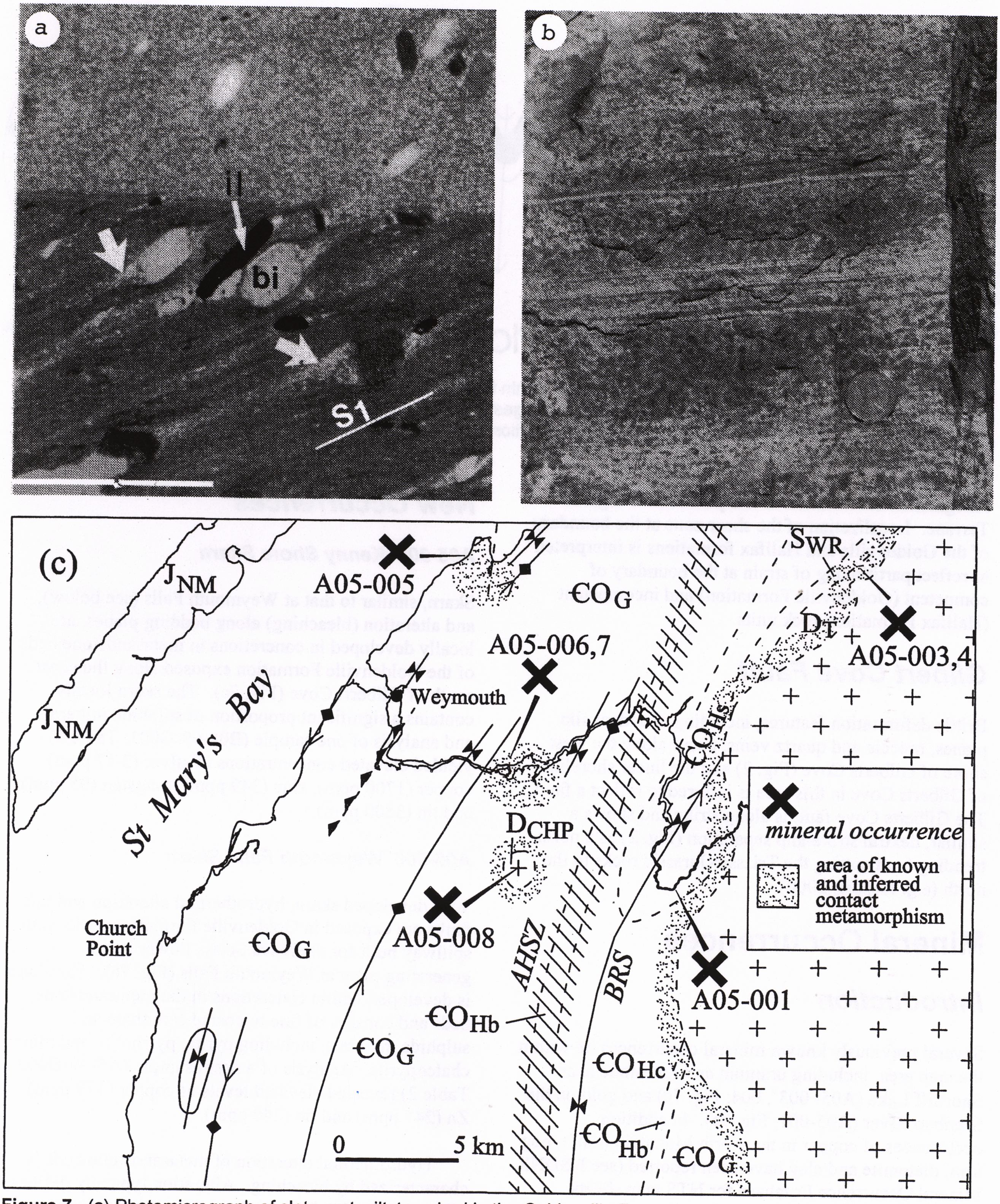


Figure 7. (a) Photomicrograph of slate-metasiltstone bed in the Goldenville Formation showing biotite (bi) and illmenite (il) porphyroblasts (bar scale is 1 mm). Porphyroblasts appear to overprint regional cleavage defined by fine- grained mica; however, pressure shadows (arrow) around porphyroblasts indicate later down-dip extension along cleavage planes (S_1). Sample cut perpendicular to cleavage and the bedding-cleavage intersection (i.e. fold hinge).
(b) Photograph of cordierite hornfels in the contact aureole of the South Mountain Batholith (diameter of coin is 2.6 cm).
(c) Simplified geology map of the area showing the known and inferred distribution of contact metamorphism and the location of selected mineral occurrences. See Figure 2 for legend.

