Correlation chart for Late Devonian to Permian stratified rocks of the Maritimes Basin, Atlantic Canada.

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Abstract

A new stratigraphic chart of the Maritimes Basin has been prepared in connection with an atlas of onshore sedimentary basins in Nova Scotia. The chart has been extended into Newfoundland (NL), New Brunswick (NB), and Prince Edward Island (PEI), where Nova Scotian units have close regional correlatives. The available stratigraphic information is simplified into 22 representative columns.

Correlation in the Maritimes Basin is challenging, both because of a lack of isotopically datable rocks and because biostratigraphically useful fossil groups tend to lack key species, due to unusual environments. Based on a review of recent International Commission on Stratigraphy timescales, together with more recent published isotopic ages, we have developed a working numerical timescale, tied to chronostratigraphy. Then, we have adopted a standard correlation of biostratigraphic zones to this chronostratigraphic scale.

The stratigraphic chart shows well-known major subdivisions, including the volcanic-dominated Fountain Lake and Piskahegan groups in the Late Devonian, and Late Devonian through Early Mississippian mainly clastic successions of the Horton and (in NB) Sussex groups. Some rocks assigned to the Horton Group in NS (and the equivalent Anguille Group in NL) are time-equivalent to the Sussex Group in NB. In addition, the age of organic-rich shales in the Horton Group varies from place to place. Overlying rocks of the Visean Windsor Group include carbonates, evaporites, and clastic sedimentary rocks. Four competing options for the age of the basal Windsor Group are presented. Estimates of the duration of the time-gap at the base-Windsor unconformity range from ~3-11 Myr. Overlying Mabou Group is dominated by clastic rocks but also includes significant evaporites. Its boundary with the Windsor is strongly diachronous where higher Windsor Group marine bands reach their depositional limits. Correlative rocks of the Barachois Group in Newfoundland contain significant coal seams.

A major unconformity separates the Mabou from overlying Cumberland Group, representing a gap of 3-4 Myr straddling the Mississippian-Pennsylvanian boundary. The Joggins section appears highly condensed when plotted against geologic time. An unconformity in the Duckmantian is widespread but represents a shorter break in sedimentation than previously inferred. Post-Duckmantian coal-bearing units in the Pennsylvanian are assigned to the Morien Group in Cape Breton Island, although this designation has been inconsistently applied. The highest, Pictou Group is also strongly diachronous. Its base has been inconsistently correlated by the Nova Scotia and New Brunswick surveys. It is hoped that the new stratigraphic chart will encourage resolution of some of these controversies.

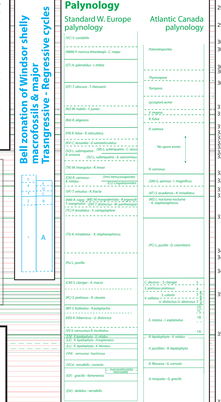
Introduction

The correlation chart represents a compilation of many authors' work. Correlation in the Maritimes Basin is challenging, both because of a lack of isotopically datable rocks and because biostratigraphically useful fossil groups, such as conodonts, foraminifera, and palynomorphs, tend to lack key species as a result of the unusual environments that existed, especially during the Mississippian.

A second challenge resides in the dispersed nature of the literature. Many larger compilations reference biostratigraphic reports that have not been formally published. In some cases these are unavailable, or are only available in hard-copy at the library of the institution where the work was submitted. Because of this, we have relied on larger-scale compilations rather than recording primary sources in many cases. All citations in the chart should be read as if implicitly followed by the words "and references therein".

A third challenge is representing lithologies that have been described by different authors working for diverse organizations using different terminologies over many decades. Many lithostratigraphic units in the Maritimes basin show great lithological diversity, but with a few exceptions are shown as single shaded blocks in the chart. For example, decisions had to be made whether units are shown as "mainly red" or "mainly grey", or whether mixed units should be shown using shadings representing carbonates or clastics. These decisions were based on published descriptions and the authors' experience where available. They necessarily are judgement calls, and others might differ in these assessments.

