Mesozoic-Cenozoic foraminiferal, ostracod and calpionellid zonation of the north Atlantic margin of North America: Georges Bank-Scotian basins and northeastern Grand Banks (Jeanne d'Arc, Carson and Flemish Pass basins). Biostratigraphic correlation of 51 wells.

by

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ABSTRACT

The first foraminiferal-ostracod zonation of the Scotian Basin was published by the author in 1976 and consisted of 56 foraminiferal and 14 ostracod zones, correlating the Bathonian to Miocene sediments of 15 deep oil exploratory wells. The zonation presented here represents a substantial expansion and updating of the previous one and consists of 87 zones in all: 25 planktic Foraminifera zones (from Bathonian to Late Miocene), 24 calcareous benthic Foraminifera zones (from Bathonian to Late Miocene), 15 arenaceous benthic Foraminifera zones (from Bathonian to Early Eocene) and 18 ostracod zones (from Bathonian to Maastrichtian). Furthermore, five calpionellid zones have been added for calibrating the age of foraminiferal and ostracod zones in the proximity of the Jurassic-Cretaceous boundary (Tithonian-Berriasian interval). Fifty-one wells located in five different basins have been studied: two wells in the Georges Bank Basin, 36 wells in the Scotian Basin (Scotian Shelf and southwestern Grand Banks) and 13 wells in the Jeanne d'Arc, Carson and Flemish Pass basins (northeastern Grand Banks).

All 87 zones are informal "assemblage zones', whose upper boundaries are defined by the highest stratigraphic occurrences of one or two "zone marker species", after which all zones are named. In several zones, one of the two "zone marker species" (or, exceptionally, a third one) has highest stratigraphic occurrence in the lower part of the zone, thereby effecting a subdivision of the zone into lower and upper part. In addition to "zone marker species", also "zone diagnostic species" have been used for identifying zone boundaries. "Zone diagnostic species" are species different from "zone marker species", but also having their highest stratigraphic occurrence at the top or in the lower part of their zone. The total number of "zone marker species" utilized for defining the zones is 142 and the numer of "zone diagnostic species" is 410. All these species are listed within their respective zone.

The composite zonation described here has been used in correlating all 51 wells studied. In biozonation charts, the biostratigraphically examined sections of these wells are subdivided into foraminiferal, ostracod and calpionellid zones, related to corresponding ages and given upper and

lower depth boundaries. The different kind of zones best represented and stratigraphically most instrumental for dating the various intervals of each well are pointed out, as well as those parts of sections having biostratigraphic core control, those undatable or missing owing to stratigraphic hiatuses, etc. This represents an updated biostratigraphic synthesis of all the work carried out so far by the author on the Georges Bank Basin and the Canadian Atlantic Shelf.

INTRODUCTION

Publication of geologic and micropaleontologic-biostratigraphic studies on the Canadian Atlantic Shelf was initiated shortly after oil exploration began in this area in 1966.

The geology of the Canadian continental margin off Nova Scotia and Newfoundland - and particularly its tectonic framework, lithostratigraphy and basin features - was described in detail by Jansa and Wade (1975) and Grant et al. (1986) and others.

In the field of micropaleontological biostratigraphy, the following publications are mostly concerned with the general biozonation of the Middle-Late Jurassic and the entire Cretaceous section of the Canadian Atlantic Shelf (Labrador Shelf excluded) and with the northernmost part of the adjoining U.S. Shelf.

Following a first list of foraminiferal, ostracod, calpionellid and palynomorph assemblages for 17 Scotian Shelf and Grand Banks wells and one Labrador Shelf well given by Gradstein, Williams, Jenkins and Ascoli (1975), Ascoli (1976) established a Jurassic to Miocene four-fold foraminiferal-ostracod zonation of the Scotian Basin (= Scotian Shelf + western Grand Banks), whereas Gradstein (1976) established a Jurassic foraminiferal zonation for the central and eastern Grand Banks. Ascoli's 1976 zonation (updated for the Late Jurassic by Ascoli, 1981) was partially extrapolated and applied to the Carson Basin of the eastern Grand Banks by Jansa, Remane and Ascoli (1980), and to the northern part of the Baltimore Canyon Trough and Georges Bank (northernmost part of the U.S. Atlantic Shelf) by Poag (1980, 1982) and by Ascoli, Poag and Remane (1984). A calpionellid zonation of the Tithonian-Berriasian interval was firstly established by Remane for the Scotian and Carson basins and illustrated in Jansa, Remane and Ascoli (1980). This zonation was later expanded, applied to the Georges Bank Basin, redescribed on the basis of highest stratigraphic occurrences of characteristic forms, and closely integrated with zones of Foraminifera and Ostracoda by Remane and Ascoli in Ascoli, Poag and Remane (1984). More recently, Stam (1986) established a foraminiferal zonation for the Middle and Late Jurassic of the Grand Banks, updating Gradstein's 1976 zonation for the Bajocian-Kimmeridgian interval and adopting Ascoli's 1976 zonation for the

Tithonian. Williamson (1987) published a quantitative foraminiferal zonation, based on a study of 13 wells, for the Late Jurassic and Early Cretaceous of the East Newfoundland Basin (now called Jeanne d'Arc Basin), and proposed eleven zones for the Kimmeridgian-Cenomanian interval.

The microfossil zonation of the North Atlantic margin of North America (Labrador Shelf excluded) described in this paper represents an expansion and a complete updating to December 1987 of the zonation previously established and published in Ascoli (1976) and later updated in Ascoli (1981, 1984, and in press), Jansa, Remane and Ascoli (1980) and Ascoli, Poag and Remane (1984). In schematic form, this zonation has been included in Williams et al. (in press).

