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# Geology of the Cambridge Cove/ Bramber and Red Head Map Areas 21H/01-Z1, Z3 and 21H/01-Y2

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**Honourable Donald R. Downe, Minister**

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# GEOLOGY OF THE CAMBRIDGE COVE/BRAMBER AND RED HEAD MAP AREAS 21H/01-Z1, Z3 AND 21H/01-Y2

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## INTRODUCTORY STATEMENT

This report constitutes part of the geological mapping program (1993-1996) entitled the Kennetcook Basin Project which was designed primarily to update our knowledge of the stratigraphy, sedimentology, structure and related mineral and energy resource potential of the Carboniferous and Triassic systems of Hants County, Nova Scotia. It follows the Nova Scotia Department of Natural Resources Open File Report 94-022 which dealt with the geology of the Walton-Rainy Cove Brook map area (NTS 21H/01-Z2 and Z4), Hants County. Mapping is being carried out on a scale of 1:10,000. The geology map of the Cambridge Cove/Bramber and Red Head map areas (21H/01-Z1, Z3 and 21H/01-Y2 is included in the pocket.

## ACKNOWLEDGEMENTS

A. McKnight was primarily responsible for the mapping of the Wolfville Formation and continued the work of C. Cormier in assessing the provenance and lithology of the conglomerates. She has also been responsible for redrafting the maps and figures of this report. For her capable assistance, the writer is especially indebted.

The writer would also like to thank R. C. Boehner, the co-ordinator of the project, who provided resource materials, advice and general direction. Manuscript review and revisions suggested by R. Naylor are gratefully acknowledged.

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## LOCATION AND ACCESSIBILITY

Figure 1 shows the location of the Cambridge Cove/Bramber and Red Head map areas. They include NTS map sheets 21H/01-Z1, 21H/01-Z3 and 21H/01-Y2 which are located south of the Minas Basin between latitudes 45°10'00" and 45°15'00" and between longitudes 64°5'00" and 64°15'00". Highway 215 provides good access to the area from Truro or Halifax-Windsor. Lantz, Ocean Beach, Cove and Hiltz roads are paved and lead from the highway to the shore. Bennie Mackie and Goshen roads provide some access towards the south from the highway. The best rock exposures occur along the shore of the Minas Basin but some good exposures also occur on major streams

Minas Basin but some good exposures also occur on major streams

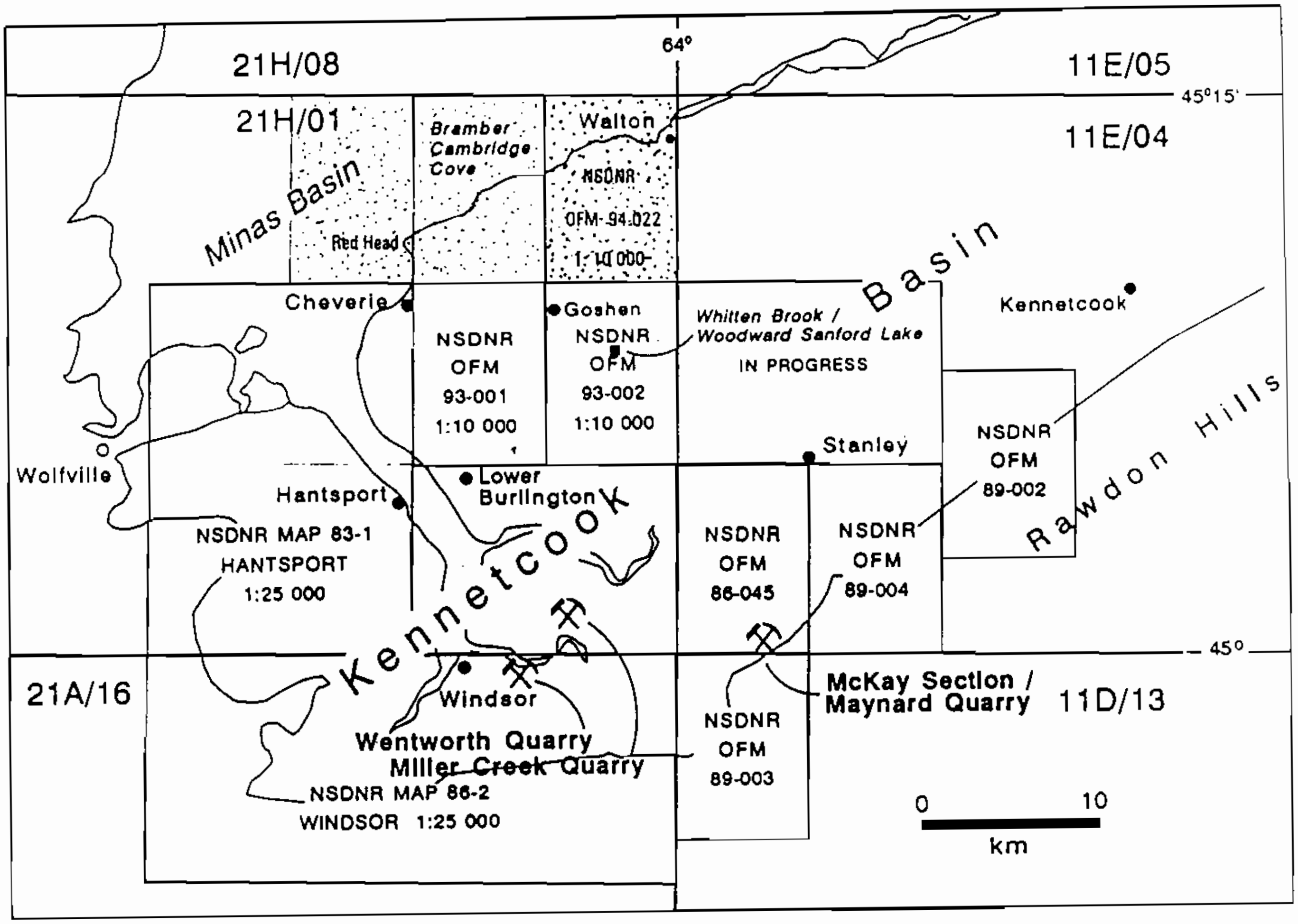


Figure 1 General location and geological map index, Kennetcook Basin, Hants County.

especially near their mouths. Otherwise outcrop is spotty and generally poor due to glacial overburden.

## PREVIOUS STUDIES

During the present century, several maps which cover the present map-areas have been published (Fletcher, 1905; Crosby, 1962; Bell, 1929; and Boyle, 1972). As might be expected, the maps increase in scale and detail with the passage of time. Also, numerous publications have appeared that have varying stratigraphic, structural, sedimentological, paleontological and economic relevance to the map-areas. A few of the more relevant references, many of which have extensive bibliographies, include the following: Adams (1991), Bell (1929, 1960) Boehner (1986), Boyle (1972), Forlenza (1982) Freeman (1972), Fyson (1964), Macdonald (1973), Moore (1967), Moore and Ryan (1976) and Martel (1990). Explication of the contributions of these and other writers will be found in the text that follows.

## STRATIGRAPHY

### HORTON GROUP

Dawson (1873) was first to use the name Horton Group and provide a general description. Bell (1929) subsequently redefined it but specified neither a type locality nor type section. The type area, however, is the southwestern part of the Minas sub-basin, Hants and Kings counties, Nova Scotia. Major facies of the group are non-marine, continental, fluvial and lacustrine, red and grey to black clastics, generally coarse grained basally and towards the top, with finer clastics between. Within the type area, two formations have been recognized - a lower Horton Bluff Formation and an upper Cheverie Formation. The group may be separated from older rocks by angular unconformity, nonconformity or fault. A regional unconformity generally separates the group from younger strata but fault relationships also occur. (e.g. Johnson Cove). In the map areas the group is also separated by angular unconformity from the Fundy Group (Triassic-Jurassic) (Table 1).

### HORTON BLUFF FORMATION

#### Introduction

The Horton Bluff Formation, named and described by Bell (1929), constituted the basal formation of his "Horton Series". He further subdivided it into basal, middle and upper members. Subsequently (in 1960), further subdivisions were made that included a basal feldspathic conglomerate member, a lower grey quartzitic sandstone and shale division, a middle argillaceous member with an upper blackish-grey argillaceous and arenaceous-argillaceous division and an upper arenaceous member. Although a type locality was not designated, the type area is the south flank of the Gaspereau Valley and the vicinity of Horton Bluffs, Kings County, Nova Scotia (NTS 21 H/1).

Table 1: Formations of the Cambridge Cove/Bramber and Red Head Map Areas, Hants County, Nova Scotia.

| SYSTEM | GROUP | FORMATION | CHARACTER |
|---|---|---|---|
| Jurassic Triassic | Fundy | Wolfville | sandstone, conglomerate, mudstone |
| | | Unconformity | |
| Mississippian | Windsor | Wentworth Station, Miller Creek, White Quarry, Macumber<br><br>Unconformity | siltstone, gypsum, anhydrite, limestone, dolostone, shale |
| Mississippian Devonian | Horton | Cheverie Horton Bluff | conglomerate, sandstone, mudstone, dolostone |

The first mapping of lithologic units of the formation was carried out by Worth (1969). Ferguson (1983) also mapped the area near Hantsport employing some lithologic units of previous workers (Bell, 1929; Worth, 1969; Macdonald, 1973). Martel (1990) subdivided the Horton Bluff Formation informally into lower Harding Brook and Curry Members, a middle Blue Beach Member and an upper Hurd Creek Member. In addition, he used a facies approach to environmental interpretation but did not carry out any mapping.

