Lithostratigraphy of the Late Devonian-Early Carboniferous Horton Group of the Moncton Subbasin, southern New Brunswick

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The threefold subdivision of the Late Devonian - Early Carboniferous Horton Group in the Moncton Subbasin of southern New Brunswick conforms to the original description and subsequent adoption of the group elsewhere in the Maritimes Basin. The Horton Group consists of the Memramcook, Albert and Moncton formations, the Moncton Formation having previously been regarded as a group. The Memramcook Formation rests unconformably on pre-Carboniferous basement and is conformably overlain by and in part the lateral facies equivalent of the Albert Formation. The Albert Formation contains five variably developed members (both spatially and, in part, temporally): the Dawson Settlement, Frederick Brook, Hiram Brook, Round Hill and Gautreau members. Of these, the Round Hill and Gautreau members have previously been the subject of much stratigraphic debate but are herein proposed simply as members of the Albert Formation. The formally proposed Moncton Formation is subdivided into a lower Weldon Member and an upper Hillsborough Member; where the contact can actually be defined it is un-conformable. The Albert Formation - Weldon Member contact is conformable and transitional. The Hillsborough Member - Windsor Group contact is marked by an abrupt facies change where Windsor Group strata are marine as distinct from non-marine in origin.

Le groupe Horton (Dévonien supérieur - Carbonifère inférieur) que l'on retrouve dans le sous-bassin de Moncton au sud du Nouveau-Brunswick est divisé en trois formations, conformément à la description originale telle qu'adoptée ailleurs dans le bassin sédimentaire des Maritimes. Le groupe Horton comprend les formations de Memramcook, Albert et Moncton (la formation de Moncton était autrefois considérée comme un groupe). La formation de Memramcook repose en discordance sur un socle pré-Carbonifère et est recouverte de façon concordante par la formation d'Albert. La formation de Memramcook est également en partie un faciès latéral de la formation d'Albert. La formation d'Albert compte cinq membres dont l'emplacement a varié dans l'espace, et em partie, dans le temps: les membres Dawson Settlement, Frederick Brook, Hiram Brook, Round Hill et Gautreau. Les membres Round Hill et Gautreau, qui par le passé ont soulevé maints débats stratigraphiques, sont ici présentés comme membres de la formation d'Albert. La formation de Moncton, présentée de façon officielle, est divisée en un membre inférieur, Weldon, et un membre supérieur, Hillsborough; là où il peut être indentifié, le contact est discordant. Le contact concordant entre la formation d'Albert et le membre Weldon en est également un de transition. Le contact entre le membre Hillsborough et le groupe Windsor n'est marqué par un brusque changement de faciès que là où les strates du groupe Windsor sont distinctement d'origine marine, plutôt que non-marine.

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INTRODUCTION

The Late Devonian-Early Carboniferous Horton Group of Bell (1927, 1929) in the Maritimes Basin (Williams 1974) of eastern Canada represents the basal group of a succession of molasse sediments which accumulated in an essentially non-marine successor-type strike-slip basin (Bradley 1982). Present-day distribution of. the Horton Group represents the erosional remnants of a complex series of subbasins and arch or uplift structures which controlled the spatial development of the strata. In southern New Brunswick, Horton Group strata accumulated in the Moncton Subbasin (Fig. 1) and are characterized by alluvial fan, fluvial-deltaic and lacustrine sediments. The Moncton Subbasin trends northeast, narrows to the southwest, and is bounded to the southeast by the pre-Carboniferous basement of the Caledonia Uplift and to the northwest by the Kingston-Indian Mountain Uplift. The eastern end of the subbasin is bounded, and in part bifurcated, by the Westmorland Uplift, the existence of which is clearly revealed when isopach data for the Horton Group are examined (Fig. 2). During deposition of the Horton Group, the Kingston and Westmorland uplifts were passive features whereas the Caledonia Uplift provided an important and continuous supply of detritus (Pickerill and Carter 1980).

Research in the Horton Group of the Moncton Subbasin has revealed that the existing stratigraphic nomenclature is unsatisfactory. Traditionally the group has been subdivided into a basal Memramcook Formation (Norman 1941a, 1941b), a medial Albert Formation (Norman 1932) and an upper unit referred to as Moncton

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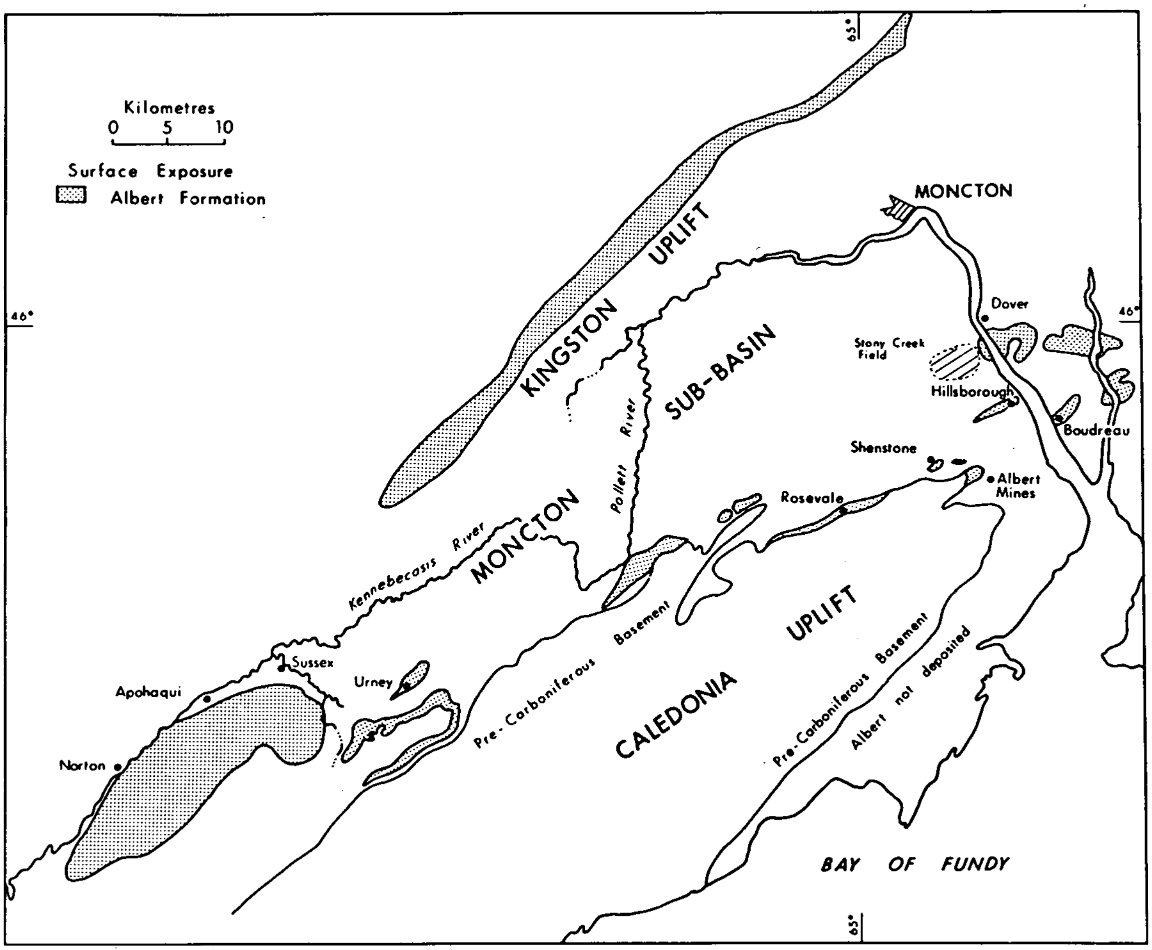