This Open File report provides all the micropaleontological documentation (complete lists of "zone markers" and "zone diagnostic species" for each zone) which could not be included in Williams et al. (in press).

Fifty-one wells were examined in whole or in part. These wells are from five sedimentary basins: Georges Bank, Scotian, Jeanne d'Arc, Carson and Flemish Pass basins. This compares with 15 wells from only one basin (the Scotian Basin) analyzed in the 1976 zonation. The location of all wells studied is shown in Figure 1; these wells are, from southwest to northeast, as follows:

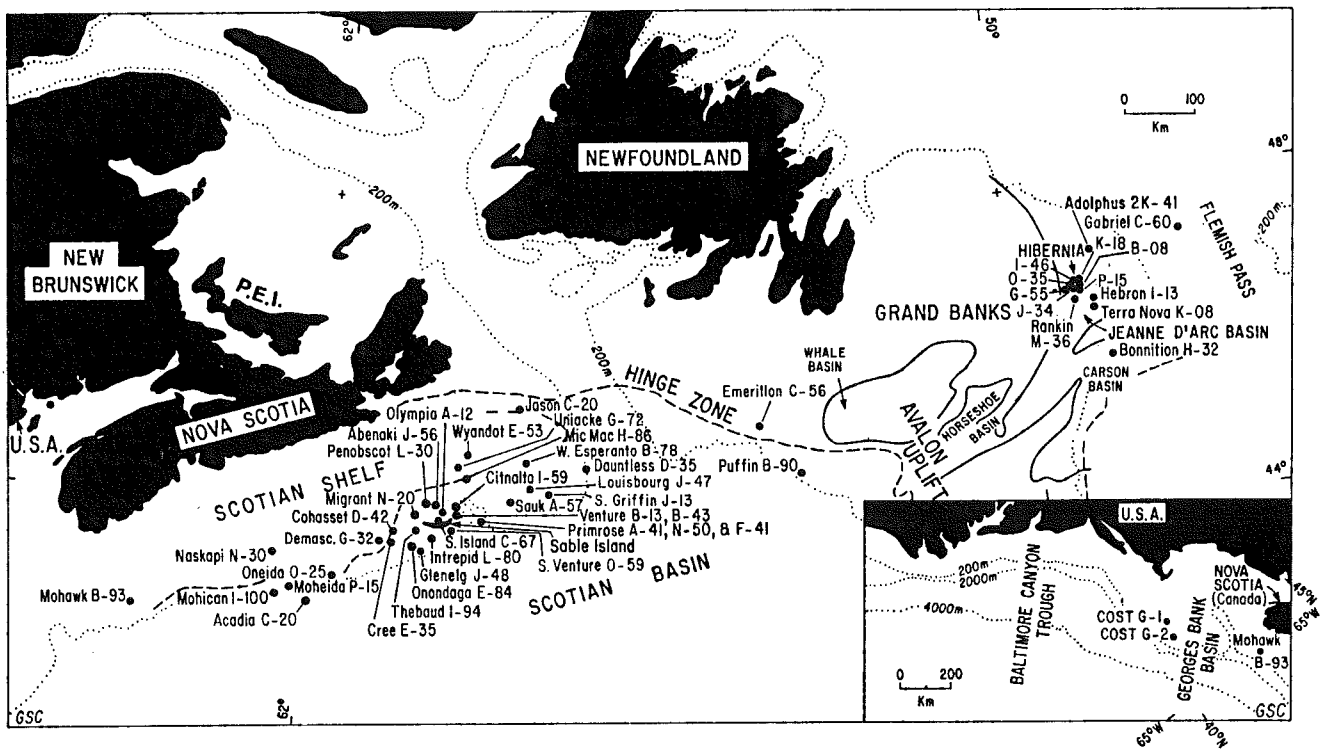

Fig. 1 LOCATION MAP OF STUDIED WELLS

Georges Bank Basin (2 wells)

* Ocean Production Co. COST NO. G-1
* Ocean Production Co. COST NO. G-2

Scotian Basin (36 wells)

** Shell Mohawk B-93
** Shell Mohican I-100
** Shell Naskapi N-30
Shell Moheida P-15
Chevron-Pex-Shell Acadia K-62
** Shell Oneida O-25
Shell Demascota G-32
** Shell Cree E-35
Mobil-Tetco-Pex Cohasset P-42
** Shell Onondaga E-84
* Shell-Petro Canada Glenelg J-48
** Mobil-Tetco-Pex Migrant N-20
** Mobil-Tetco-Pex Thebaud I-94
Petro Canada-Shell Penobscot L-30
** Texaco-Shell Intrepid L-80
** Mobil Sable Island C-67
* Mobil-Texaco-Pex Olympia A-12
Shell Abenaki J-56
Mobil et al. South Venture O-59
* Mobil-Texaco-Pex Venture B-43
* Mobil-Texaco-Pex Venture B-13
Shell et al. Uniacke G-72

Mobil-Tetco-Texaco Citnalta I-59

** Shell Mic Mac H-86

** Shell Wyandot E-53

Shell Primrose A-41

Shell Primrose N-50

Shell Primrose F-41

* Shell Sauk A-57

* Petro Canada et al. West Esperanto B-78

* Home et al. Louisburg J-47

Union et al. Jason C-20

* Husky-Bow Valley et al. South Griffin J-13

** Mobil-Tetco Dauntless D-35

* Elf et al. Emerillon C-56

* Amoco-Imperial Puffin B-90

Jeanne d'Arc Basin (11 wells)