The writer considers the Horton Bluff Formation as exposed in the map areas and the previously mapped Walton-Rainy Cove map-area (Moore, 1994), to be correlative with the Middle and Upper Members of the type area as mapped by Ferguson (1983) and Moore and Ferguson (1986). The Lower Shale/Siltstone unit plus at least the lower part of the Mudstone/Carbonate unit are considered to be at least approximately equivalent to the Blue Beach Member of Martel (1990) or the Middle Member of Ferguson (1983) and Moore and Ferguson (1986) or Middle Member, "Upper Division" of Bell, (1929, 1960). The upper part of the Mudstone/Carbonate unit, the Upper Siltstone/Shale unit and the Black Shale units are possibly equivalent to the Hurd Creek Member of Martel (1990) or Upper Member of Bell (1929, 1960), Ferguson (1983), Moore and Ferguson (1986). The level of stratigraphic separation of the Hurd Creek Member from the Blue Beach Member may occur at the base of the wave rippled marker siltstone in the Split Rock-Johnson Cove section (Table 2).

Table 2: Subdivisions of the Horton Bluff Formation (Horton Group), Minas sub-basin, by various authors

| Bell, 1929, 1960 | Worth, 1969 | Ferguson 1983; Moore and Ferguson 1986 | Martel, 1990 | Cambridge Cove Bramber, Red head map-areas |
|---|---|---|---|---|
| Upper Member | Upper Sandstone | Upper Member | Hurd Creek | Up Black Shale, Siltstone/ Shale |
| Middle Member "Upper Division" | Middle Sandstone "Middle Shale Facies" | Middle Member | Blue Beach Member | Carbonate/ Mudstone Lower Shale/Silt -stone |
| Middle Member "Lower Division" | Middle Sandstone "Sandstone Facies" | Lower Member | Curry Brook Member | Not recognized or present |
| Basal Member | Gaspereau Sandstone | | | |

The writer has not used subdivisions of the Horton Bluff Formation, which are applicable to the type area, in the current mapping, for several reasons. First, there are significant lithofacies changes across the depositional strike. These are associated particularly with the general fining in grain size from south to north and overall thickening of the section. Second, marker horizons, particularly characteristic of the Upper Member in the type area (e.g. Glass Sand Unit), appear to be absent to the north. In defining units, more emphasis has been placed on sediment characteristics related more directly to depocenter factors (e.g. lake energy, lake level, water chemistry, soil forming parameters)

Fluvial and lacustrine facies dominate the Horton Bluff Formation and include grey to green-grey, black and minor red, very fine to very coarse grained clastics (shale to conglomerate). Minor fresh water carbonates, coal seams and pedogenic horizons also occur. Compositionally, the coarser clastics are usually sublitharenites to quartz arenites with quartz generally in the range 85 to 98 percent, feldspar less than 5 percent (often altered to kaolinite) and rock fragments varying between 5 and 15 percent. Metamorphic rock fragments are significant in the Lower Member, chert and shale more important in the Upper. Planar bedding, graded bedding and planar cross-bedding are characteristic primary structures. While siliceous cements (up to 10 percent) are common, matrix may comprise up to 15 percent of sandstone basally. Lower Horton sandstones are usually poorly sorted and immature, Upper Member sandstones generally are submature to mature (Moore, 1994).

Aneimites acadica and Lepidodendropsis corrugata are the most common plant species in the Horton Bluff Formation (Bell, 1960). Higgs (1975) indicates that miospore assemblages of the Horton Group are older than the Late Tournaisian CM zone. The oldest strata may be late Devonian ($Tn_{1b}$) in age (Utting, 1989). McGregor (1971), Utting (1987) and Utting et al (1989) provide a $Tn_2$ - $Tn_3$ age for the rest of the formation.

## Map Area

The Horton Bluff Formation underlies perhaps 75 percent of the map-areas, being most prominent to the north where it forms almost continuous exposures along the coast except for areas of slump and slight interruptions by Fundy Group strata. Reasonably good outcrops may also be found on the major streams (e.g. Bass Creek, Cambridge Creek). No complete sections of the formation occur within the map area because of structural complexities.

For mapping purposes and to facilitate structural analysis, four lithologically mappable units have been separated within the formation. Three of these were previously described and mapped for the Walton Rainy Cove Map-area (Moore, 1994). These include from oldest to youngest a Lower Shale/Siltstone unit (new), a Mudstone/Carbonate unit, an Upper Siltstone/Shale unit and a Black Shale unit (Fig.2).

A very approximate estimate of the thickness of the Horton Bluff Formation for the map-areas is 1175 m. Martel (1990) shows a thickness of 341 m in his graphic log for the formation on the Walton River. Moore (1994) estimated the thickness for the Rainy Cove-Walton map area to be 415 m. A thickness of 1015 m was intersected in the Soquip Noel #1 well near Kennetcook, Hants County.

Lower Shale/Siltstone Unit

The base of the Lower Shale/Siltstone unit is not exposed in the map-areas but it conformably underlies the Mudstone/Carbonate unit in the Split Rock-Johnson Cove section (Figure 2). Here a thirteen metre measured stratigraphic section is characterized by 0.3 to over 1 m thick units of fine to coarse grained, thin to thick bedded, planar to lenticular bedded, in part wave rippled, grey to greenish grey siltstone alternating with generally grey to dark grey, finely laminated to homogeneous shale that may contain lenses of siltstone, often internally wave rippled and usually a few mm to about 3 cm in thickness. Interbedded grey to brown-grey, planar to wavy and lenticular bedded siltstone and dark grey shale units also occur. Shale comprises 68.5 percent, siltstone 17.8 percent and interbedded siltstone/shale about 13.7 percent of the measured interval. Such alternating, shale dominated facies appear to be characteristic of the upper part of this unit.

Lower in the stratigraphic column, shale appears to become even more prominent. Thus, in a "road metal" shale quarry located just west of Highway 215, and 1.4 Km north of Mill Creek (at Bramber), quarrying has exposed a continuous section of the unit dipping, on average, about 17°. The section is at least 75 metres thick and consists almost entirely of shale. Only two thin (less than 30 cm) siltstone units were noted here.

This part of the section may be correlative lithostratigraphically with part of the lower third of the Middle Member (sense of Moore and Ferguson, 1986) or Martel's (1990) Blue Beach Member.

Within the unit a zone containing many irregular to somewhat spherical dolostone nodules enclosed by shale has been observed at several localities (eg. shore at the mouth of Cambridge Creek). This zone probably lies stratigraphically between the previously described interbedded siltstone and shale units and the thick shale of the quarry but more precise location requires further study or drilling. An approximate estimate of thickness for the unit in the map areas is 375 m.

Mudstone/Carbonate Unit

The characteristic feature of this unit is the presence of "packages" of olive grey to green, commonly yellowish weathering, non-laminated, bioturbated mudstone, often with root casts; drab grey to green grey, planar to wavy laminated siltstone and; usually dolostone, present either as crudely bedded nodular weathering layers or as discrete large cauliflower to cannonball-like forms, frequently with septarian structure. The mudstone/carbonate packages commonly range from less than 1 metre to about 3.5 metres in thickness, tend to occur in clusters of 3 or 4 and are separated from each other generally by clayey often pyritic, dark grey to grey shale and at least in part wave rippled siltstone units (Figure 2).

The highest green-grey "package" forms the stratigraphic top, the lowest the stratigraphic base of the unit. Good stratigraphic sections of the unit may be seen in the map area at Split Rock (Red Head), the mouth of Bass Creek, on Cambridge Creek and the first major tributary of Bass Creek that flows westerly and may be located 350 metres upstream from Highway 215. In the Split Rock-Johnson Cove section, the unit comprises approximately 61.4 percent shale, 16.7 percent interbedded siltstone and shale and 14 percent mudstone/siltstone/carbonate facies. Here the section was measured to be 127 metres thick.

Upper Siltstone/Shale Unit

This lithologic unit conformably overlies the Mudstone/Carbonate Unit and consists primarily of dark grey to black, finely laminated, clayey, sparsely fossiliferous shale with many units of grey, fine to coarse-grained, generally wave rippled, in part planar laminated siltstone. The latter units generally range from one to six metres in thickness and usually occur at stratigraphic intervals of one to six metres. Reasonably good stratigraphic sections of the unit may be observed on Cambridge Creek immediately above and below Highway 215, on Bass Creek upstream from Highway 215 and the first westerly flowing major tributary and on the shore east of Mutton Cove, west of Bass Creek. The top of the last thick siltstone unit indicates the top of this unit. Complexity of structure makes accurate estimates of thickness difficult. A very approximate total thickness of 375 metres, however, is suggested.

Upper Shale Unit

The Upper Shale Unit has been identified in outcrop in the shale (gravel) quarry located about 0.7 Km south of Highway 215 adjacent to Goshen Brook; in the vicinity of this quarry near Goshen Road and; on Bass Creek downstream from Goshen Road about 0.9 Km and further beyond from the Cheverie contact. The unit is distinguished by the great dominance of dark grey to black, planar to slightly wavy laminated, clayey shale usually with good fissility. Planar laminated and/or wave rippled siltstone units that may be present are sparse and thin, usually less than one metre in thickness. Most outcrops in the map area are shale.