TIME SCALE REFERENCE



LEGEND

Mainly Red · Mainly Grey

Mainly conglomerate
Conglomerate & sandstone
Mainly sandstone
Mudstone with subordinate sandstone
Mainly mudstone (Shale and siltstone, minor sandstone)
Claystone and siltstone

AGE CONSTRAINT (generalized)
Shelly fossils / Foraminifera
Palynomorphs
Isotopic, with 2σ error

Dolostone
Limestone
Halite, potash
Sulphate evaporites
Limestone/evaporite interlayered
Limestone/clastic/evaporite interlayered
Limestone/clastic interlayered
Sandstone/evaporite interlayered
Mafic volcanic and clastic sedimentary rocks
Felsic volcanic and clastic sedimentary rocks
PLUTON

LITHOSTRATIGRAPHIC STATUS indicated by typeface.
GROUP NAME
Formation Name
Member Name

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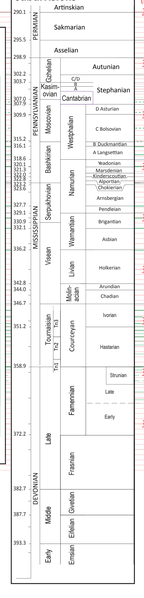
Open File Illustration MU 2018-001

Chronostratigraphic subdivisions



Numerical time scale

In reconciling biostratigraphic data from diverse fossil groups with sparse isotopic data we have primarily used the International Commission on Stratigraphy Geologic Time Scale (GTS 2012) (Becker et al., 2012; Davydov et al., 2012).

In the Devonian Period we use the divisions of Becker et al. (2012). However, we have modified the interpolated correlation between Late Devonian palynomorph zones and the numerical timescale shown by Becker et al. (2012), so as to take into account the precise work of Tucker et al. (1998) in the biostratigraphically well constrained Piskahegan Group of New Brunswick.

In the Carboniferous, our age dates are based on those of Davydov et al. (2010, 2012). However, some isotopic data not available for that compilation (Lyons et al., 2006; Pointon et al., 2012, 2014) suggest that certain ages need revision. A modified time scale has been used here to accommodate these data. In addition, it should be noted that Giles (2009) has suggested further revision of the timescale based on a correlation of transgressive-regressive cycles to orbital forcing; further work, not attempted here, would be required to incorporate these suggestions in a revised timescale.

Biostratigraphic time scale

The majority of biostratigraphic ages in the Maritimes basin are based on palynomorphs. However, the palynostratigraphic zonal scheme used is local to the Atlantic region, and no correspondence to numerical ages has been published. In placing the spore zones in the numerical timescale we first used Utting & Giles (2004) to match the larger zonal subdivisions in Atlantic Canada to stages and European fossil zones. We then mapped the spore zonation of Britain and Ireland (Clayton et al., 1977; Higgs et al., 1988; Riley, 1993; Owens et al., 2004; Waters et al., 2011) to conodont and foraminiferal zones using Davydov et al. (2004, 2010); and finally adjusted again for consistency with the numerical scale adopted here.

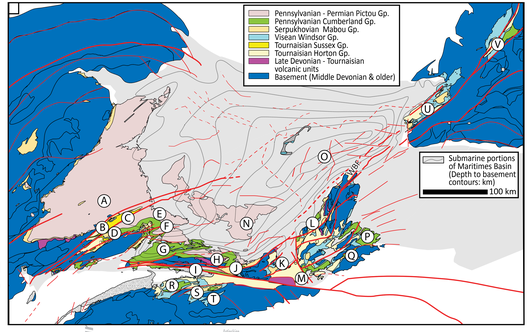
In the chart, palynostratigraphic boundaries and zone names are shown in green. Solid lines are tied to a foraminiferal or conodont zone boundary that can then be assigned a numerical age using the work of Davydov et al. (2004, 2010, 2012). Dashed lines are interpolated between these relatively constrained boundaries.

Other biostratigraphic schemes, mainly applicable in marine rocks of the Windsor Group, include Bell's (1929) system of macrofossil zones, used by Moore & Ryan (1976) (shown in cyan). However, these zones are difficult to correlate outside the Maritimes Basin, probably because the unusual, highly saline environments hosted a restricted fauna. Foraminifera are found in the same rocks and Mamet's (1970) zonation can be correlated with other regions (Mamet and Skipp, 1970; Von Bitter et al., 2006). However, the correlation with the European and international stages proposed by von Bitter is difficult to reconcile with that of Davydov et al. (2010, 2012), leading to further uncertainty.