Fig. 1 - Location of the Moncton Subbasin, southern New Brunswick and the Caledonia and Kingston uplifts (modified after Macauley et al. 1984).

Group (Norman 1932) comprising a lower Weldon Formation and an upper Hillsborough Formation as shown in Table 1. Clearly, this scheme contravenes all existing codes of stratigraphic nomenclature. To alleviate these difficulties we herein propose to retain the threefold stratigraphic subdivision of the Horton Group but formally propose that the Moncton Group be relegated to formational status and the Weldon and Hillsborough formations to member status within the Moncton Formation. This scheme conforms to existing stratigraphic codes and, as we will demonstrate, is a more realistic subdivision of the lithostratigraphy.

Of equal importance is the confusion that has arisen over the last two decades or so with respect to the internal stratigraphic nomenclature of the Albert Formation. This confusion has arisen not only as a result of different workers with different professional backgrounds adopting different stratigraphic philosophies, but also as a result of the complex spatial and temporal facies relationships existing within the Albert Formation. In this paper we identify some of these nomenclatural problems, briefly review existing nomenclature, formally propose that the Gautreau Formation of Norman (1932) and Round Hill Formation of McLeod (1980) be included as members of the Albert Formation and outline areas for future and more detailed stratigraphic research.

It must be emphasized that in this paper we do not propose additional stratigraphic units within the Horton Group of the Moncton Subbasin; rather, we place previously established units into a more workable and realistic lithostratigraphic framework which conform to

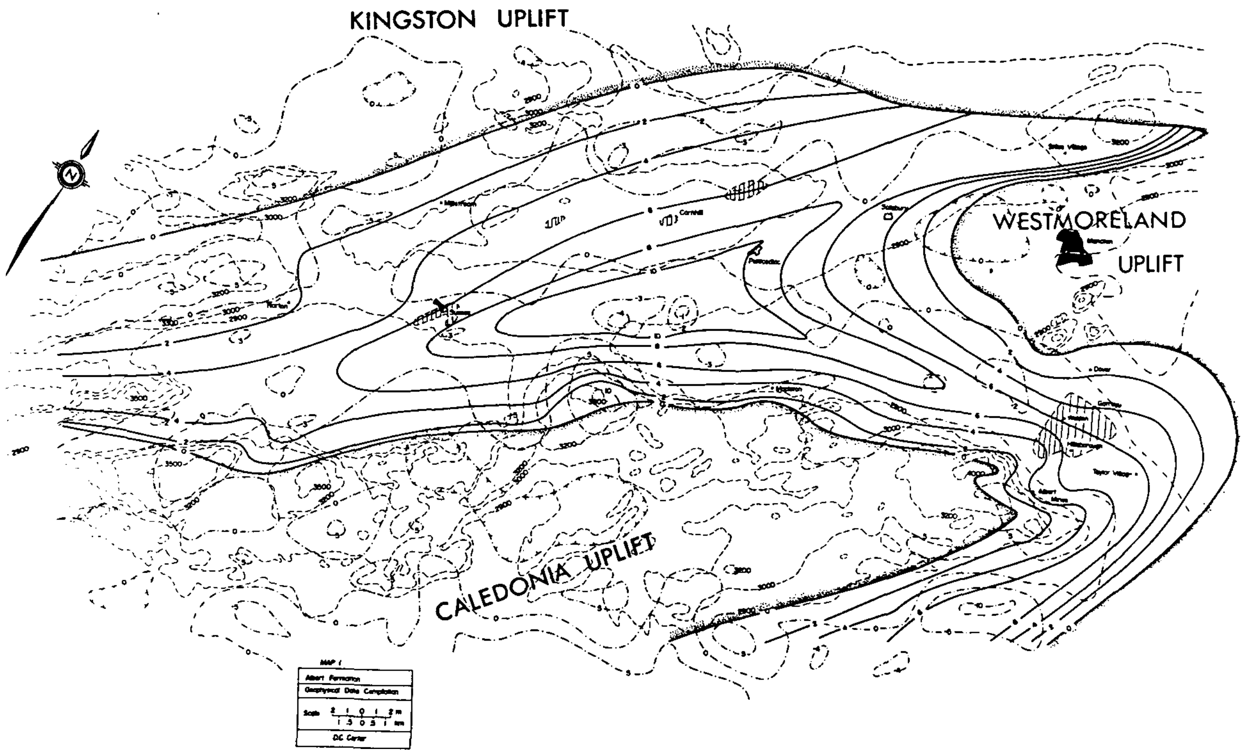


Fig. 2 - Gravity, aeromagnetic and isopach data for the Horton Group in the Moncton Subbasin. Gravity data shown in dip/strike and dot pattern and is in milligals. Aeromagnetic data shown in line and dot pattern and is in gammas. Isopach data shown in solid line and scale is in thousands of feet. Vertical line ornament outlines presumed Horton gravity anomalies (= salt bodies).