Microscopic examination of 8 thin sections of the shale from Goshen Road outcrops indicated an average silt content of 5.5 percent (range from 1 to 15 percent). Silt occurred as discrete thin laminae and as thin lenses sometimes graded. The average sand content was 1.8 percent with a range from 1 to 5 percent. Sand grains were usually disseminated clastic quartz. The main accessory minerals identified included micas (muscovite, biotite, chlorite with muscovite dominant), tourmaline and zircon.

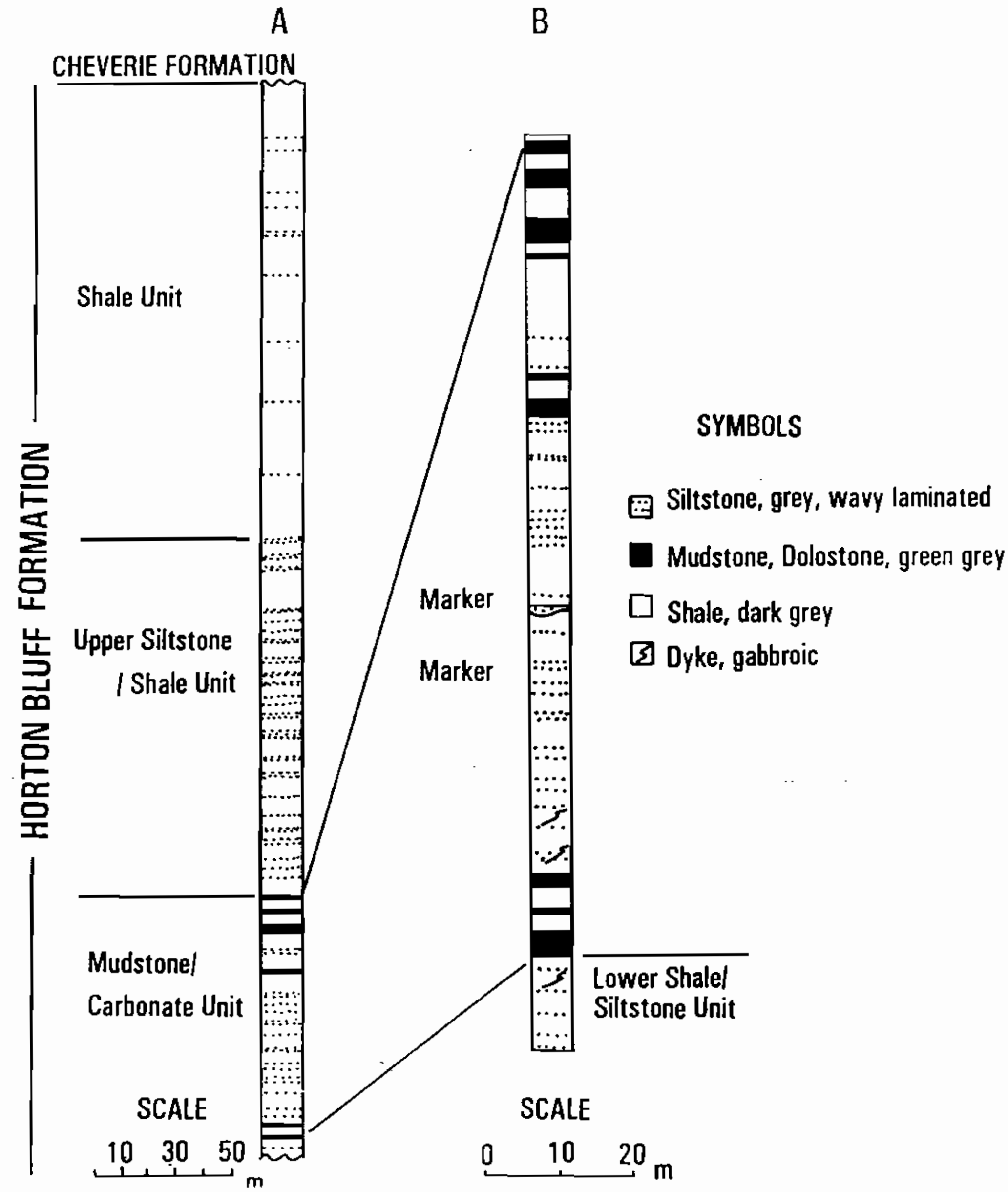


Figure 2. Graphic Stratigraphic logs, Horton Bluff Formation

A. Walton-Rainy Cove map area

B. Split Rock-Johnson Cove map area

A thin (20 cm thick), poorly laminated, indistinctly pelletal, medium grey, limonite stained micritic limestone has also been observed in this unit (Goshen Road Quarry).

The unit may be as thick as 350 metres in the map area and may occur in faulted or unconformable contact with the younger Cheverie Formation.

**Cheverie Formation**

Introduction

The Cheverie Formation is a late Tournaisian-early Visean, non-marine, mainly fluvial lithostratigraphic unit that was first named, described and mapped by Bell (1929). He noted that the area of best exposure was "on the east side of the Avon River from the headland northeast of Cheverie Point (NTS 21H/1) to a point opposite Summerville" (NTS 21H/1) in Kings County, Nova Scotia. Subsequently, Freeman (1972) established a type section for the formation, composite in nature, based on individually measured and described sections on Crowell Creek, Hurd Creek and Blue Beach (Hantsport area, Hants County) and Cheverie Point. He also distinguished two informal members (Lower and Upper).

Mainly red or mottled grey and orange, feldspathic, biotitic and muscovitic, arkosic to subarkosic coarse to very coarse grained clastics are characteristic of the formation. Feldspar, dominantly potash, is common as relatively unaltered, euhedral grains. Trough cross-bedding, cross-lamination, desiccation cracks and channelling are frequently occurring structures. Also, characteristic of the formation are thick laminated and homogeneous siltstone sequences, often brick red in colour due to hematite.

Drilling by Saarberg Interplan indicated a thickness of about 100 m on the south flank of the Minas sub-basin (Moore and Ferguson, 1986). Freeman (1972) estimated a thickness of 260 metres (854 ft.) for the type section (south flank plus Cheverie Point sections). Moore (1994) estimated 375 metres for the Walton River mouth section and 775 metres for the section in the southwest corner of the Rainy Cove map area. For the Cheverie Mountain area a total thickness of about 1275 metres is possible.

The Cheverie Formation is regionally unconformable with the underlying Horton Bluff Formation. Locally, as in the present map area, it may exhibit fault relationships with it. In respect to older strata, the Cheverie Formation may be nonconformable, unconformable (angular) or faulted.

Late Tournaisian age determination of the formation by Bell (1960) was based on plant fossils. Palynological studies have generated seven spore zones for the Horton Group indicating a range in age from Middle Devonian to early Visean (Barss, 1967; Barss and

Hacquebard, 1967; McGregor, 1971; Hacquebard, 1972; Utting et al., 1989).

Map Area

The Cheverie Formation underlies about 25 percent of the map areas but is confined to the southern half where it is dominant in areal distribution. The best most continuous exposure occurs along the coast, west of Bramber in the vicinity of Johnson Cove. Outcrops of generally limited area extent, however, are not uncommon in the Cheverie Mountain area west of Goshen and on Mill Brook. Two informal lithostratigraphic units have been recognized within the formation and are shown on the map sheet. These correspond approximately to the Lower and Upper Members of Freeman (1972) but see the subsequent discussion.

Lower Member

Freeman's (1972) type section of the Lower Member is composite and comprises sections located on Crowell and Hurd Creeks and Blue Beach, Hants County, Nova Scotia. The Lower Member was distinguished from the Upper on the basis of its coarse grained textures (conglomerates are especially common) and generally arkosic composition. Large scale festoon cross-bedding, channelling and reworking of older, underlying strata were considered characteristic. He determined the thickness of the member to be 295 feet (90 metres).

Conglomerates are typically light grey to white orthoconglomerates but occasionally maroon usually paraconglomerates also occur. Clasts are most commonly in the granule to pebble range and variably rounded to angular. Pebble size clasts predominate along the present southern margin of the basin (e.g. Bog Creek, St. Croix River, Hants County) but north, across the depositional strike fining occurs such that the granule size is dominant at Blue Beach. Conglomeratic units exhibit massive (homogeneous) to trough cross-bedded structure, the latter with amplitudes in excess of 2 metres (Freeman, 1972; Conrod, 1987) and occur in thicknesses of up to 10 metres. The conglomerates are generally especially kaolinitic towards the base of the member and generally calcareous high in the section. Lag mudstone clasts and plant debris may occur at the base of individual conglomerate units.

Conglomerates comprise over 80 percent of 50 metre thick sections on Bog Creek and the St. Croix river exposures and about 50 percent of Freeman's (1972) type section (Crowell plus Hurd Creeks and Blue Beach) (computed from Freeman data). Conrod (1987) estimated that conglomerate (Gm facies) comprised about 25 percent of his measured section (60 metres thick) at Blue Beach (mainly Lower Member. In the map-areas, conglomerates probably comprise no more than 1 or 2 percent of the section.

Sandstones of the Lower Member are characteristically arkosic, primarily grey to greenish-grey but sometimes maroon and fine to coarse grained. They may be massive to trough cross-stratified (St facies - Miall) or laminated to massive (Sl facies) (Conrod, 1987). Sandstone comprises probably less than 10 percent of the Bog Creek section and about 10 percent of the type section (computed from Freeman, 1972 data) Sandstone facies constitute about 39 percent of Conrod's (1987) Blue Beach section. Data is insufficient to accurately estimate the percentage of sandstone in the map area section. At most outcrops, however, except near the stratigraphic base of the member, it forms a minor percentage of the section. A very approximate estimate would lie between 10 and 20 percent of the total section.