* Mobil et al. Rankin M-36

* Mobil et al. Hibernia G-55

* Mobil et al. Hibernia I-46

* Mobil et al. Hibernia J-34

* Mobil et al. Hibernia O-35

* Mobil et al. Hibernia K-18

* Chevron Hibernia P-15

* Mobil et al. Hibernia B-08

* Mobil et al. Hebron I-13

* Petro Canada et al. Terra Nova K-08

* Mobil-Gulf Adolphus 2K-41

Carson Basin (1 well)

** Mobil-Gulf Bonnition H-32

Flemish Pass Basin (1 well)

Esso-Voyageur Gabriel C-60

In the above list, the 15 wells examined in their entirety are marked with two asterisks (**). The 22 wells whose entire Mesozoic section has been examined (with the exception of its topmost part for the COST NO. G-2 and Hibernia O-35 wells) are marked with one asterisk (*). In the remaining 14 wells (unmarked), only a part of their Mesozoic section (for most wells encompassing the interval from the top of the Abenaki Formation to T.D.) has been studied.

In all wells examined, the great majority of samples analyzed consists of washed residues processed from cuttings samples, each representing an interval of 10 m or 30 ft, generally composited over a 30 m or 100 ft interval. Sidewall core samples which are usable for micropaleontological study are very scarce, and utilizable conventional core samples are rarer still. Many of the sidewall cores collected are too small for micropaleontological analysis, and conventional cores are usually too hard and unwashable. The sample coverage normally utilized for this study has been of one cuttings sample every 30 m or 100 ft of section, plus all the sidewall and conventional cores available. In particular cases requiring greater stratigraphic detail, cuttings samples have been examined every 10 m and even 3 m (30 ft and 10 ft respectively).

All cuttings and core samples examined from wells of the Canadian Atlantic Shelf have been processed for micropaleontology in the C.O.G.L.A. laboratory located at the Bedford Institute of Oceanography, Atlantic Geoscience Centre, Dartmouth, Nova Scotia, and microfossil assemblages were picked from washed residues by Atlantic Paleoservices Ltd.

Washed residues from cuttings and sidewall cores and some picked slides from COST NO. 1 and NO. 2 wells (Georges Bank Basin, U.S. Shelf) were kindly loaned by Dr. C.W. Poag (U.S. Geological

Survey, Woods Hole, Massachusetts). Additional picked slides for these two wells were provided by Atlantic Paleoservices Ltd. All biostratigraphic data from the examined wells were recorded on standard analysis sheets, computer-loaded and retrieved as faunal and sample lists and as well reports. Entirely computerized biostratigraphic well reports and microfossil range-charts have been generated for each well, thus providing, in convenient format, a thorough compilation of all the biostratigraphic data which constitute the basis for the new updated zonation presented here.

BIOZONATION

A combination of planktic Foraminifera, calcareous benthic Foraminifera, arenaceous benthic Foraminifera, ostracod and calpionellid zones has been used for dating and correlating the Bathonian to Late Miocene sediments of the study area. Foraminiferal and ostracod zones are informal "assemblage zones", as already described in detail by Ascoli (1976), their upper boundaries being defined by the highest stratigraphic occurrences of one or two "zone marker species", which give their names to the zones.

In some zones (26 out of 87), one of the two "zone marker species" (or, exceptionally, a third one) has highest stratigraphic occurrence in the lower part of the zone, thereby effecting a subdivision of the zone into lower and upper parts. In addition to "zone marker species", also "zone diagnostic species" have been used for identifying zone boundaries. "Zone diagnostic species" are species different from "zone marker species", but also having their highest stratigraphic occurrence at the top or in the lower part of their zone.

The use of highest or last occurrences, instead of lowest or first occurrences for zonal indices and correlation is necessary because most samples are well cuttings; such samples are commonly contaminated by fossil material caved from the overlying part of the wells. Sidewall core samples have also occasionally been found contaminated with younger fossil material, transported by the drilling mud and compressed into the "mud-cake" which often penetrates the hole-facing side of sidewall core samples.

Calpionellid zones were originally defined by the lowest stratigraphic occurrences of characteristic forms (Alleman et al., 1971). In order to be consistent with foraminiferal and ostracod zones and to allow utilization of calpionellid zones in subsurface biostratigraphy, calpionellid zones have been redescribed on the basis of the highest stratigraphic occurrences of their characteristic forms (Ascoli, Poag and Remane, 1984), and applied here to calibrate the age of both foraminiferal and ostracod zones across the Jurassic-Cretaceous boundary.

The correlation chart of Figure 2 shows ages and relationships of all zones presented in this new zonation, which includes a total of 87 zones (compared to 70 in the 1976 edition). There are five calpionellid zones (from Late Tithonian to Early-Middle Valanginian), 25 planktic Foraminifera zones (21 in 1976) from Bathonian to Oxfordian and from Berriasian to Late Miocene, 24 calcareous benthic Foraminifera zones (23 in 1976) from Bathonian to Late Miocene, 15 arenaceous benthic Foraminifera zones (12 in 1976) from Bathonian to Early Eocene and 18 ostracod zones (14 in 1976) from Bathonian to Maastrichtian. The total number of "zone marker species" utilized for defining these zones is 142 and the number of "zone diagnostic species" is 410.

From the paleoenvironmental standpoint, the arenaceous benthic foraminiferal and ostracod zones are best recognized in littoral and inner neritic coarse-grained deposits, whereas the calpionellid, calcareous benthic and planktic foraminiferal zones are best recognized in finer-grained middle and outer neritic and bathyal deposits.