existing codes of stratigraphic nomenclature. As this paper places more emphasis on the Albert Formation, we initially discuss the underlying Memramcook and the overlying Moncton formations. Figure 3 is a location map of all sites referred to in the ensuing text or in the additional figures and Table 1. More detailed sedimentological descriptions and facies interpretations of the Horton Group in the Moncton Subbasin can be found, for example, in Gussow (1953), Schroder (1963), Popper (1965), McLeod and Ruitenberg (1978), Pickerill and Carter (1980), Macauley and Ball (1982), Pickerill **et al.** (1985) and references therein.

MEMRAMCOOK FORMATION

The Memramcook Formation, introduced formally by Norman (1932), rests unconformably on pre-Carboniferous basement and is composed of a series of red, often distinctively purplish red, arkosic and micaceous conglomerates, sandstones, siltstones and shales with minor green intervals. The upper boundary of the formation is generally conformable and gradational with the overlying Albert Formation; however, local disconformities were suspected by Greiner (1962). The suspected disconformities, however, are based on the absence of the coarse basal unit of the Albert Formation (Greiner 1962) and such relationships can equally, and more readily be explained by transgressive overlap of the finer grained Albert facies (cf. Pickerill and Carter 1980). The suspected disconformities are therefore considered as unnecessary and unsubstantiated. Due to the interdigitating nature of color types, the Memramcook/Albert contact has traditionally been arbitrarily placed where either red or grey coloration becomes dominant. Miospores from the Memramcook Formation indicate a Late Devonian (Famennian) age (Hacquebard 1972, Barss **et al.** 1979).

Outcrop and drill data suggest that the formation is, on the whole, present throughout the Moncton Subbasin, though its thickness varies considerably from c. 140m in the southwest to more than 2350m in the belt near Lutz Mountain (Gussow 1953), adjacent to the Kingston Uplift. In its type area near Memramcook Village, the Memramcook Formation is c. 500m in thickness (Norman 1941a, 1941b). An important exception to this generalization occurs in the Rosevale area where the Memramcook Formation is absent, and instead, the Albert Formation rests directly and unconformably on pre-Carboniferous basement strata of the Caledonia Uplift (Gussow 1953, Greiner 1962). This implies either a period of pre-Albert Formation erosion of the Memramcook Formation in this area, or alternatively, transgressive overlap of the Albert Formation onto basement strata. Because the transition between Memramcook and Albert strata is everywhere else gradational, the latter suggestion is favoured. Strata of the Memramcook Formation are representative of a post-orogenic redbed molasse facies formed by deposition of sediments in piedmont alluvial fan(s) and associated braided fluvial environments.

MONCTON FORMATION
(Weldon and Hillsborough members)

Since formally defined by Norman (1941a, 1941b) the Moncton "Group" has been the subject of a complex and varied stratigraphical debate but has consistently been divided into two units, herein formally proposed as the Weldon and Hillsborough members. Thickness of the "group" is difficult to estimate because of the few well-exposed and structurally simple sections available. However, in general, it thickens northward away from the Caledonia Uplift from as little as c. 100m near Upham to as much as 2000-2400m southwest of Sussex (Gussow 1953). Thickness of individual members also varies accordingly.