Fine grained clastics include blocky weathering massive or homogeneous, maroon, green grey and variegated mudstones and siltstones. Desiccation structures and carbonate nodules may occur. Another common facies is laminated siltstone that may be interlaminated with claystone or fine sandstone. Collectively, fine grained clastics are estimated to comprise about 35 percent of the Blue Beach section (Conrod, 1987) and 29 percent of the type section (computed from Freeman, 1972 data).

Other facies comprise less than one percent of the member (e.g. paleosols). The reader may wish to consult Bell (1960) Boyle (1972), Freeman (1972) and Conrod (1987) for additional information.

Within the map areas, outcrops of strata probably correlative with the Lower Member of the type section are not common but also occur mainly along or near Goshen Road south of Bass Brook, on Bass Brook west of Goshen Road and on Mill Brook east of Highway 215. "General" correlation with the type section is based upon stratigraphic position between the Horton Bluff and Macumber Formations, general paucity of shale and similarity in lithofacies types present. Differences from the type area occur in the apparent rarity of coarse-grained clastics (sandstone/conglomerate) except at or close to the base of the section. Coarse clastics constitute perhaps less than 10 percent of the member (70 percent of the type section). The member in the map area also appears to be much thicker (750 m vs 90 m).

Pebbly subarkosic, trough cross-bedded sandstone occurs at or near the base of the member on Bass Creek (actual basal contact with the Horton Bluff formation is not exposed) and arkosic sandstone outcrops within 100 metres stratigraphically above the base on the same creek. A thin (less than 25 cm thick) arkosic sandstone unit and a thin arkosic paraconglomerate have also been observed outcropping along Goshen Road. Both occur within the lower quarter of the member.

Suprabasal sandstones that have been noted in the member are typically interbedded with siltstone, exhibit homogeneous to planar bedding, are laminated or cross-laminated, fine to very fine grained, micaceous and subarkosic to sublitharenitic in composition.

Most of the observable section in the map areas, however, is dominated by drab green grey, often limonite stained, laminated to massive fine clastics ranging from arenaceous siltstones, through siltstones to mudstones. Coarser facies may be laminated and cross-laminated. Claystone laminae often occur in the siltstone and fining upward grading is not uncommon. Red mottling is typical where some hematite is present. Nodular siltstone occurs in the section on Goshen Road.

For convenience in mapping, the writer has used the base of the first significant coarse-grained sandstone and/or conglomerate unit to define the top of the Lower Member. This also may mark a change in the sandstone composition (arkosic to subarkosic) as used by Freeman (1972).

Upper Member

The type section of the Upper Member was designated and described by Freeman (1972) and is located at Cheverie Point, Hants County, where it was measured to be 559 feet (168 metres) thick. It differs from the Lower Member in the composition of the coarser clastics (subarkosic to orthoquartzitic above vs arkosic) and in being finer grained.

Sandstones of the upper half of the member in the type area are mainly calcareous, occasionally in part hematite cemented, fine to medium grained generally grey quartz arenites. The sandstones of the lower half are mainly hematitic, fine to medium grained, maroon subarkoses. Blocky weathering, brick red, quartzose to hematitic siltstone are the other major constituent of the member. The red siltstones are commonly nodular. Minor well laminated, dark grey, micaceous and carbonaceous shales also occur and thin paleosols.

The most common primary and penecontemporaneous structures (apart from bedding) are cross-laminae (vs cross-bedding), current ripple marks and desiccation cracks.

Two major areas of outcrops of the Upper Member occur within the map areas, one at and in the vicinity of Johnson Cove, the other in the southwestern part of the map areas, west of Goshen Road.

Freeman (1972) measured and described a section of the Upper Member, 355 feet (107 metres) thick at Johnson Cove (Figure 3). The writer estimates the total thickness of the member in this area to be about 135 metres thick (450 feet). In the Cheverie Mountain area, the section may be 4 times as thick (525 metres). Much of the additional thickness may in part be attributable to the occurrence there of many thick, coarse grained and pebbly sandstone units which form elongated, lenticular, resistant masses, in part responsible for the mountain's existence and not evident at Johnson Cove.

At Johnson Cove, the section comprises about 66.7 percent mainly brick red to purplish, predominantly blocky massive siltstone and arenaceous siltstone; 20.3 percent sandstone (about one-half quartz arenite, the other subarkose to arkose); 8.7 percent shale, predominantly red with minor grey, 2.9 percent conglomerate (granule to pebble) and 1.4 percent other sediment.

In the Cheverie Mountain area, generally poor exposure of the finer clastics and the lack of a good stratigraphic section make it difficult to estimate textural percentages. Individual coarse clastic units, however, are thicker and more frequent in the section as well as coarser grained than in the type section. Some may be 10 or more metres in thickness.

In both major areas of outcrop, quartz arenites are characteristic of the upper part of the member and subarkoses the lower part. In the mountain area sandstones are commonly bleached white, feldspar has been frequently kaolinized, and manganese staining and liesegang structure are common, particularly near the old Goshen mine area (Moore, 1994). A representative sample of a sandstone from the lower half of the member (at the shale quarry) contained about 88 percent quartz, 7 percent feldspar (K spar dominant) and 5 percent rock fragments (mainly chert and metaquartzite). Minor accessories included muscovite and biotite (less than 2 percent). Both hematite and calcite were present as cements.

Finer grained clastics are fairly rare in outcrop in the mountain area, but where observed (e.g. west of Goshen Road) are similar in facies types to those of the Lower Member in the same area and those of the Upper Member in the type area ie. massive and laminated, red and green grey to variegated mudstones and siltstone.

## WINDSOR GROUP

The Middle and Late Visean to possibly Early Namurian age Windsor Group (Bell 1929; Mamet, 1970; Utting, 1978; Moore and Ryan, 1976; was originally defined by Dawson (1873). Bell (1929) established a composite lectostratotype incorporating sections on the east bank of the Avon River, Hants County at Windsor (NTS 21A/16), Maxner Point, the mouth of the Kennetcook River (NTS 21H/1) and the mouth of the Avon River at Cheverie (NTS 21H/1).

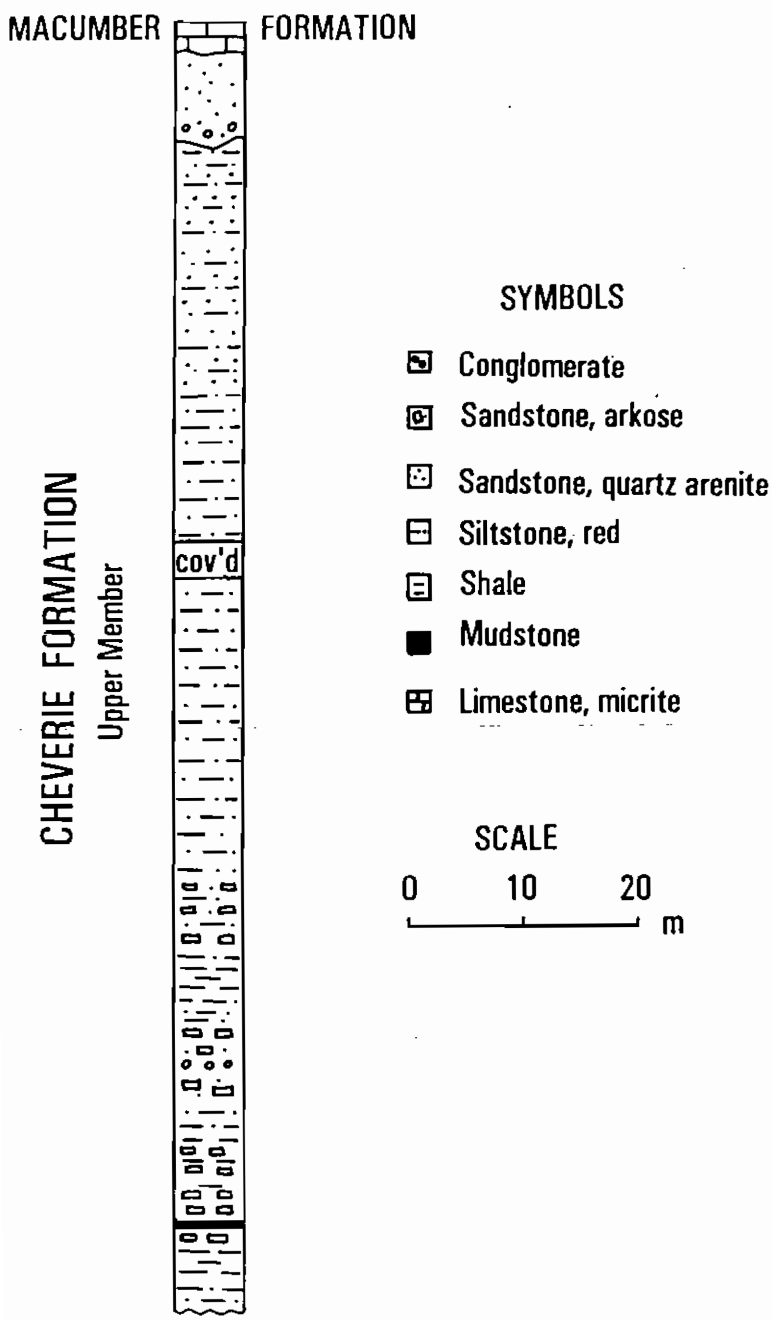


Figure 3. Graphic log, Cheverie Formation, Johnson Cove (modified from Freeman, 1972).