A certain degree of environmental overlap between coeval zones may of course exist, i.e. arenaceous Foraminifera and/or ostracod assemblages may well be associated with calcareous Foraminifera zones, and vice-versa. Similarly, not all arenaceous benthic Foraminifera "zone marker species" and "zone diagnostic species" are 100% arenaceous, but they also include a few associated calcareous benthic species (belonging to the genera Trocholina and Neotrocholina) which typically occur in shallow water environments as well.

The relationships between microfossil zones and lithostratigraphic units on the Scotian Shelf and Grand Banks were described by Ascoli (1976).

Microfossil zones established for the studied area are listed below from youngest to oldest. For each zone the names of the "zone marker" and "zone diagnostic species" are indicated.

In all zones, an asterisk (*) characterizes all species which have highest stratigraphic occurrence in the lower part of their respective zone.

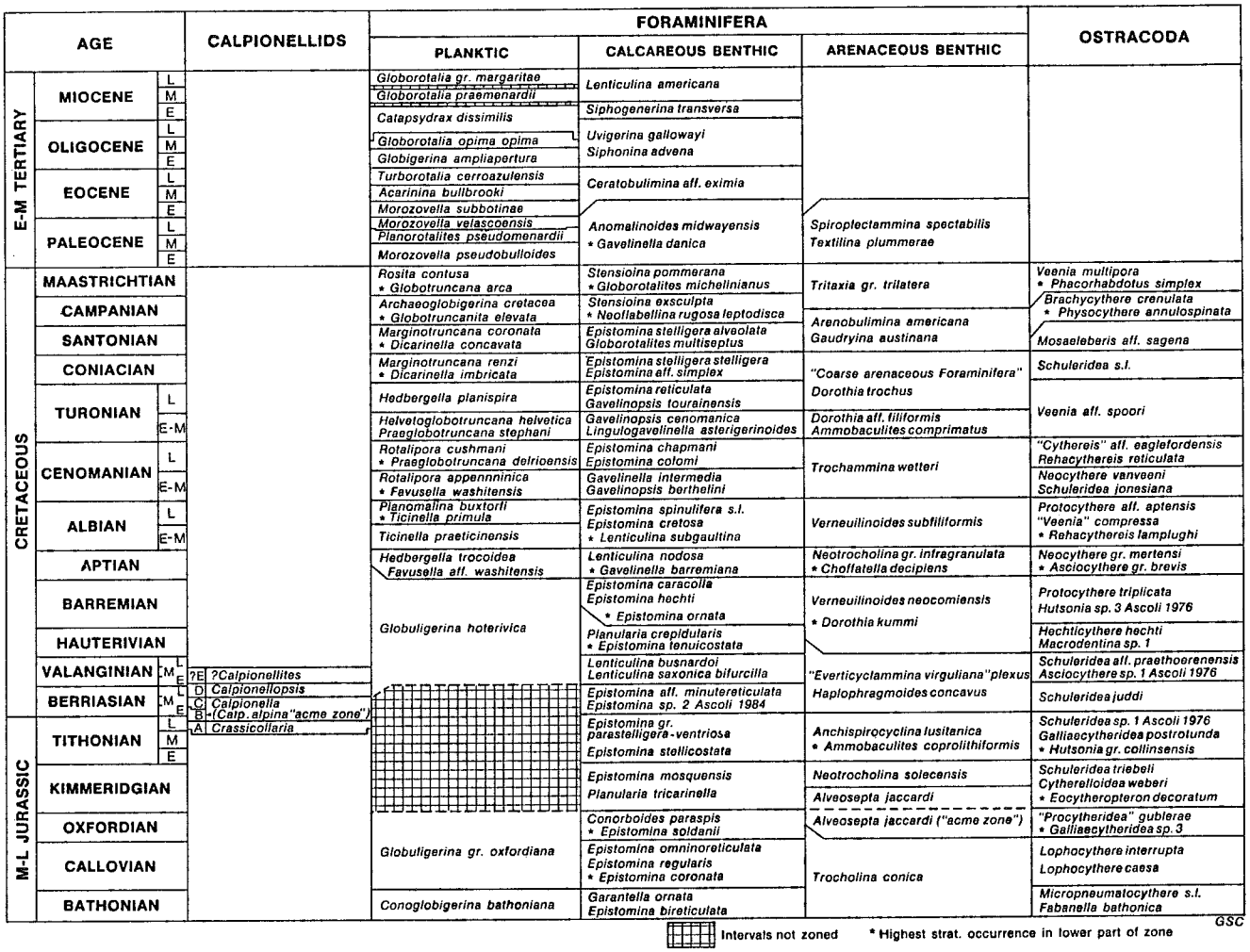

Figure 2. Mesozoic-Cenozoic calpionellid, foraminiferal and ostracod informal assemblage zones, Georges Bank-Scotian Basins and N.E. Grand Banks (Jeanne d'Arc, Carson and Flemish Pass basins).