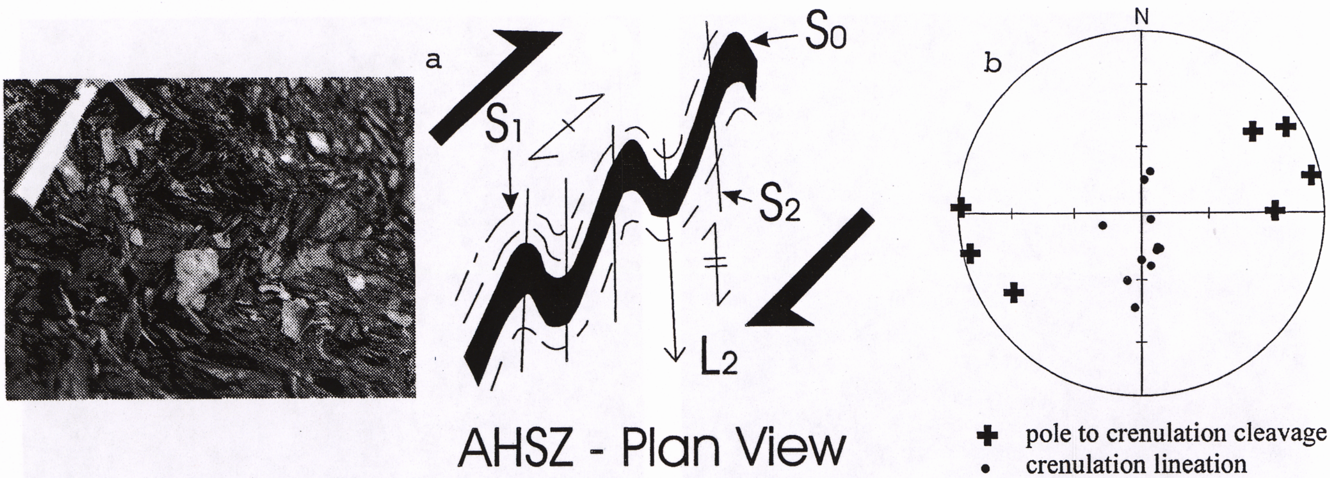


Figure 8. (a) Photograph of minor shear-related folds within the Acacia-Havelock shear zone. Sketch shows the relationship of structural elements in plan view, which suggest mainly dextral strike-slip displacement. S_0 = bedding, S_1 = regional cleavage, S_2 = crenulation cleavage, L_2 = crenulation lineation. (b) Stereoplot of crenulation data for the Acacia-Havelock shear zone.

Alleghanian deformation in this part of the Meguma Terrane. Localization of the shear zone at the boundary of the Goldenville and Halifax formations is interpreted to reflect partitioning of strain at the boundary of competent (Goldenville Formation) and incompetent (Halifax Formation) rock units.

Gilbert Cove Fault

Brittle deformation features, including abundant slip planes, breccia and quartz veins, occur along the west shore of Gilberts Cove (Fig. 2) and the linear shoreline of Gilberts Cove in this area is inferred to reflect a fault. The Gilberts Cove fault is along strike and shows a similar, dextral strike-slip separation (Fig. 2) as a north-trending fault cutting the Triassic-Jurassic rocks to the north (e.g. Keppie, 2000).

Mineral Occurrences

Introduction

Several previously known mineral occurrences lie within the map area, including uranium and limestone near Shortliff Lake (A05- 003*, 004; Fig. 7c) and gold on the Sissiboo River (A05-001; Fig. 7c). In addition, occurrences of copper in the North Mountain basalt, bog iron, diatomite and clay have been reported (see NSDNR Mineral Occurrence Database for NTS map sheets 21A/05 and 21B/08). Following are descriptions of new mineral occurrences found during 1999 field mapping.