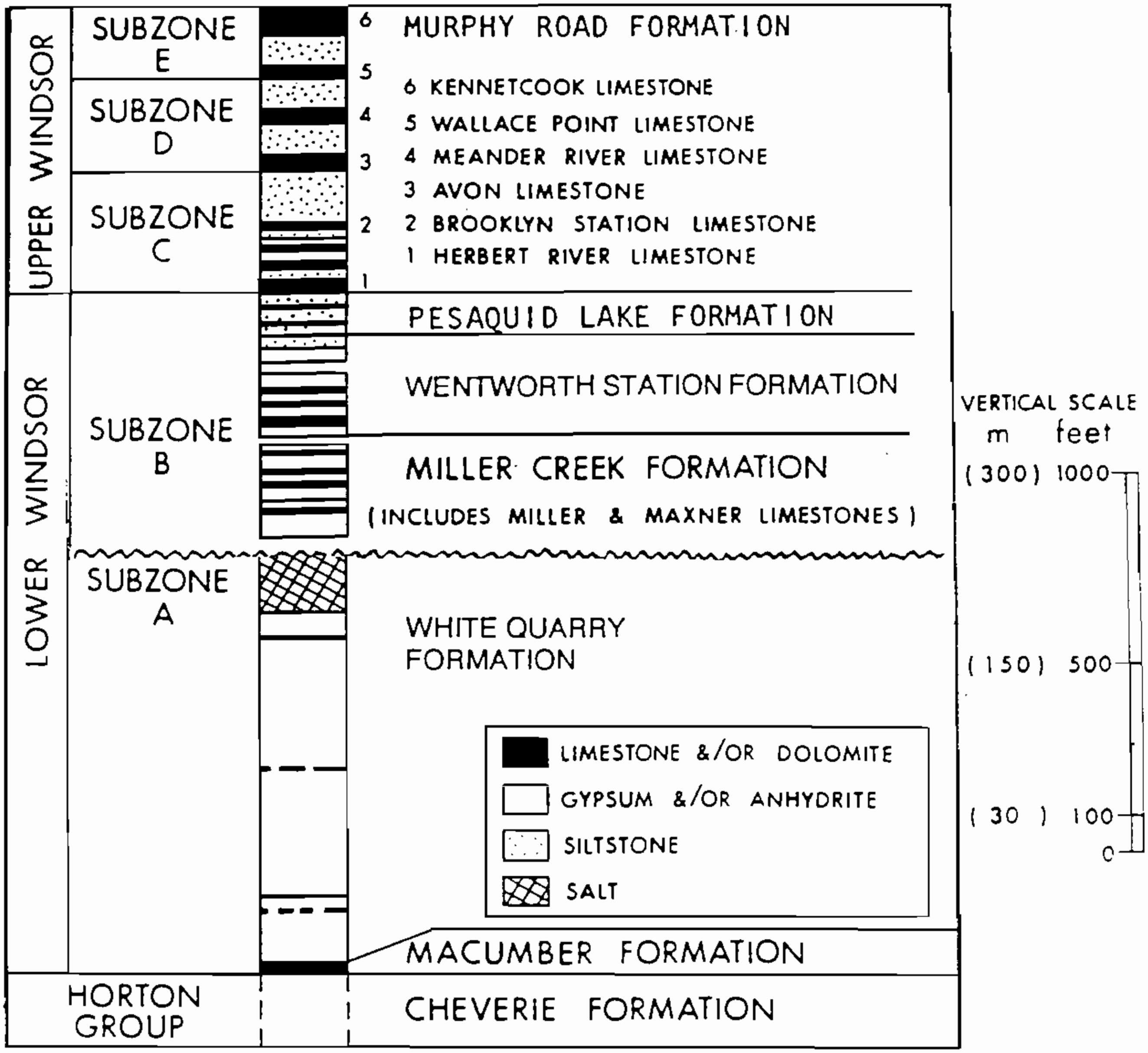


**Figure 4.** Windsor Group stratigraphy (Modified from Moore and Ryan, 1976).

Within the Minas sub-basin, some six formations including twenty members have been recognized and mapped (Moore and Ferguson, 1986; Moore, 1994).

Formations and members of the group are generally tabular or sheet-like in form marine carbonates (limestone and/or dolostone), typically with well developed transgressive-regressive nearly symmetric cycles except for the basal asymmetric Macumber Formation which is largely regressive (Table 1; Figure 4). Many carry diversified mega- and microfaunas useful in zonation (Bell, 1929; Moore and Ryan, 1976; Mamet., 1970; Utting, 1978; von Bitter and Austin, 1984). Intercalated clastics are dominantly red, fine grained siltstone and siltstone breccias of mainly continental origin and are usually massive but occasionally laminated. Evaporites in the Windsor include gypsum, anhydrite and salts and exhibit diverse textures and structures. They are dominant volumetrically in the basal to lower middle portion of the Windsor Group in the Minas sub-basin (Adams, 1991, Boehner, 1986).

The Group is about 800 m thick in the type area where it unconformably or nonconformably overlies the Cambrian to Ordovician Meguma Group, Acadian "granitic" rocks or Upper Devonian to Mississippian Horton Group strata. It may be conformably overlain by the Watering Brook Formation or unconformably by younger strata (e.g. Scotch Village Formation).

Windsor Group rocks have only limited areal distribution in the map areas and are restricted to the southwest. Exposures of only two formations are known to occur - the basal Macumber and the overlying White quarry Formations. Younger formations shown on the map are assumed to be present.

## Macumber Formation

Weeks (1948) applied the name Macumber to a formation of "well-bedded, grey to buff, fine grained limestone overlying conformably the top-most sandstones and sandy shales of the Cheverie Formation". Moore (1994) suggested as lectostratotype, section 1, units b, c and the marine fossil-bearing sandstone part of a, of Bell's (1929) type section of the Windsor Group. The section is located about 1219 m north of Cheverie Point, on the east bank of the Avon river, southwest of Cheverie, Hants County, N. S. (NTS 21/H1).

Planar to wavy, even parallel laminae and/or thin beds characterize the formation in the map area and elsewhere. These may vary from buff through light brown to reddish or even greenish-grey in colour. The most common lithologies are pelmicrite, intramicrite, biomicrite and oomicrite often interlaminated. The micrite matrix is frequently recrystallized to microspar and may be dolomitized or sideritized as at Goshen. Pellets and peloids are the most common allochems. Less common intraclasts may be micritic, pelletal or oolitic in composition. Ostracods and calcispheres are characteristic fossils but less commonly brachiopods and gastropods may be found, usually near the base of the formation.

A thin (less than 5 cm thick) black, calcareous, fissile, organic rich shale occurs locally at the base of the Macumber (Bog Creek, Meander River, Hants County; Walton borehole 583 - Smith and Collins, 1981).

In the upper part of the formation, synsedimentary slump breccias and tectonic related breccias also may be present (Lavoie, Savard, Sangster, 1994). At depth in the basin, the formation typically grades upwards conformably into the overlying White Quarry Formation. In outcrop, along strike at Johnson Cove, the normal Macumber facies are locally completely transformed to breccia ("Pembroke breccia"). The formation varies significantly in thickness from locality to locality mainly in response to differential solution but may be up to 35 m in the type area. (Weeks, 1948; Clifton 1963; Boyle, 1972). The Pembroke breccia is included in the Macumber Formation by the writer (See Moore, 1994 for discussion).

Within the map areas, the Macumber Formation is in fault contact with the Horton Bluff Formation to the north. To the south, the actual contact with the White Quarry formation is not exposed but appears to be a zone of solution collapse and brecciation.

## White Quarry Formation

The White Quarry Formation, a designation used informally by Moore and Ferguson (1986), is a mainly evaporitic, thick sequence of lithologic units that may conformably overlie the Macumber Formation but generally is in fault contact with the carbonate, clastic or evaporite units of the Miller Creek or younger Windsor Group formations (Figure 4). The formation is commonly referred to as the "basal anhydrite".

The dominant lithology is anhydrite which characteristically is finely crystalline, blue grey to brown grey in colour and may exhibit bedding, nodular or mosaic structure in the sense of Maiklem et al. (1969). Felted and lath textures are common as are wisps of dolomite.

Brown to nearly black dolostone also occurs in the formation where it forms laterally extensive thin marker units as in the map area.

The formation is a basin centre deposit of the type interpreted by Schmalz (1969), McCutcheon (1981) and Boehner (1986) rather than a sabkha (Schenk, 1967). Lateral facies relationships, the vertical sequence of lithologies and the areal distribution of the facies of the A subzone (Bell, 1929) all support this interpretation (Moore, (1994).

Within the map area considerable flowage of the evaporite has occurred thereby producing complex flow folds with highly variable dips.

## MILLER CREEK AND WENTWORTH STATION FORMATIONS

The existence of the Miller Creek and Wentworth Station Formations within the map areas is somewhat conjectural. The assumed presence is based upon inference only since outcrops of these formations do occur along the structural strike to the north and south. Drilling will be required for confirmation, however.