1. Calpionellid Zones

Crasssicollaria Remane Zone (= Zone "A" by Remane in Alleman et al., 1971)
Age: middle part of Late Tithonian

Crassicollaria brevis Remane
Crassicollaria intermedia (Durand-Delga)
Crassicollaria massutiniana (Colom)

Calpionella alpina Lorenz "acme zone" (= Zone "B" by Remane)
Age: latest Tithonian-Early Berriasian

Crassicollaria parvula Remane

Calpionella Lorenz Zone (= Zone "C" by Remane)
Age: Middle Berriasian

Calpionella alpina Lorenz
Calpionella elliptica Cadisch
Remaniella cadischiana (Colom)
Tintinnopsella carpatica (Murgeanu and Filipescu)

Calpionellopsis Colom Zone (= Zone "D" by Remane)
Age: Late Berriasian-earliest Valanginian

Calpionellopsis simplex Colom

**?Calpionellites Colom Zone (= Zone "E" by Remane)
Age: Early-Middle Valanginian

Calpionellidae sensu Bonet
(**Zone "E" has not yet been recognized with confidence in the studied area)

2. Planktic Foraminifera Zones

Conoglobigerina bathoniana (Pazdro) Zone
Age: Bathonian
(No "zone diagnositic species" other than zone indicator have been identified so far in this zone)

Globuligerina ex. gr. G. oxfordiana (Grigelis) Zone
Age: Callovian-Oxfordian

*Conoglobigerina ex. gr. C. bathoniana (Pazdro)

Globuligerina hoterivica (Subbotina) Zone
Age: (Berriasian, Valanginian - Barremian and ?Early Aptian)

Hedbergella ventriosa Fuchs

*Favusella aff. F. washitensis (Carsey) - Hedbergella trocoidea (Gandolfi) Zone
Age: Aptian

(No "zone diagnostic species" other than zone indicators have been identified so far in this zone)

Ticinella praeticinensis Sigal Zone
Age: Early-Middle Albian

Rotalipora subticinensis (Gandolfi)

*Ticinella primula Luterbacher - Planomalina buxtorfi (Gandolfi) Zone
Age: Late Albian

Ticinella breggiensis (Gandolfi)
Ticinella gaultina Morozova
Ticinella roberti Gandolfi

*Favusella washitensis (Carsey) - Rotalipora appenninica (Renz) Zone
Age: Early-Middle Cenomanian

Rotalipora evoluta Sigal
Rotalipora reicheli Mornod
*Rotalipora ticinensis (Gandolfi)

*Praeglobotruncana delrioensis (Plummer) - Rotalipora cushmani (Morrow) Zone
Age: Late Cenomanian

Rotalipora greenhornensis (Morrow)

Praeglobotruncana stephani (Gandolfi) - Helvetoglobotruncana helvetica (Bolli) Zone
Age: Early-Middle Turonian

Helvetoglobotruncana praehelvetica (Trujillo)

Hedbergella planispira Tappan Zone
Age: Late Turonian

Plaeglobotruncana turbinata (Reichel)

*Dicarinella imbricata (Mornod) - Marginotruncana renzi (Gandolfi) Zone
Age: Coniacian

Dicarinella primitiva (Dalbiez)
Hedbergella amabilis Loeblich and Tappan
Hedbergella delrioensis (Carsey)
Marginotruncana ex. gr. M. schneegansi (Sigal)

*Dicarinella concavata (Brotzen) - Marginotruncana coronata (Bolli) Zone
Age: Santonian

Archaeoglobigerina bosquensis Pessagno
Dicarinella carinata (Dalbiez)
Marginotruncana marginata (Reuss)
*Marginotruncana sigali (Reichel)

*Globotruncanita elevata (Brotzen) - Archaeoglobigerina cretacea (d'Orbigny) Zone
Age: Campanian

Globotruncana ex. gr. G. ventricosa White
*Marginotruncana angusticarinata (Gandolfi)

*Globotruncana arca (Cushman) - Rosita contusa (Cushman) Zone
Age: Maastrichtian

Gansserina gansseri Bolli
Globotruncana aegyptiaca Nakkady
*Globotruncana bulloides Vogler
*Globotruncana lapparenti Brotzen
*Globotruncana linneiana (d'Orbigny)
Globotruncana trinidadensis Pessagno
Globotruncanella citae Bolli
Globotruncanita conica (White)
Globotruncanita stuarti (De Lapparent)
Globotruncanita stuartiformis (Dalbiez)
Guembelitria cretacea Cushman
Heterohelix navarroensis Loeblich
Pseudotextularia elegans (Rzehak)

*Rosita fornicata Plummer
Rugoglobigerina rotundata Bronnimann

Morozovella pseudobulloides (Plummer) Zone
Age: Early Paleocene and lower part of Middle Paleocene

Morozovella imitata (Subbotina)

Planorotalites pseudomenardii (Bolli) Zone
Age: Middle Paleocene and lower part of Late Paleocene

Globigerina triloculinoides Plummer
Planorotalites compressa (Plummer)

Morozovella velascoensis (Cushman) Zone
Age: Late Paleocene

Morozovella acuta (Toulmin)

Morozovella subbotinae (Morozova) Zone
Age: Early Eocene

Morozovella aequa (Cushman & Renz)

Acarinina bullbrooki (Bolli) Zone
Age: Top of Early Eocene; Middle Eocene

Globigerina senni (Beckmann)
Morozovella aragonensis (Nuttall)
Morozovella spinulosa (Cushman)
Pseudohastigerina wilcoxensis (Cushman and Ponton)

Turborotalia cerroazulensis (Cole) Zone
Age: Top of Middle Eocene; Late Eocene

Globigerina linaperta Finlay
Globigerinatheca mexicana (Cushman)
Turborotalia centralis (Cushman and Bermudez)

Globigerina ampliapertura Bolli Zone

Age: Early Oligocene and base of Middle Oligocene

Globigerina yequaensis Weinzierl and Applin
Pseudohastigerina micra (Cole)