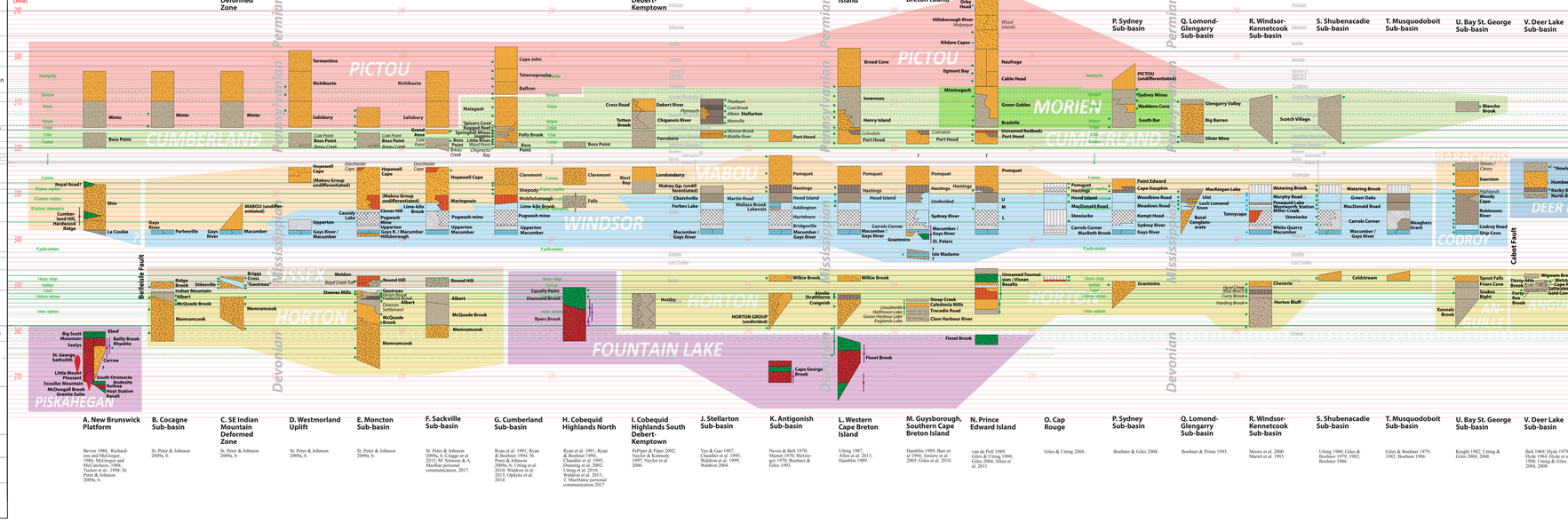
As a result of these problems, significant differences of opinion have arisen on the age of the lower part of the Windsor Group, equivalent to Bell's A subzone. In the chart, we show four different possibilities in a sidebar. The youngest age assigned to the basal Windsor Group shown is Early Asbian (~336 Ma in the timescale adopted here), as favoured by Mamet (1970) and St. Peter & Johnston (2009b). An older age of early Holkerian (~344-343 Ma) is favoured in most of the work of Utting and Giles (e.g. 2004), but von Bitter et al. (2006) favour a late Chadian age (~345 - 344 Ma) for the basal Windsor Group. A single isotopic constraint (Barr et al., 1994) implies that the base of the Windsor Group is younger than the St. Peters Gabbro dated at 339 ± 2 Ma. In the chart we place the base of the Windsor Group in a compromise position, above the dated gabbro, but older than the Asbian age favoured by St. Peter & Johnston (2009b), at ~ 338-339 Ma. We reconcile the older foraminiferal age of von Bitter et al. (2006) by suggesting (in our column for southern Cape Breton Island) that the Isle Madame limestone from which it was obtained is significantly older than the typical basal Windsor Group rocks elsewhere in the region.

Lithostratigraphy

We have tried to encompass most of the formal, and some informal litho-stratigraphic divisions that have been defined in the Maritimes Basin, but inevitably some are omitted. In organizing formations into groups, we have followed what we perceive to be a majority usage, giving priority to geological surveys who use lithostratigraphic subdivisions as a basis for mapping. There are notable differences between different organizations and authors, particularly in the use of the terms "Morien Group" and "Percé Group". Future versions of the chart may be constructed as interactive documents which will be able to show competing versions of lithostratigraphic organization.



SECTION LOCATIONS



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