Both formations comprise intercalated evaporites (gypsum/anhydrite), fine clastics (chiefly red, minor green grey siltstone and siltstone breccias and variably fossiliferous generally thin carbonates (limestone/dolostone). A high ratio of siltstone to carbonate aids in distinguishing the Wentworth Station from the Miller Creek formations. Also some limestone members in the Miller Creek Formation (Fisher, Belmont) contain pelagic faunas (fish and nautiloids) and may exhibit mound facies unlike the Wentworth Station (Moore, 1994).

The two formations are commonly separated from each other by faults considered to be related to gravity sliding and by unconformity from younger formations.

### Igneous Sills/Dykes

The existence of igneous rocks at Johnson Cove has been noted in the literature at least since the time of Fletcher (1905) who indicates Triassic sediment and "three ares of trap". Crosby (1962) observed diabase sills intruding Horton strata in the sea cliff and Boyle (1972) also reported the occurrence of "several parts of two faulted gabbroic sills" in the cliff faces but as well at scattered points on the flats. Igneous dykes/sills in fact occur at at least six distinct sites and three stratigraphic levels within the Horton Bluff Formation at Johnson Cove. One horizon lies within the Lower Siltstone/Shale unit, the other two the lower part of the Mudstone/Carbonate unit. Similar dykes have also been observed in the Cheverie - Lower Burlington map area (Moore, 1993) on Devils Brook and in a quarry adjacent to the New Cheverie Road. Stratigraphically these are also in Upper Horton Bluff rocks. Dykes have not been observed in younger(Cheverie, Windsor) strata.

The rocks, dark to medium greenish grey when fresh, weather brownish and are fine to medium grained, with fine grained chilled margins. Small apophyses have partly devitrified to glass (Boyle, 1972). Locally, adjacent shales may be converted to "hard flinty hornfels".

Barr (Acadia University) observed the igneous rocks in outcrop with the writer and kindly examined 6 thin sections representing samples taken from the six sites and three stratigraphic levels. She (personal written communication) noted that "None of the sections seem to retain any primary igneous minerals - the original plagioclase has been altered to albite or to zoisite, carbonate, and other secondary minerals. The original pyroxene has been replaced by carbonate, sericite, clays, and iron oxide (hydroxide)." Boyle (1972) suggests the rocks were originally gabbros with diabasic texture.

Some authors, (Fletcher, 1905; Crosby, 1962; Boyle, 1972) have considered the igneous rocks to be Triassic in age and consanguineous with the North Mountain Basalt. Their rationale appears to have been in part geographic - the "position of sills with respect to North Mountain basalts" and in part to a general similarity in textural and mineral composition (Boyle, 1972). Durocher (1974) suggested a Late Mississippian age because of cleavage cutting the sills (not observed by writer). Barr (1994, personal communication) states that the type and intensity of alteration are unlike anything she has observed in North Mountain basalts and that the "intense alteration strongly indicates that the rocks are not Mesozoic".

The dykes form disparate blocks within the fault zone at Johnson Cove (ie. are pre-faulting). Similar dykes have not been observed in rocks younger than the Horton Bluff Formation in areas mapped by the writer. Only minor faults affect the Fundy Group locally and elsewhere. The alteration of the dykes is intense. This combination of factors suggests a Tournaisian age for the igneous rocks of the map area.

## FUNDY GROUP

### Wolfville Formation

The Anisian to Carnian (Middle to Lake Triassic) Wolfville Formation occurs at the base of the Fundy Group (Klein, 1962). Its type area extends from Paddys Island south to Kingsport along the western shore of the Minas Basin at the mouth of the Avon River, Kings County, Nova Scotia.

Medium to coarse grained, red and brown sandstone is characteristic but pebbly sandstone and conglomerate are usual near the base of the formation. Minor mudstone also occurs. Characteristic primary structures are crude to massive bedding, planar and trough cross-bedding, channelling and scour related features. Caliche paleosol profiles occur throughout (Forlenza, 1982). Sparry calcite is a common cement. Prevailing compositions are arkoses, lithic arkoses and feldspathic litharenites but minor quartz arenites also occur.

The thickness of the formation has been estimated to be about 375 metres by Forlenza (1982) or 363 metres by Klein (1962) for the type area.

The sediments are mainly the products of braided rivers including upsection alluvial fan, pebbly sandy braided river and sandy braided river deposits along the south shore of the Minas Basin (Forlenza, 1982).

Paleocurrent studies by Cormier (in Moore, 1994) and McKnight (this study) indicate a change in average paleo-current direction from northeast to north across the Walton-Rainy Cove and Bramber-Cambridge Cove map-areas (east to west). This also appears to be accompanied by a slight decrease in grain size. No conglomeratic facies appears to be present at the base of the Triassic section at Johnson Cove.

## STRUCTURE

### Folds

#### Horton Bluff Formation

The most significant fold structure affecting the Horton Bluff formation in the map-area appears to have broad anticlinal form and trends approximately 25 to 30° from the junction area of Cove road and Highway 215 towards Bass Brook near its mouth and then generally about 60° towards Cambridge Brook and the shore near Little Rainy Cove. Consequently, coastal sections southwest from Rainy Cove lie on the northwest limb of the structure, the section at Walton on the southeastern limb. Thus, the section in a general way is ascending stratigraphically from Little Rainy Cove to the vicinity of Red Head (Split Rock), from Johnson Cove north to Red Head and from Whale Cove south to Walton.

The broad structure comprises many minor anticlines and synclines and perhaps is equivalent to Bell's (1929) Greenfield anticlinorium which he states extends northeast from the old settlement of Greenfield on Halfway River to Walton and beyond where the structure is partly covered unconformably by Triassic rocks". Boyle (1972) states that the axial trace of the Walton anticline (included in the anticlinorium) would pass through the Devils Burrow, the area just north of Cheverie Mountain and the area in the vicinity of Stubborn Head. The trace is not shown on either Bell's (1929) nor Boyle's (1972) maps however.

Complexity and intensity are normative for folds of the Horton Bluff Formation and this is particularly evident along the coast where folds are well exposed. The style of the folding is generally similar, that is asymmetric, chevron type but locally box and recumbent folds occur. The coarser clastics tend to exhibit concentric or parallel forms, the finer clastics often have disharmonic or diapiric forms. Due to ductility contrast small thrust faults also may telescope limbs due to layer parallel shortening.

Hinges of the main folds, locally visible, commonly have curvilinear traces that trend 20° to 30° (for 7 folds) and average 26° between Cambridge Cove and Bass Creek. In the vicinity of Red Head, trends ranged from 26° to 71° (for 15 folds), average 52°. In the latter area over 73 percent of the hinges were more than 50° with the azimuths decreasing in angle towards the fault zone to the south. Curvilinear hinges have been attributed either to cross-folding or irregular folding of beds of variable thickness (Fyson, 1964).

The axial planes of the main folds from Split Rock to Johnson Cove (see cross-section) generally have more steeply dipping southeast than northwest limbs with axial planes usually overturned to the northwest and with dips ranging from 56 to 76° (average 62°). (Boyle, 1972; Fyson, 1964).

Plunges of the main folds are generally low but variable along the hinge. They may be northeast or southwest as noted by Fyson (1964) at Split Rock but are dominantly southwest along the coast.

Cross-folds are not uncommon but often too small in scale to show on the map. In the map areas they include both S and Z shaped types or form conjugate pairs or box folds as observed by Fyson (1964). Commonly, they have steep and variable plunges.

A number of different opinions have been expressed in relation to the origin of the Horton Bluff folds. A shallow depth of origin seems clearly indicated by the shallow fold amplitude, frequent failure of fold limbs and variable geometry. High ductility contrast between shales and siltstones is also a factor affecting fold intensity (Moore, 1994).

For the Walton area, to the northeast, Stevens (personal communication) suggested compression along a northwest-southeast axis and that the family of folds at Walton constitutes a box fold system in which axial planes have been tilted in two directions, northwest and southwest. Boyle (1972) suggested that relationships at Split Rock, Starratt Point and the mouth of the Walton River pointed to thrusting and overriding movements from the northwest, but locally faulting modified the pattern. Fyson (1964) suggested that unusual cross-folds and folded folds might be due to the veering of a regional thrust from the northwest to a more northerly direction late in the folding process.

Fyson (1967) also proposed gravity sliding due to vertical movements in the flanks of the basin as a causative agent for folding. Bradley (1982) considered basin folding and minor thrusting to be second order effects of major dextral-slip faulting that occurred to the north across the Minas Basin.

As noted by Moore (1994) the shallow amplitude of the Horton Bluff folds, the frequent failure of fold limbs and their variable geometry suggest a shallow depth of origin. The average overturning direction is southeast along the coast as noted by Fyson (1964) and illustrated in the cross-section for Red Head (this paper). Overriding of upper beds towards the southeast seems the most likely cause of main fold development. Secondary and tertiary folds and main folds deviating from the regional trend appear to be related to strike slip faulting of local origin.

Cheverie Formation

Folds affecting the Cheverie Formation are more open than those occurring in the Horton Bluff, even where they occur in close proximity to tightly folded Horton Bluff strata (e.g. Johnson Cove). The major fold at Johnson Cove is an anticline with east-west trending hinge. A north-east trending fold axis may also occur east of Mill Brook but the rest of the Cheverie exhibits a mainly southeast dipping monoclinal structure. Local variation in attitudes are attributable to the lenticular nature of resistant sandstone and conglomerate beds and strike slip faulting.