Globorotalia opima opima Bolli Zone
Age: middle part of Middle Oligocene

Globigerina ciperoensis angulifficinalis Blow
Globigerina ouachitensis Howe and Wallace

Catapsydrax dissimilis (Cushman and Bermudes) Zone
Age: Top of Middle Oligocene - Early Miocene

Globigerina ciperoensis angustiumbilicata Bolli
Globorotalia opima nana Bolli

Globorotalia praemenardii Cushman and Stainforth Zone
Age: Middle Miocene

Globigerina ex. gr. G. falconensis Todd

Globorotalia ex. gr. G. margaritae Bolli Zone
Age: Late Miocene

Globoquadrina dehiscens (Chapman, Parr and Collins)
Globorotalia mayeri Cushman and Ellisor
Globorotalia siakensis (Le Roy)

3. Calcareous benthic Foraminifera Zones

Epistomina bireticulata Pazdro - Garantella ornata (Hofker) Zone
Age: Bathonian

Epistomina ex. gr. E. mosquensis Uhlig
Lenticulina daphne Bielecka and Styk
Reinholdella aff. R. crebra Pazdro
Reinholdella media (Kaptarenko)

*Epistomina coronata Terquem - Epistomina regularis Terquem - Epistomina omninoreticulata Espitalié and Sigal Zone
Age: Callovian

Epistomina sp. 6
Epistomina sp. 7
Epistomina minutereticulata Espitalié and Sigal
Epistomina nuda Terquem
Lenticulina fracta Espitalié and Sigal
Ophthalmidium carinatum Kübler and Zwingli
Reinholdella crebra Pazdro
Vaginulinopsis eritheles Loeblich and Tappan

*Epistomina soldanii Ohm - Conorboides paraspis (Schwager) Zone
Age: Oxfordian

*Astacolus ectypus Loeblich and Tappan
Conorboides scutuliformis (Seibold and Seibold)
Lenticulina audax Loeblich and Tappan
Lenticulina dilecta Loeblich and Tappan
*Marginulinopsis phragmites Loeblich and Tappan
Ophthalmidium strumosum (Guembel)
Patellinella sp. 2
*Planularia enodis Loeblich and Tappan
?*Reinholdella crebra Pazdro
Saracenaria cornucopiae (Schwager)
*Saracenaria triquetra (Guembel)

Planularia tricarinella (Reuss) - Epistomina mosquensis Uhlig Zone
Age: Kimmeridgian

Conorboides sp. 1
Conorboides marginata Lloyd
Conorboides aff. C. paraspis (Schwager)
*Eoguttulina inovroclaviensis Bielecka and Pozaryski
Eoguttulina liassica (Strickland)
Epistomina aff. E. mosquensis by Ascoli 1984
Epistomina? mosquensis by Ascoli 1984
Lenticulina brueckmanni Mjatliuk
Lenticulina vistulae Bielecka and Pozaryski

Epistomina stellicostata Bielecka and Pozaryski - Epistomina ex. gr. E. parastelligera (Hofker) - E. ventriosa Espitalié and Sigal Zone
Age: Tithonian

Euguttulina sp. 1
Eoguttulina exserta (Berthelin)
*Epistomina dneprica Kaptarenko

Epistomina madagascariensis (Espitalié and Sigal)
Epistomina aff. E. uhligi by Ascoli 1984
*Lenticulina polonica Wisniowski
*Lenticulina quenstedti (Guembel)
*Lenticulina varians (Bornemann)
Neobulimina varsoviensis Bielecka and Pozaryski
Patellinella sp. 1
*Planularia beierana (Guembel)

Remarks: This zone corresponds to the "Epistomina stellicostata Bielecka and Pozaryski - Epistomina uhligi Mjatliuk Zone" extablished by Ascoli (1976) and later employed by Jansa et al. (1980), Ascoli (1981, 1984 and in press) and Ascoli et al. (1984).

Some Scotian Shelf Epistomina specimens of Tithonian age, considered by the author to be typical eastern Canadian representatives of Epistomina uhligi Mjatliuk, have been recently compared with topotipic specimens of E. uhligi from the Soviet Union. The eastern Canadian specimens have been found to differ from topotypic specimens of E. uhligi and to represent two other Epistomina species: Epistomina parastelligera (Hofker 1954) and Epistomina ventriosa Espitalié and Sigal 1963. The main difference between the two latter species is very slight, involving merely the number of chambers in the last whorl: 7-9 in E. parastelligera and 9-11 in E. ventriosa. Specimens with either 7-9 or 9-11 chambers in the last whorl were both previously included in the "Epistomina uhligi" assemblages from the Middle-Late Jurassic section of the examined wells, where they are mixed together in the heterogeneous cuttings samples which constitute the greatest part of our studied material. Thus, it is not now possible to separate the stratigraphic range of the specimens with 7-9 chambers from the stratigraphic range of those with 9-11 chambers. Therefore, it has been decided to encompass all specimens in this complex under the informal name "Epistomina ex. group E. parastelligera (Hofker) - E. ventriosa Espitalié and Sigal". In any case, forms conforming with both Epistomina parastelligera and E. ventriosa have their highest stratigraphic occurrence at the same horizon, i.e. the top of the Tithonian as defined by calpionellid biozonation (see Jansa et al., 1980; Ascoli et al., 1984). The complex "Epistomina ex. group E. parastelligera - E. ventriosa", specimens of which are abundant in Late Jurassic parts of the section, is thus a most useful marker in defining the Jurassic-Cretaceous boundary in the study area.