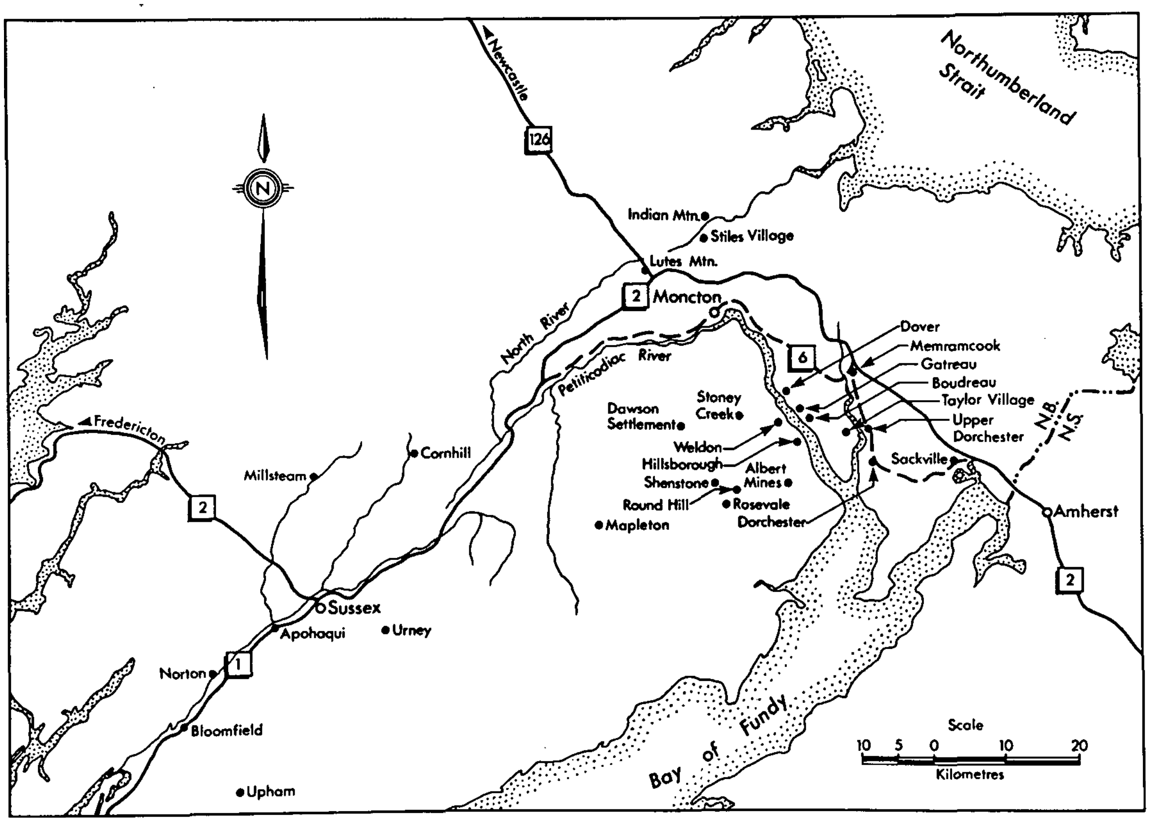
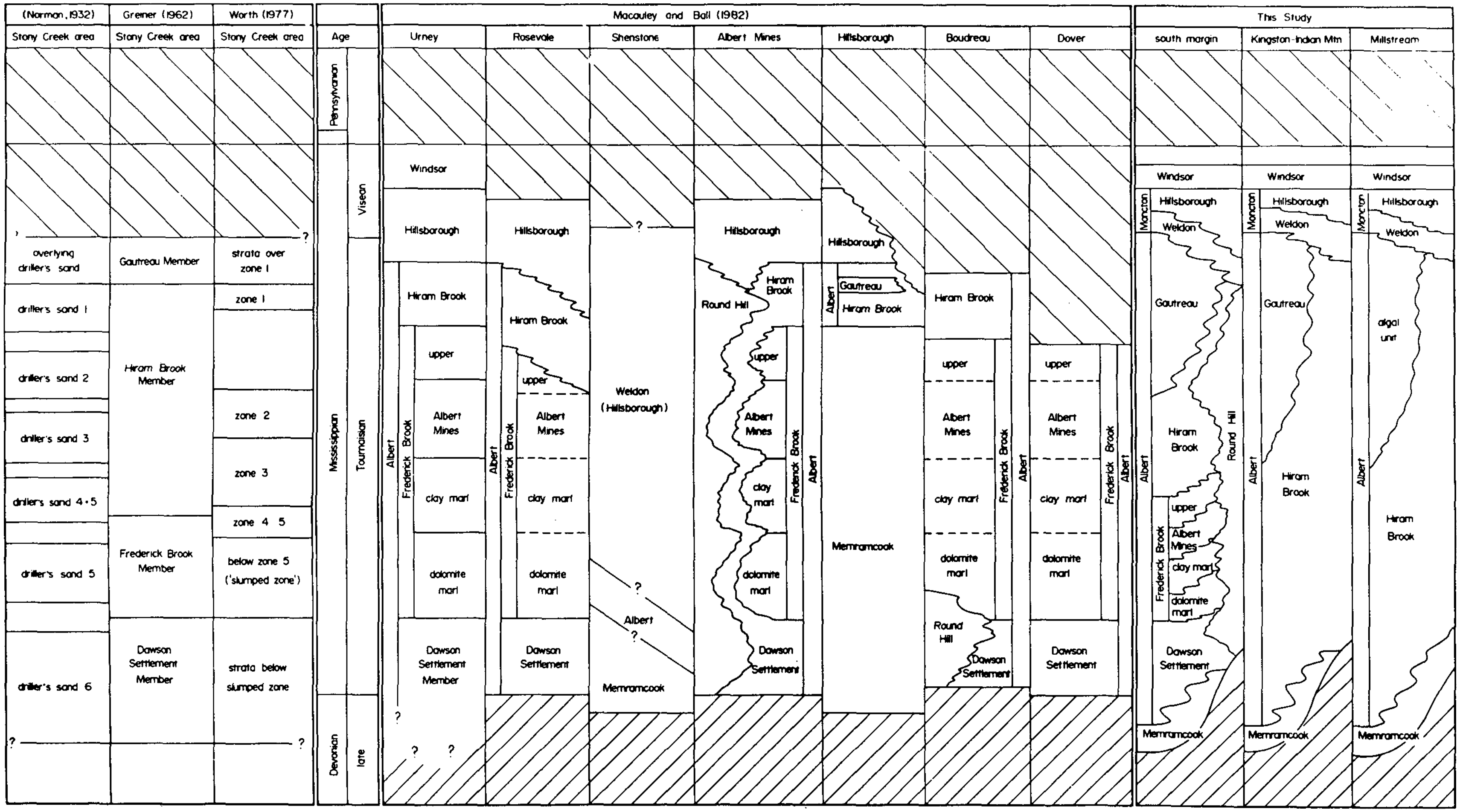


Fig. 3 - Simplified map of the Sussex-Moncton area, southern New Brunswick, illustrating locations referred to in the text and in Figures 1, 2 and Table 1.

TABLE 1

Stratigraphic nomenclatural schemes of the Albert Formation, Moncton Subbasin, southern New Brunswick (see text for details)



There is little doubt that these two units are mappable, can normally be differentiated and belong to a single package of redbed strata which separate underlying grey strata (=the Albert Formation) from the overlying marine limestones/evaporites and associated strata of the Windsor Group. If, however, these strata are to be included within the Horton Group, which seems reasonable when considering the threefold subdivision of Carboniferous strata elsewhere in eastern Canada (see Knight 1983 for review), then the term Moncton "Group" should be abandoned. Thus to conform with existing stratigraphic codes, we formally propose that the term Moncton Formation should be adopted for this redbed sequence and the Weldon and Hillsborough be regarded as members of this formation (cf. Kelley 1967, 1970; van de Poll 1972).

The basal Weldon Member consists predominantly of interchannel, overbank and floodplain deposits of red conglomerate, sandstone, siltstone and mudstone and the Hillsborough Member comprises coarser grained red fluvial channel and alluvial fanglomerates and a basal volcanic ash bed. The contact of the Weldon Member with the underlying Albert Formation is generally conformable and gradational, similar to that of the Albert-Memramcook contact. The Albert-Weldon contact is defined; (l) by the occurrence of a basal Weldon conglomerate overlying finer grained Albert lithofacies (ii) by dominance of color (lowest red bed, highest grey bed) in coarse- or fine-grained lithofacies, (iii) where the Weldon overlies the more easily recognizable Gautreau Member (as defined herein) of the Albert Formation.