Windsor Group

The Macumber Formation appears to have been folded to the same degree and in conformity with the underlying Cheverie in the map area. The overlying White Quarry Formation exhibits many flow folding structures which are not accordant with the main folding. B subzone (Bell, 1929) lithostratigraphic units from Windsor to at least the East Walton gypsum quarries characteristically are recumbently folded. The writer attributes the fold style to gravity sliding in part at the stratigraphic level(s) of former salt horizons at or towards the top of the White Quarry Formation. (Moore, 1994)

The Wolfville Formation generally dips north to northwesterly in the map area and usually between 4 and 7 degrees (McKnight, personal communication) It is part of the southern limb of a broad southwestward plunging, asymmetrical syncline in which the northern limb is steeper than the south (Swift et al, 1967)

### Faults

A set of faults trending northwesterly (about 300 degrees in the map areas) is steeply dipping, where observable, with a modest strike slip component of movement, perhaps 500-700 metres and is represented at Johnson Cove, southwest of Red Head. Faults of this set also may be observed near the mouth of the Walton River and at Rainy Cove (Moore 1994, Boyle, 1972).

Older east trending faults also transect the area. At Johnson Cove, for example, the Horton Bluff Formation has been brought into juxtaposition with the Macumber Formation by thrusting (cf. cross-section). It is also possible that the Horton Bluff Formation may be in contact with the Cheverie Formation along an east-west trending fault of similar origin through the middle part of the map area but the contact is not exposed.

Faults of nearly north trend commonly are steeply dipping, normal and reverse types of local significance and little displacement but low angle similar trending faults of unknown displacement also occur and may be observed along the shore.

Northeast trending faults also affect the map area and probably have greater significance (vicinity of Bramber). Some are inferred to separate the Macumber from the Cheverie, the Macumber from the White Quarry Formation and the latter from the Miller Creek Formation. Some of these may represent decollement faults associated with gravity sliding (Moore, 1994).

With respect to the Triassic, Forlenza (1982) has observed that two sets of high angle faults dissect Triassic rocks. The dominant set is oriented parallel to the synclinal axis, the second at a high angle to the first. Master border faults during Middle and Late Triassic time were located along the Cobequid fault system which lies to the north of the map area (Klein, 1962). Keppie (1976) and Zietz et al (1980) have postulated also a southern border fault now overlapped by upper Triassic strata.

Faults mapped by McKnight for this study in the map area have a dominantly northerly trend ranging from about 315 to 25 degrees. Displacements of these faults commonly range between one and three metres.

## ECONOMIC CONSIDERATIONS

### Horton Group

Many authors have commented upon the significance of the Horton Group for hydrocarbons in the Atlantic region. The reader may wish to consult, in this regard, Howie (1968), Williams (1974), Martel (1987) and McMahon (1988). Oil shales will be found discussed in Greiner (1962), Hyde (1984), and Macauley and Ball (1984). Papers dealing with mineral deposits include Worth (1969) and Ravenhurst and Zentilli (1987). Within the general Walton area, which includes the map areas, Boyle (1972) reports the occurrence of supergene copper minerals, mainly malachite, atacomite and paralacamite after chalcopyrite and barite, siderite, manganite-pyrolusite-psilomelane deposits in the Cheverie Formation. He also observes that the copper mineralization is usually associated with porous plant-bearing zones, the other mineralization with intersecting east-west and northwest trending faults.

## Windsor Group

Windsor strata, since at least the 18th century, have been significant contributors to the mineral wealth of the Atlantic region. Thus, gypsum, anhydrite, salt, potash, limestone, barite, siderite, lead, zinc, manganese and silver have all been mined and utilized to varying extent. As indicated by Boehner (1986), gypsum, anhydrite and their by-products have been used particularly for wallboard manufacture, plaster, cement retarder, soil conditioner and road metal. Salt has been used in food preparation and preservation, the chemical industries and for snow and ice removal on roads. Although both anhydrite and gypsum occur within the map-areas and immediately to the southwest near Cheverie, cultural development and usually thin hydration (of the basal anhydrite) precluded the likelihood of mine development. In Saarberg's hole S2-5, however, located near Cheverie, some 23.1 m of gypsum were encountered (Adams 1991). (White Quarry Formation).

Macumber and stratigraphically equivalent Gays River Formation carbonates host the economically significant Walton (Ba, Cu, Pb, Zn, Ag), Gays River (Pb, Zn) and Jubilee (Zn, Pb) deposits of Nova Scotia. Mineralization is associated with either dolomitized or sideritized intervals of the Macumber (Lavoie et al, 1994). Migration of burial related fluids is considered responsible for the transformation of the "tight" micritic limestone into porous dolostone or siderite host rock for Pb-Zn-and Ba-Cu mineralization. Sangster and Savard (1994) suggest a northwest source for the mineralizing fluids. Boyle (1972 found that mineralization was often associated with intersecting northwest and east-west trending faults in the Walton area. Other studies of the mineralization may be found in papers by Patterson (1989) and Smith and Collins (1981).

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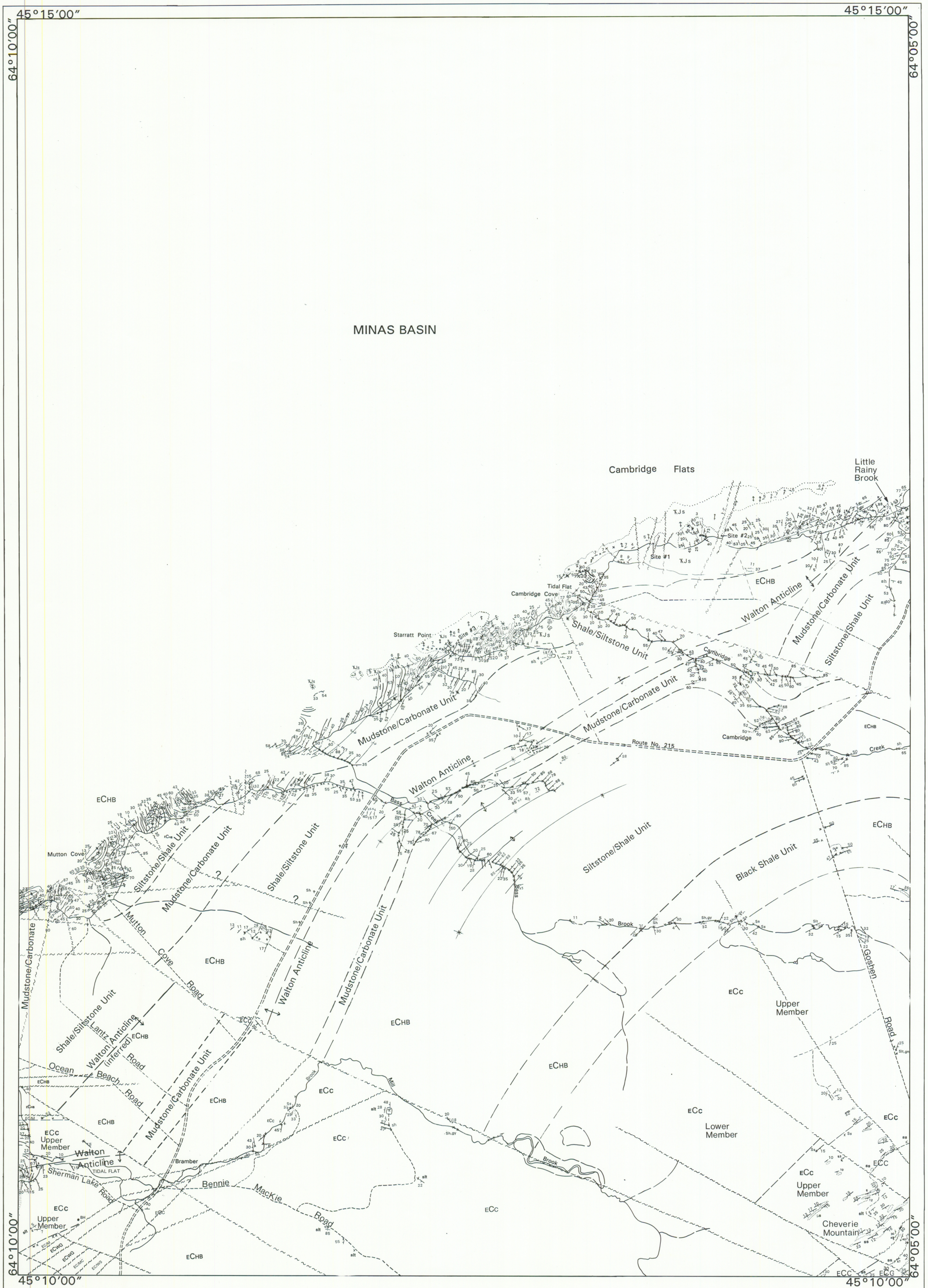



# CAMBRIDGE COVE - BRAMBER QUADRANGLE

## NTS 21H/01-Z1 AND Z3

## LEGEND

MESOZOIC

TRIASSIC-JURASSIC

FUNDY GROUP

TJs — WOLFVILLE FORMATION (TJs): red arkosic sandstone, minor cross-bedded pebble conglomerate, partly calcite cemented.

——— angular unconformity ———

PALEOZOIC

EARLY CARBONIFEROUS

ECws — WENTWORTH STATION FORMATION (ECws): gypsum, minor siltstone, limestone, dolostone.