Epistomina sp. 2 Ascoli 1984 - Epistomina aff. E. minutereticulata Espitalié and Sigal Zone
Age: Berriasian

Astacolus calliopsis (Reuss)
Astacolus vacillantes Espitalié and Sigal
?Epistomina sp. 1 Ascoli 1984
Epistomina sp. 3 Ascoli 1984
Epistomina sp. 4 Ascoli 1984
Epistomina aff. E. praereticulata Mjatliuk
Lenticulina haesitans Espitalié and Sigal

Lenticulina saxonica bifurcilla Bartenstein and Brand - Lenticulina busnardoi Moullade Zone
Age: Valanginian

Conorboides aff. C. hofkeri (Bartenstein and Brand)
Epistomina sp. 5 Ascoli 1984
Epistomina praeornata Bartenstein and Brand
Epistomina aff. E. praeornata Bartenstein and Brand
Epistomina aff. E. tenuicostata Bartenstein and Brand
Marginulina bettenstaedti Bartenstein and Brand
Marginulinopsis sp. 1
Paalzowella feifeli (Paalzow)
Saracenaria valanginiana Bartenstein and Brand

*Epistomina tenuicostata Bartenstein and Brand - Planularia crepidularis (Roemer) Zone
Age: Hauterivian-Early Barremian

Conorboides valendisensis (Bartenstein and Brand)
Epistomina aff. E. hechti Bartenstein, Bettenstaedt and Bolli
*Lenticulina eichenbergi Bartenstein and Brand
Lenticulina guttata (Ten Dam)
Lenticulina cf. L. meridiana Bartenstein and Kovatcheva
*Lenticulina nodosa gibber (Espitalié and Sigal)
Lenticulina saxonica saxonica Bartenstein and Brand
*Lenticulina subtilis Wisniowski

*Epistomina ornata (Roemer) - Epistomina hechti Bartenstein, Bettenstaedt and Bolli - Epistomina caracolla (Roemer) Zone
Age: Barremian

Conorboides hofkeri (Bartenstein and Brand)
Epistomina ex. gr. E. caracolla (Roemer)
Epistomina ex. gr. E. ornata (Roemer)
Epistomina ex. gr. E. reticulata (Reuss)
Gavelinella sigmoicosta (Ten Dam)
*Lenticulina collignoni Espitalié and Sigal

Lenticulina schreiteri (Eichenberg)
Marginulinopsis sigali Bartenstein, Bettenstaedt and Bolli
Saracenaria frankei Ten Dam

*Gavelinella barremiana Bettenstaedt - Lenticulina nodosa (Reuss) Zone
Age: Aptian

Conorboides glabra Fuchs
Conorboides lamplughi (Sherlock)
Conorboides ornata Fuchs
Lenticulina heiermanni Bettenstaedt

*Lenticulina subgaultina Bartenstein - Epistomina cretosa Ten Dam - Epistopmina spinulifera s.l. (Reuss) Zone
Age: Albian

Epistomina carpenteri (Reuss)
Epistomina spinulifera polypioides (Eichenberg)
Epistomina spinulifera spinulifera (Reuss)
Epistomina suturalis (Ten Dam)
Gyroidinoides parva Khan
*Lenticulina sulcifera Reuss
Lingulogavelinella ciryi Malapris
Marginulinopsis robusta (Reuss)
Vaginulina gaultina Berthelin

Gavelinopsis berthelini (Keller) - Gavelinella intermedia (Berthelin) Zone
Age: Early-Middle Cenomanian

Lenticulina gaultina Berthelin
Vaginulina recta (Reuss)

Epistomina colomi Sigal - Epistomina chapmani Ten Dam Zone
Age: Late Cenomanian

Epistomina ?chapmani Ten Dam

Lingulogavelinella asterigerinoides (Plummer) - Gavelinopsis cenomanica (Brotzen) Zone
Age: Early-Middle Turonian

Gavelinella baltica Brotzen

Gavelinopsis tourainensis Butt - Epistomina reticulata (Reuss) Zone
Age: Late Turonian

Lingulogavelinella turonica Butt

Epistomina aff. E. simplex Colom - Epistomina stelligera stelligera (Reuss) Zone
Age: Coniacian

Neoflabellina ovalis (Wedekind) forma "A" Ohmert

Globorotalites multiseptus (Brotzen) - Epistomina stelligera alveolata Ohm Zone
Age: Santonian

Neoflabellina ovalis (Wedekind)
*Neoflabellina praerugosa Hiltermann
Neoflabellina sphaenoidalis praecursor (Wedekind)

*Neoflabellina rugosa leptodisca (Wedekind) - Stensioina exsculpta (Reuss) Zone
Age: Campanian

Bolivinoides decoratus decoratus (Jones)
Bolivinoides strigillatus (Chapman)
Gavelinella pertusa (Marsson)
Gavelinella spissocostata (Cushman)
*Kyphopyxa christneri (Carsey)
Neoflabellina aff. N. buticula Hiltermann
*Neoflabellina deltoidea (Wedekind)
Neoflabellina numismalis Wedekind
Neoflabellina rugosa rugosa (d'Orbigny)
*Stensioina exsculpta gracilis Brotzen

*Globorotalites michelinianus (d'Orbigny) - Stensioina pommerana Brotzen Zone
Age: Maastrichtian

Bolivina incrassata Reuss
Bolivina incrassata gigantea Wicher
Bolivinoides decoratus delicatulus Cushman
Bolivinoides draco draco (Marsson)
*Bolivinoides draco miliaris Hilterman and Koch
*Bolivinoides laevigatus (Mariae)
Bulimina kickapooensis (Cole)
Eouvigerina americana Cushman
Epistomina favosoides (Egger)
Epistomina supracretacea Ten Dam
*Gavelinella clementiana (d'Orbigny)
Gavelinella aff. G. clementiana (d'Orbigny)