Contact of the Weldon and Hillsborough members is not so straightforward. In places there is an upward transition from fine- to coarse-grained strata representing a conformable succession. At such localities the Moncton Formation cannot be easily subdivided (Gussow 1953, Greiner 1962). Elsewhere, the Weldon Member has been eroded and structurally deformed before deposition of the Hillsborough Member (Gussow 1953, Schroder 1963, McCutcheon 1978), and where such contacts are exposed the two members are easily differentiated.

Gussow (1953) regarded the Weldon Member as the upper unit of the Horton Group and the Hillsborough Member as the lower unit of the overlying Windsor Group. However, Kelley (1970) and van de Poll (1972) included both the Weldon and Hillsborough members within the Horton Group in order to satisfy Bell's (1929) original definition of the Windsor Group, the base of which was placed at the lowermost marine unit. More recently, McCutcheon (1981) also removed the Hillsborough Member from the Windsor Group. Additionally, Schroder (1963) suggested that the term Moncton Group be dropped but the Weldon and Hillsborough units retained since they were mappable units separated, at least locally, by an unconformity. Kelley (1970) and van de Poll (1972) suggested, as we do herein more formally, that the Weldon and Hillsborough be given member status within a newly proposed Moncton Formation.

We propose, therefore, that the Weldon and Hillsborough members be included in the Horton Group to conform to the original description and definition of the group by Bell (1929). Not only does this conform with the majority of recent suggestions by workers in the Moncton Subbasin (see above) but also the scheme is more consistent with more recent work in other parts of the Maritimes Basin (e.g. Anderle **et al.** 1979, Knight 1983). This work places the base of the Windsor-Codroy groups at the first occurrence of marine beds within the sequence. Additionally, McCutcheon (1981) has reported that the contact between Hillsborough and Windsor strata is structurally conformable but not gradational and that rocks typical of a transition from a terrestrial to a marine environment are absent. Because strata of the Windsor Group simply represent a marine transgression into the subbasin, we suspect that this latter conclusion is probably an oversimplification and that, in part, marine Windsor Group strata are in fact lateral temporal equivalents of the upper parts of the non-marine Hillsborough Member. Nevertheless, this still does not preclude inclusion of both the Weldon and Hillsborough members as an integral part of the Horton Group. Although locally an unconformity exists between the Weldon and Hillsborough members (cf. Schroder 1963), in most areas they are apparently in conformable contact. In these latter areas, where the lithofacies are similar, it is extremely difficult and often impossible to allocate specific outcrops and/or sections to one or the other member. In such a case, the only real differentiating criterion is that in general, the Weldon Member, when considered in total, is finer grained than the Hillsborough Member. Nevertheless, because both members contain similar lithofacies, and facies relationships are varied and complex, the term Moncton Formation is perhaps the best descriptor, particularly where outcrop is sparse and, or, discontinuous.

ALBERT FORMATION

Four stratigraphic nomenclatural schemes have, to date, been proposed to describe the internal stratigraphy of the Albert Formation, which has been interpreted as a composite alluvial fan, fluvial-deltaic and lacustrine sequence (e.g. Greiner 1962, Pickerill and Carter 1980, St. Peter 1982). The first proposed scheme was based on the "driller sands" recognized by geologists of the New Brunswick Gas and Oilfields Limited at the Stoney Creek field (Norman 1932); the second was based on examination of the Albert Formation in the entire Moncton Subbasin (Greiner 1962), which was in fact based on the earlier work by Wright (1922); the third was based on a modification of the driller sand terminology and described by Worth (1977); and the fourth was a modification of Greiner's subdivision by Macauley and Ball (1982) and Macauley **et al.** (1984). Table 1 summarizes the nomenclatural schemes previously applied to the Albert Formation including the modifications recommended herein.

1. The original "driller sand" terminology was based on the recognition of six oil- and gas-bearing zones, five of which are sandstones and one a bituminous shale, separated by intervening or transitional zones (Norman 1932, Henderson 1940). Driller sands I and II, the uppermost in the sequence, produce only small quantities of oil and natural gas and, in the Stoney Creek field, are laterally discontinuous, passing transitionally into bituminous and calcareous shale, limestone and salt (Howie 1968). Driller sands III and IV are the major gas producers. Driller sand V is the most persistent and thickest bituminous shale (actually a dolomitic marlstone) which, however, yields little free-flowing oil, while the upper part of driller sand VI is the major oil producer.

In the Stoney Creek field, the Albert Formation is represented by a stratigraphic section in the order of between c. 1350 and 1650m (Howie 1979), the upper 670m of which are strata overlying driller sand I consisting of thinly interbedded sandstones, siltstones and shales (some of which are more or less calcareous) and dolomites (Howie 1979). The remaining 680-980m (driller sands I-VI) consist of shales, siltstones, sandstones, minor conglomerates and minor and thinly bedded limestones. The sandstones are arranged in "packages" that in thickness range up to 35m (Howie 1979, Pickerill and Carter 1980). The number of sandstones per "package" varies from well to well, a maximum of 30 having thus far been recorded (Howie 1979). These sandstone "packages" form the driller sand groups and are separated by 15-130m of non-bituminous or bituminous shales and siltstones that in some areas appear to merge laterally into thin sandstones.

2. The second stratigraphic nomenclatural scheme was proposed by Greiner (1962), who subdivided the Albert Formation into three members based on the three zones described originally by Wright (1922). Greiner (1962) noted that in the driller sand terminology, only driller sand V could be readily recognized outside the Stoney Creek and Dover fields. This effective marker horizon he referred to as the Frederick Brook Member the stratotype of which is along Frederick Brook in the vicinity of Albert Mines (Fig. 3). Strata underlying the Frederick Brook Member were referred to as the

Dawson Settlement Member and the overlying strata the Hiram Brook Member. The stratotype of the Dawson Settlement Member was designated by Greiner (1962) as New Brunswick Gas and Oilfields Limited, Well Number 166 between 1200 and 1557.9m, Albert County and the Hiram Brook Member as New Brunswick Gas and Oilfields Limited, Well Number 104 between 362.7m and 985.8m, Albert County. The upper boundary of the Hiram Brook Member was marked by conformable contact with either the overlying Weldon Formation or Gautreau evaporites.