New Occurrences

A05-005* Kenny Shore Skarn

Skarn, similar to that at Weymouth Falls (see below), and alteration (bleaching) along bedding planes, are locally developed in concretions in metasandstone beds of the Goldenville Formation exposed along the coast south of Gilberts Cove (Fig. 7c). The skarn locally contains a significant proportion of sulphide minerals and analysis of one sample (B08-99-G001; Table 2) yielded elevated concentrations of silver (2.47 ppm) copper (1700 ppm), zinc (349 ppm), tungsten (95 ppm) and tin (3800 ppm).

A05-006* Weymouth Falls Skarn

Well developed skarn, hydrothermal alteration and late faults are exposed in Goldenville Formation rocks at the spillway built for the Nova Scotia Power hydro-generating plant at Weymouth Falls (Fig. 7a). The skarn is developed within concretions in the metasandstone beds and consists of fine to coarse carbonate and sulphide minerals, including pyrite, pyrrhotite and minor chalcopyrite. Analysis of a skarn sample (A5-99-G002, Table 2) revealed elevated levels of copper (179 ppm), Zn (247 ppm) and tin (240 ppm).

Hydrothermal alteration of metasandstone beds is characterized by bleaching. Alteration typically defines a (tiger) striped colour pattern, where alteration occurs adjacent to fractures. Thin quartz veins occur in some

* refers to Nova Scotia Department of Natural Resources mineral occurrence number in the Mineral Occurrence Database.

Table 2. Table of geochemical analysis for selected mineralized samples from the map area. Analysis provided by the Minerals Engineering Centre, DalTech Campus of Dalhousie University, Halifax. As and W levels were determined by colorimetric technique and CO_2 by a LECO system. All other elements were determined by atomic absorption.

	WEYMOUTH FALLS			GILBERTS COVE	MISTAKE RIVER	CLAYTON HILL		
	A5-99-G001	A5-99-G002	A5-99-G003	B8-99-G001	A05-ML	A5-99-G004	A5-99-G005	A5-99-G006
Ag (ppm)	0.92	0.03	0.02	2.47	0.01	0.71	0.13	0.01
Au (ppm)	0.005	0.013	0.008	0.013	0.021	0.045	0.023	0.08
Co (ppm)	9	19	12	21	6	2	3	28
Cu (ppm)	1120	179	143	1700	12	173	40	73
Ni (ppm)	49	36	38	54	13	3	3	8
Pb (ppm)	20	10	8	69	9	4	20	8
Sb (ppm)	<2	<2	<2	<2	<2	<2	<2	<2
Zn (ppm)	40	247	88	349	19	68	37	191
As (ppm)	80	25	25	60	540	34	17	5
W (ppm)	1	2	2	95	6	2	3	3
Mo (ppm)	20	2	2	2	3	131	7	3
Sn (ppm)	11	240	2	3800	1	8	9	3
CO_2 (%)	26.20	14.79	1.76	2.06				

fractures; however, veins are relatively rare given the amount of fluid implied by abundant bleaching, which locally accounts for half of the rock volume. In thin section, bleaching can be seen to reflect alteration of biotite to chlorite + titanite, marginal to thin quartz veins (D. Kontak, personal communication, 1999).

The Kenny Shore and Weymouth Falls skarns occur in areas where metamorphism resembles contact hornfels adjacent to intrusions, including biotite-cordierite porphyroblasts. Contact metamorphic features, the significant alteration noted at the Weymouth Falls skarn occurrence, and an elevated granophile element association (Cu, Zn, Mo, Sn, W), all support a probable granite source for mineralizing fluids. Considering the general lack of exposure in the area and the indication of widespread hydrothermal alteration, these occurrences suggest the potential for significant mineral deposits in the area. Regional till geochemistry identified some anomalous concentrations, most notably a >2000 ppm tungsten level in the Gilberts Cove area (Stea and Grant, 1992). Further detailed till geochemistry may be a useful method to locate possible mineralized areas.