——— fault usually ———

ECmc — MILLER CREEK FORMATION (ECmc): gypsum, minor siltstone, limestone, dolostone.

——— fault usually ———

ECwq — WHITE QUARRY FORMATION (ECwq): anhydrite, minor dolostone, salt.

ECm — MACUMBER FORMATION (ECm): thin bedded arenaceous limestone.

——— angular unconformity ———

HORTON GROUP

ECc — CHEVERIE FORMATION (ECc): arkose, sandstone, siltstone, conglomerate.

——— angular unconformity ———

ECHB — HORTON BLUFF FORMATION (ECHB):

Dark Grey/Black Shale Unit: dark grey to black shale, finely laminated, often pyritic, with minor siltstone, usually planar laminated.

Siltstone/Shale Unit: dark grey to black shale, finely laminated, clayey and grey; fine to course siltstone, mainly rippled, in part planar laminated.

Mudstone/Carbonate Unit: olive grey to green, non-laminated and bioturbated mudstone; drab grey to green grey, planar to wavy laminated siltstone; and usually dolostone either crudely bedded layers with nodular weathering or indiscrete large cannonball like forms. All units are separated by intervals of dark grey to black shale. Highest green-grey mudstone/carbonate unit forms the stratigraphic top of unit.

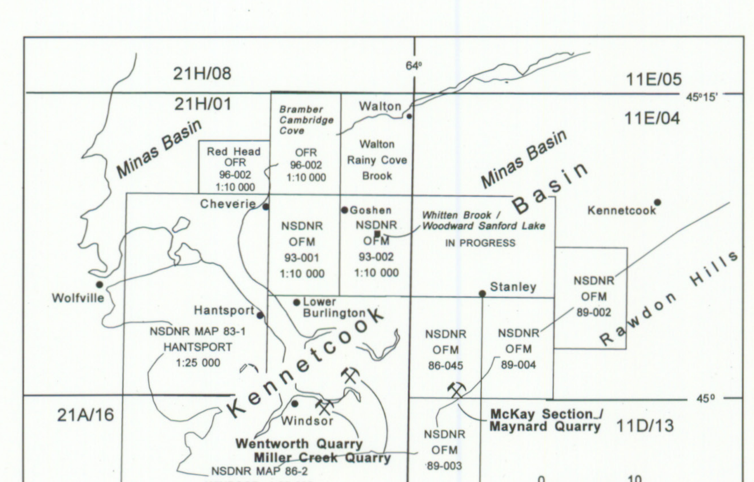
Shale/Siltstone unit: shale dominant, dark grey, finely laminated to homogeneous, with thin, often wave rippled siltstone lenses; siltstone, grey to green-grey, planar to lenticular bedded, in part wave rippled; some interbedded siltstone and grey shale.

Mafic sills and dykes associated with periods of intrusive and extrusive activity occurring throughout the geological column: diabase (Mdb)

## SYMBOLS

- Highway or primary road
- Other roads or trails
- Lake or pond
- Stream
- Indefinite stream
- Marsh or bog
- Area of outcrop, small outcrop
  - siltstone, sandstone, feldspathic sandstone — slt, ss, fsp
  - limestone, shale, gypsum — ls, sh, gyp
  - carbonate marker
  - siltstone marker
  - gy, gn — grey, green
- Dyke
- Geological boundary (defined, assumed)
- Bedding (horizontal, inclined, vertical, overturned)
- Fault (defined, approximate)
- Joint (inclined, vertical)
- Mean paleocurrent direction
- Anticline, syncline
- Karst topography, sink — K
- Mine or quarry (abandoned)
- Drill hole

**Scale 1:10000**




Project funded by The Nova Scotia Department of Natural Resources as a contract (Project 80801) under The Canada-Nova Scotia Cooperation Agreement on Mineral Development 1993-1996.

Geology by R.G. Moore 1993-94
Redrafted by A.D. McKnight and C.F. Cormier
Triassic Mapping by A.D. McKnight

Nova Scotia Department of Natural Resources
Minerals and Energy Branch

OFR 96-002

Geological map of

**CAMBRIDGE COVE - BRAMBER QUADRANGLE**

(N.T.S. SHEET 21H/01)

Hants County

NOVA SCOTIA

R.G. Moore

Scale 1 : 10 000

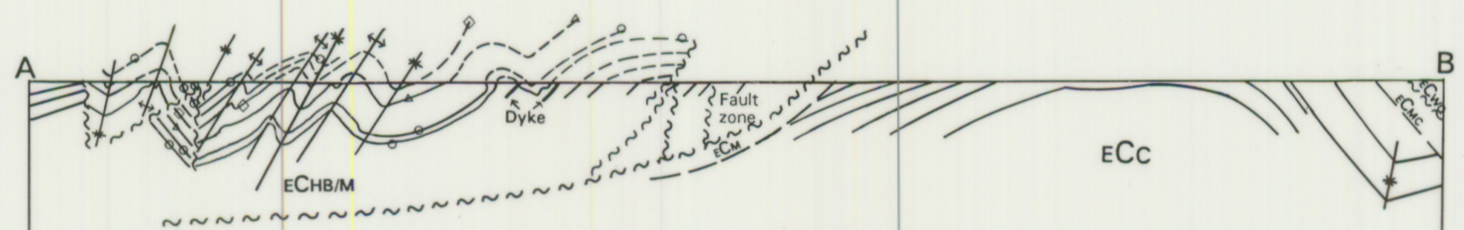
0 0.5 1

kilometres

Nova Scotia Department of Natural Resources
Honourable Donald R. Downe, Minister
Halifax, Nova Scotia
1996

Nova Scotia Department of Natural Resources


# RED HEAD NTS 21H/01-Y2




Semi-Schematic Cross Section; Line A-B

Geology by R.G. Moore 1994
Redrafted by A.D. McKnight

## LEGEND

MESOZOIC
TRIASSIC-JURASSIC

TJs — FUNDY GROUP
WOLFVILLE FORMATION (TJs): red arkosic sandstone, minor cross-bedded pebble conglomerate, partly calcite cemented.

——— angular unconformity ———

PALEOZOIC
EARLY CARBONIFEROUS

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ECM — MACUMBER FORMATION (ECM): thin bedded, arenaceous limestone.

——— angular unconformity ———

HORTON GROUP

ECc — CHEVERIE FORMATION (ECc): arkose, sandstone, siltstone, conglomerate

——— angular unconformity ———

ECHB — HORTON BLUFF FORMATION (ECHB):
Dark Grey/Black Shale Unit: dark grey to black shale, finely laminated, often pyritic, with minor siltstone, usually planar laminated.
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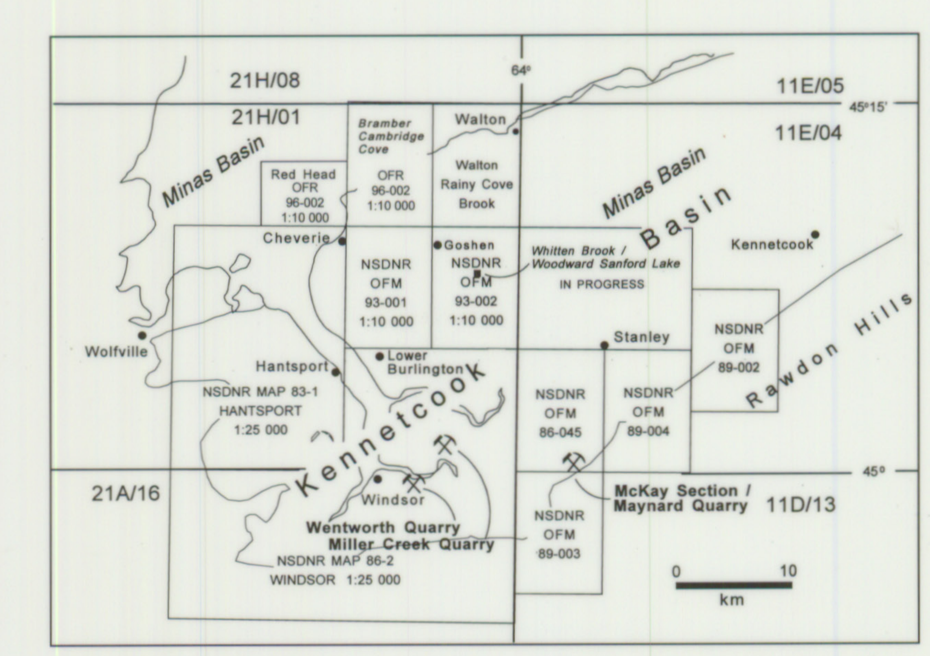
## SYMBOLS

Highway or primary road
Area of outcrop, small outcrop
Geological boundary (defined)
Bedding (horizontal, inclined, vertical, overturned)
Fault (defined, approximate)
Anticline, syncline
Dyke
Lenticular Silt Marker
Ripple Marked Silt Marker
Carbonate/Mudstone/Siltstone Marker
Silt Unit
Projected Unit

**Scale 1:10 000**

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Nova Scotia Department of Natural Resources
Minerals and Energy Branch

OFR 96-002


Geological map of
**RED HEAD**
(N.T.S. SHEET 21H/01)
Hants County
NOVA SCOTIA

R.G. Moore

Scale 1 : 10 000
0 0.5 1
kilometres


Nova Scotia Department of Natural Resources
Honourable Donald R. Downe, Minister
Halifax, Nova Scotia
1996

Nova Scotia Department of Natural Resources