The stratigraphic rank of the Gautreau evaporities has proved to be somewhat of an enigma particularly as no stratotype was ever defined. Norman (1932) formally proposed the Gautreau "Formation" as "... salt tongue in the upper Albert Formation." Greiner (1962) accepted the formational status of the "... evaporite unit of local occurrence"; however, he also extended it "... to include argillaceous dolomites, and anhydrite and gypsiferous beds of obvious evaporitic origin". This was based on and expanded the work of Gussow (1953). In later work, Greiner (1974, 1977) referred to the Gautreau "Formation" as part of the Albert Formation and occurring in "Albert time". Recent workers have either chosen to ignore the problem entirely (e.g. Webb 1977) or have informally treated the Gautreau evaporites as a member of the Albert Formation (e.g. Hamilton 1961, Pickerill and Carter 1980, Macauley and Ball 1982, Macauley **et al.** 1984). As the member status of this laterally discontinuous package of evaporites and associated sediments has become more commonly recognized we herein formally propose that the package be referred to as the Gautreau Member. Although no strato-

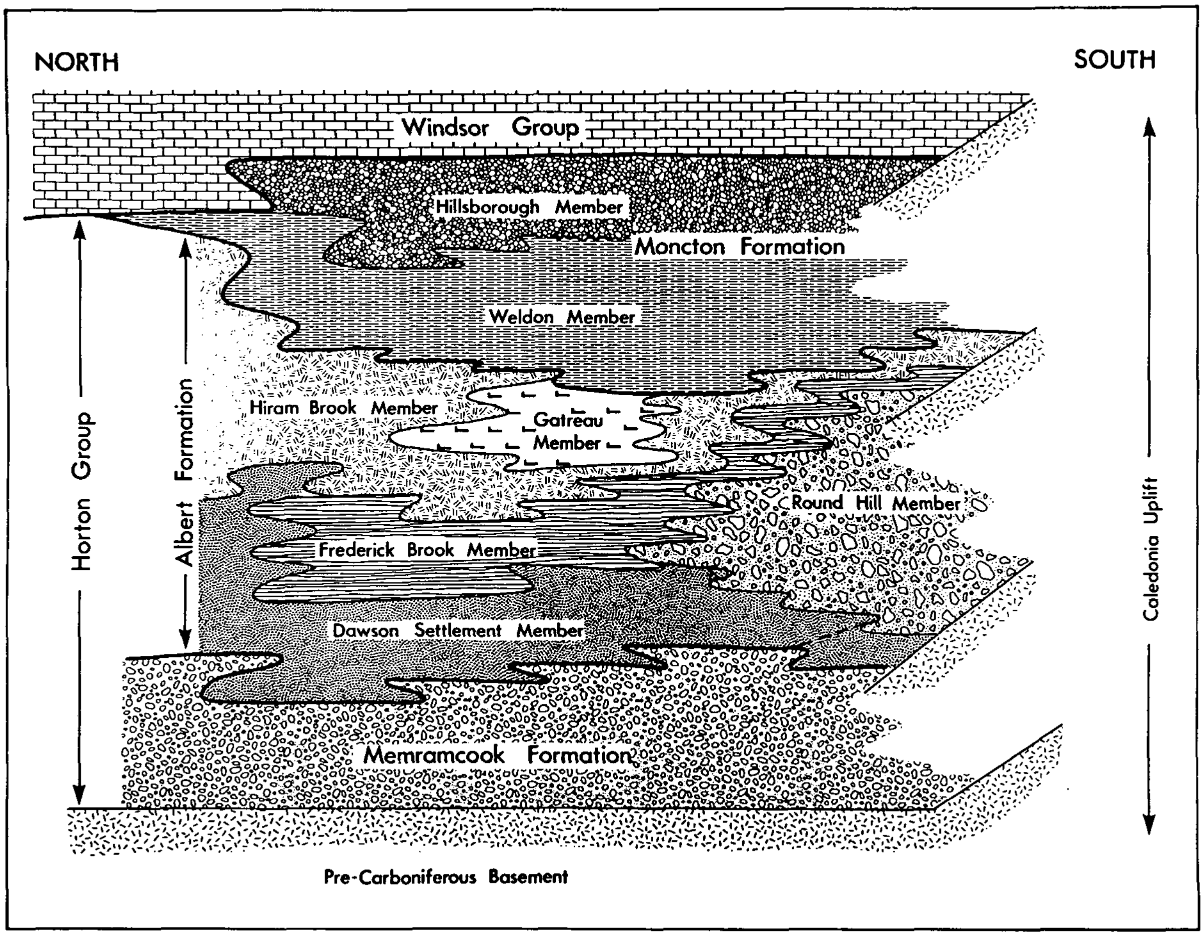


Fig. 4 - Schematic representation of the internal stratigraphy of the Horton Group, Moncton Subbasin, southern New Brunswick.

type was formally designated, two wells, which between them provide almost a complete section, may be considered as the principal reference section. These are New Brunswick Gas and Oilfields Limited, Well Number 112 between 360.6 and 937.8m and Well Number 49-1 from 387m to the bottom of the hole at 750.3m, Albert County. These cores are stored at the Mineral Resources Division, New Brunswick Department of Natural Resources in Fredericton.

The Hiram Brook Member consists of an heterogeneous assemblage of grey sandstone, siltstone and shale, the latter of which can be calcareous, bituminous or both. It is bounded at the base by the underlying Frederick Brook Member and, as noted above, at the top by the Gautreau Member and is c. 670m in thickness. In driller sand terminology it is equivalent to driller sands I (and even higher, i.e. Gautreau Member) stratigraphically down through to the top of V. Borehole data indicate that the member exhibits considerable vertical and lateral facies variation even within a short geographic distance (Greiner 1962, Howie 1968).