A05-007 Weymouth Falls Breccia*

Several discordant brittle faults are exposed in the Weymouth Falls spillway. These faults record minor (1-2 m) vertical displacement and vary in character and thickness along strike, from simple slip-planes to metre-wide breccia zones. The breccia zones commonly have a calcite ± sulphide mineral cement, possibly reflecting remobilzation of carbonates and sulphides from local skarn. The main sulphide mineral is pyrite (marcasite) but minor chalcopyrite and malachite were also noted. Analysis of two samples (A5-99-G001, 3, Table 2) indicated elevated levels of copper (up to 1120 ppm).

A05-008* Clayton Hill Pluton Cu-Mo Occurrence

As mentioned above, boulders of the Clayton Hill pluton are cut by numerous quartz veins which commonly host sulphide minerals, most notably coarse molybdenite, pyrite and chalcopyrite. Several boulders with mineralized veins were located on the new logging road off the west side of Highway 340 and in a gravel pit on the road to Danvers (Fig. 5a). Similar large leucomonzogranite boulders cut by mineralized veins, presumably from the above pit, form a sea-wall at Gilberts Cove. Quartz-muscovite greisen borders are developed adjacent to the veins, and disseminated sulphides locally occur within the granite. Analysis of mineralized samples indicated only slightly elevated levels of copper, zinc and molybdenum (Table 2), although one boulder contained coarse (>1 cm) flakes of molybdenite along the border of a quartz vein with altered leucomonzogranite. The occurrence of numerous mineralized veins and disseminated minerals, including miarolitic cavities, indicates the presence of significant hydrothermal activity which may have resulted in local concentrations of copper-molybdenum. Dakers (1982) reported slightly anomalous copper and silver concentrations in soils over the Clayton Hill pluton relative to the region. The Clayton Hill pluton may be related to the magmatism proposed to be the cause of contact-like metamorphism and mineralized skarns throughout this map area.

A05-009 Mistake River Quartz-sulphide Veins*

Quartz veins occur in bedrock and float along Mistake River north of the Sissiboo River (Fig. 2). These veins contain sulphide minerals, including pyrite and arsenopyrite; one sample yielded 540 ppm As (sample A05-ML; Table 2). Veins occur within the Acacia - Havelock shear zone and are typically deformed (e.g. boudinaged, faulted). The veins include cleaved slate fragments indicating a post-F_1 fold origin, and deformation likely records a sequence of progressive faulting and veining associated with the shear zone.

Summary

The general stratigraphy in the map area is comparable with that defined in the Digby area to the north (White *et al.*, 1999), with the distribution of units controlled by regional folds (e.g. the Bear River Syncline). The Goldenville Formation is the dominant metamorphic unit and, as in the Digby area, has not been subdivided. The Halifax Formation in the map area has been subdivided into three distinct units: (1) the Bloomfield member, which also occurs in the Digby area, (2) the Cunard member, which is interpreted to represent a facies equivalent to the Acacia Brook member in the Digby area, and (3) the Sissiboo member, which is interpreted as a facies equivalent of the Bear River member in the Digby area.

Regional folds are the dominant structure; they trend north-northeast and generally plunge moderately to the north-northeast. A regional-scale shear zone at the boundary of the Goldenville and Halifax formations extends from Digby to the Yarmouth area and is related to widespread middle Carboniferous deformation affecting southwestern Nova Scotia.

Several new and interesting mineral occurrences have been identified in the Weymouth area. In particular, Cu-Mo in the Clayton Hill pluton and skarn at Kenny Shore and Weymouth Falls indicate the widespread occurrence of mineralizing fluids associated with exposed and buried granites and suggest the possibility of economic deposits within the area.

Acknowledgments

Photograph of concretion, Figure 3c, was taken by Howard Donohoe. Geochemical data from mineralized samples were provided by George O'Reilly. Dan Kontak provided comments on mineralization, including the nature of hydrothermal alteration of metasandstone beds at the Weymouth Falls occurrence. We appreciate the comments of a constructive review provided by G. O'Reilly.

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