The Frederick Brook Member (equivalent to driller sand V) consists of thinly laminated to papery, flexible, grey bituminous shale with minor interbeds of siltstone and thin argillaceous limestone. Upper and lower contacts are gradational and are arbitrarily positioned where sandstone/siltstone beds predominate or, alternatively, where the first shales low in bitumen or lacking palaeoniscid fish remains become prominent. Total thickness is difficult to estimate but is usually quoted in the order of c. 180m (Greiner 1962). A more detailed description of the types and relationships of lithologies may be obtained from King (1963) and Pickerill and Carter (1980).

The Dawson Settlement Member consists of an heterogeneous assemblage of sandstones, siltstones and shales with minor limestone interbeds near its top, as exhibited in the stratotype (Greiner 1962). Vertical and lateral facies variations are quite complex and variably developed. In driller sand terminology, the member is equivalent to driller sand VI. In contrast to the Hiram Brook Member, bituminous zones and argillaceous limestones are rare or absent in the Dawson Settlement Member. Otherwise, the distinction between lithotypes of the Hiram Brook and Dawson Settlement members is difficult and their recognition relies on the presence of the intervening, readily recognizable, Frederick Brook Member.

As outlined previously, the upper contact of the Hiram Brook Member is marked by transition into the overlying Weldon Member of the Moncton Formation, or, alternatively, into the Gautreau Member. In the Weldon-Gautreau area, the Gautreau Member represents a small "salt basin" which probably developed diachronously so that in part the member is laterally equivalent to driller sands I and II and elsewhere overlies driller sand I (see Howie 1968, fig. 7). A comparable salt occurrence was documented by Worth (1975) and Webb (1977) in the Cornhill area, where a single drillhole intersected salt-bearing strata at a depth of c. 670m within the Albert Formation, viz.: at an approximately equivalent depth to that of the Weldon-Gautreau deposit. Unfortunately, the lateral extent of the Cornhill deposit is unknown. Nevertheless, it may well represent another of several small restricted 'salt basins' which pass laterally into coeval evaporitic and non-evaporitic strata.

3. Worth (1977), informally proposed a modification of the driller sand terminology for his report on the geology of the oil shales and lithofacies of the Albert Formation in the Hillsborough "Subbasin", that is, that portion of the area of the Moncton Subbasin to the south of the Westmorland Uplift. Essentially Worth's classification applied only to this "subbasin" and was erected for working purposes alone. For reasons outlined below, the reader is referred to the report by Worth (1977), the review by Carter and Shaw (1979) and Table 1 for a more detailed consideration of this nomenclatural scheme. Further comment is deemed unnecessary because:

(i) The scheme was not designed to be

applied outside the Stoney Creek and Dover fields of the Hillsborough "Sub-basin".

(ii) Although the scheme was supposedly a modification of driller sand terminology, it is extremely difficult to relate the two.

(iii) The scheme was based on the occurrence, according to Worth (1977), of several diastems occurring within the Albert Formation. Evidence for such diastems was not presented and, furthermore, in the absence of chronostratigraphic indicators or unconformities, cannot be realistically demonstrated.

4. The most recent publications on the stratigraphic nomenclature of the Albert Formation were by Macauley and Ball (1982) and Macauley **et al.** (1984), who:

(i) accepted and based their scheme on Greiner's (1962) threefold subdivision;

(ii) incorporated some of the more recent work, i.e. the complex temporal and spatial facies relationships described by Pickerill and Carter (1980) for the Albert Formation itself and the mapping and stratigraphic relationships suggested by McLeod (1980) in the Hillsborough area, and

(iii) reappraised previously unavailable drill core which intersected the oil shales.

Essentially, Macauley and Ball (1982) and Macauley **et al.** (1984) incorporated the Round Hill "Formation" described by McLeod (1980) as a member of the Albert Formation laterally equivalent to the three main members, **viz:** - the Hiram Brook, Frederick Brook and Dawson Settlement members. As noted by Carter and Pickerill (1985) in their discussion of the results presented by Macauley **et al.** (1984), the Round Hill "Formation" of McLeod (1980) should in fact be more realistically recognized as a member of the Albert Formation. Recent mapping in the type area by C. St. Peter (pers. comm. 1984) suggests that the originally defined Round Hill Formation of McLeod (1980) should, in fact, be more appropriaately referred to the Weldon Member of the Moncton Formation. Nevertheless, the descriptor Round Hill Member is still regarded as useful and appropriate to describe the development, both spatially and temporally, of grey-green fanglomerates that clearly interdigitate with the three main members of the Albert Formation (see for example Macauley **et al.** 1984, fig. 8). Herein we therefore relegate the Round Hill to member status within the Albert Formation, though do accept that possibly in the future a new stratotype will have to be defined.

The primary focus of Macauley and coworkers was on the Frederick Brook Member, which they informally subdivided into four lithologic units. In ascending order they recognized a dolomite marlstone, a clay marlstone, an Albert Mines zone, and an upper unnamed unit (Table 1). Recognition of this subdivision is difficult and not applicable to field studies since it is based primarily upon the distinction of the high grade oil shales of the Albert Mines zone or recognition of the clay marlstone with its increased clay content and associated relatively high water content as indicated by Fischer assay results. In fact Macauley and Ball (1982, p. 75) state ... "In areas such as Albert Mines, recognition of the Albert Mines zone is assured by the high kerogen content; however, such recognition is not nearly so positive in areas where environmental conditions were not favourable to the concentrated accumulation of algal material" (e.g. Boudreau, Dover, Rosevale and Urney). In the absence of the Albert Mines zone (e.g. due to nondeposition, poor exposure, etc.) the zonation therefore hinges on the recognition of the clay marlstone by its increased clay content and increased water yield determined by Fischer assay results. In short, this is not a particularly extremely useful zonation system for the field or well-site geologist.

LITHOSTRATIGRAPHIC RELATIONSHIPS WITHIN THE HORTON GROUP

Interpretation of stratigraphic relationships within the Horton Group has been complicated by:

(i)* Original complex depositional facies variations, both in a temporal and spatial sense.

(ii)* Post-depositional folding and faulting, and, at least in some cases, syndepositional, pre-Hillsborough Member erosion.

(iii) The paucity of continuously exposed sections.

(iv) The disregard of previous workers to the palaeoenvironmental framework in *which formational diachronism* is the 'norm' rather than the 'noise' in the system.

(v) The absence of chronostratigraphic indicators.

Table 1 is a schematic representation of several of the previously outlined stratigraphic relationships. There is little doubt that, apart from the Rosevale area, the Memramcook Formation is present throughout the entire Moncton Subbasin and lies with marked unconformity on pre-Carboniferous basement. Although the Albert Formation is clearly underlain by the Memramcook Formation and overlain by the Weldon Member of the Moncton Formation, particularly in the central portions of the Moncton Subbasin, it is also in part a lateral facies equivalent to both (see McLeod and Ruitenberg 1978, Pickerill and Carter 1980). We suspect that this situation is also complicated by a possible structurally and sedimentologically conformable contact between dolomitic shales (?Hiram Brook Member) of the Albert Formation and limestones and evaporites of the Windsor Group, as revealed by our recent examination of cores from the Upper Dorchester area (together with C. St. Peter and S.R. McCutcheon). Thus it would appear that the Albert Formation and Windsor Group are in direct contact and the Moncton Formation did not develop in this particular area. As similar relationships have not been observed in surface outcrop, this occurrence requires further and more detailed examination. Neverthelss, it does reflect the complex group and formational relationships developed within the Moncton Subbasin.

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*NOTE: Both (i) and (ii) above are further complicated by the nature of the poorly understood pre-depositional strike-slip and/or block faulting leading to basin development and molding.

Equally as enigmatic are the stratigraphic relationships within the Albert Formation itself. As previously noted by Pickerill and Carter (1980), not only are the Dawson Settlement and Hiram Brook members in part temporally equivalent to, respectively, the Memramcook and Moncton formations, but also member relationships within the Albert Formation itself are equally as complex (see Table 1 and Fig. 4). The Round Hill Member, as previously noted, clearly interdigitates with the Hiram Brook, Frederick Brook and Dawson Settlement members (see Macauley **et al.** 1984, fig. 8) and is overlain by the Weldon Member of the Moncton Formation. Whereas Macauley and Ball (1982) and Macauley **et al.** (1984) included, in part, the Round Hill Member as the (?) "sub-aqueous facies equivalent of the red conglomerates of the Memramcook and Moncton formations", we regard this as totally inappropriate. Firstly, this inclusion was not substantiated by these authors from either their surface map interpretation or their drill data and secondly, and more importantly, extending a member of the Albert Formation across additional formational boundaries not only contravenes codes of stratigraphic nomenclature but also serves to compound an already complicated stratigraphic package (see Carter and Pickerill 1985). We therefore suggest that the Round Hill Member be strictly regarded as a member of the Albert Formation which, in the Hillsborough area of the Moncton Subbasin, exhibits complex spatial and temporal development. To date, the relationship between the Round Hill and Gautreau members of the Albert Formation are unknown.

Considering these relationships, it is likely that in different portions of the Moncton Subbasin, formation and member contacts within the Horton Group, and with the Windsor Group, can be gradational or one can be a lateral facies equivalent to the other. It is suggested that these lateral facies relationships are most common adjacent to the Caledonia Uplift, whereas in the more central portions of the Moncton Subbasin, the formation contacts can be expected to be more transitional, with one formation clearly overlying the other (see Pickerill and Carter 1980). This is not unusual in the interpretation of strike-slip or pull-apart related basin structures or fluvial-lacustrine deposits described in other areas (see for example Hardie **et al.** 1978, Eugster 1980, Bradley 1982, Farquharson 1982, Nickel 1982, Collinson 1983, Eugster and Kelts 1983, Mann **et al.** 1983, Hardie 1984, and others).

Also, the concept of diachronism applied to comparable Carboniferous formations in eastern Canada is by no means a new one. Hacquebard (1972, and references therein), for example, demonstrated formational diachronism between all Visêan-Westphalian strata in eastern Canada based on extensive collections of spore data.

CONCLUSIONS

The threefold subdivision of the Horton Group in the Moncton Subbasin into a basal Memramcook Formation, a medial Albert Formation and an upper Moncton Formation conforms to the original description and definition of the group by Bell (1929) as well as to more recent work in the Maritimes Basin (for review see Knight 1983). In particular the Moncton "Group" should be relegated to formational status with previously established Weldon and Hillsborough "formations" assuming member status (cf. Kelley 1967, 1970; van de Poll 1972). The Moncton Formation, although more properly included within the Horton Group, is in part laterally equivalent to the Windsor Group.

The threefold subdivision of the Albert Formation proposed by Greiner (1962) and based on the original work of Wright (1922) is regarded as the most applicable to the subbasin as a whole, with the addition of the Round Hill member as a spatial and temporal equivalent of all three members in the Hillsborough to Sussex area, and the Gautreau Member (although to date not fully delineated spatially) being a temporal equivalent of the Hiram Brook Member. The basal Dawson Settlement and the upper Hiram Brook and Gautreau members of the Albert Formation are, in part, temporal equivalents of, respectively, the Memramcook and Moncton formations.

The subdivision of the Frederick Brook Member into four units by Macauley and Ball (1982) and Macauley **et al.** (1984) is regarded as useful but only in a limited context that certainly cannot be applied to the subbasin as a whole.

As indicated in Table 1, the Albert Formation on the northern margin of the Moncton Subbasin, from Millstream in the southwest to Indian Mountain in the northeast, consists of the Hiram Brook and Gautreau members (cf. Greiner 1962). In this area the medial Frederick Brook Member is not present to define the threefold subdivision of the Albert Formation; nevertheless, the occurrence there of the Gautreau Member defines the strata as 'upper' Albert Formation. It is also notable that Pickerill (1981) has recorded in detail an extensive "algal swamp" unit in the Millstream area proper which occupies a similar stratigraphic position to the Gautreau Member. This unit consists of bituminous shales with associated and extensive developments of diagenetic nodular carbonates and algal and oncolitic carbonates (see Pickerill 1981). The algal unit has not been extensively delineated because of its original recognition in three closely spaced drill holes (Gulf Minerals Canada Limited, LM8, 9 and 10 - see Pickerill 1981) and is merely regarded at this time as a facies variant within the Hiram Brook Member.

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