*Gavelinella taylorensis (Carsey)

*Gavelinella danica (Brotzen) - Anomalinoides midwayensis (Plummer) Zone
Age: Paleocene-Early Eocene

*Anomalinoides acuta (Plummer)
*Bulimina cacumenata Cushman and Parker
*Coleites reticulosus (Plummer)
*Stilostomella midwayensis (Cushman and Todd)
Valvulineria wilcoxensis Cushman and Ponton

Ceratobulimina aff. C. eximia (Rzehak) Zone
Age: Middle-Late Eocene

Anomalinoides dorri (Cole)
Bulimina jacksonensis Cushman
Cibicides cocoaensis (Cushman)
*Cibicidoides granulosa (Bykova)
Eponides ex. gr. E. jacksonensis (Cushman and Applin)

Siphonina advena Cushman - Uvigerina gallowayi Cushman Zone
Age: Oligocene

Bolivina imporcata Cushman and Renz
Oridorsalis lunatus (Brotzen)
Siphonina aff. S. danvillensis Howe and Wallace
Turrilina alsatica Andreae
Uvigerina tumeyensis Lamb

Siphogenerina transversa Cushman Zone
Age: Early Miocene

Lenticulina bowdenensis (Cushman)
Lenticulina suteri Cushman and Renz
Planularia clara Cushman and Jarvis
Plectofrondicularia cookei Cushman

Lenticulina americana (Cushman) Zone
Age: Middle-Late Miocene

Asterigerinoides gurichi (Francke)
Bolivina floridana Cushman
Bolivina plicatella Cushman
Ceratobulimina contraria (Reuss)

Florilus pizarrensis (Berry)
Lenticulina americana spinosa (Cushman)
Marginulinopsis basispinosus (Cushman)
Melonis pompilioides (Fichtel and Moll)
Nonion barleeanum Williamson

4. Arenaceous benthic Foraminifera Zones

Trocholina conica (Schlumberger) Zone
Age: Bathonian-Early Oxfordian

*Ammopalmula infrajurensis (Terquem)
Gaudryina heersumensis Lütze
Haplophragmoides aff. H. canui Cushman

Alveosepta jaccardi (Schrodt) "acme Zone"
Age: Middle-Late Oxfordian

Ammobaculites spongiphilus Seibold and Seibold
Ammobaculites venustus Loeblich and Tappan
Textularia foeda Reuss
Trocholina transversarii Paalzow
Verneuilinoides aff. V. tryphera Loeblich and Tappan

Alveosepta jaccardi (Schrodt) Zone
Age: Early Kimmeridgian

Everticyclammina sp. 2
Gaudryina ex. gr. G. heersumensis Lütze
Valvulina cf. V. meentzeni Klingler

Neotrocholina solecensis (Bielecka and Pozaryski) Zone
Age: Late Kimmeridgian

Alveosepta aff. A. jaccardi (Schrodt)
Alveosepta ex. gr. A. jaccardi (Schrodt)
Everticyclammina sp. 1

*Ammobaculites coprolithiformis (Schwager) - Anchispirocyclina lusitanica (Egger) Zone
Age: Tithonian

Haplophragmoides canui Cushman
Neotrocholina sp. 1 (Ascoli 1976)
Neotrocholina ex. gr. N. alpina (Leupold)
Neotrocholina elongata (Leupold)

Haplophragmoides concavus (Chapman) - "Everticyclammina virguliana" (Koechlin) plexus (sensu Brun and Rey 1975) Zone
Age: Berriasian-Early Hauterivian

Ammobaculites sp. 4274 Espitalié and Sigal
*Ammobaculites alaskensis Tappan
Neotrocholina valdensis (Reichel)
Trochammina inflata (Montagu)

*Dorothia kummi (Zedler) - Verneuilinoides neocomiensis (Mjatliuk) Zone
Age: Hauterivian-Barremian

*Pseudocyclammina lituus Yokoyama

*Choffatella decipiens (Schlumberger) - Neotrocholina ex. gr. N. infragranulata (Noth) Zone
Age: Aptian

Trocholina aptiensis Jovcheva

Verneuilinoides subfiliformis Bartenstein Zone
Age: Albian

Gaudryina dividens Grabert
Haplophragmoides ex. gr. H. topagorukensis Tappan
Verneuilinoides ex. gr. V. schizeus (Cushman and Alexander)

Trochammina wetteri Stelck and Wall Zone
Age: Cenomanian

Ammobaculites ex. gr. A. albertensis Stelck and Wall
Arenobulimina conoidea (Perner)

Ammobaculites comprimatus Cushman and Applin - Dorothia aff. D. filiformis (Berthelin) Zone
Age: Early Turonian

Dorothia gradata (Berthelin)

Dorothia trochus (d'Orbigny) - "Coarse Arenaceous Foraminifera" Zone
Age: Late Turonian-Coniacian

Haplophragmoides sp. 3
*?Haplophragmoides sp. 51
*?Haplophragmoides sp. 52

Gaudryina austinana Cushman - Arenobulimina americana Cushman Zone
Age: Santonian-Early Campanian

(No "zone diagnostic species" other than zone indicators have been identified so far in this zone)

Tritaxia ex. gr. T. trilatera (Cushman) Zone
Age: Late Campanian-Maastrichtian

Tritaxia sp. 1 Ascoli 1976
Tritaxia plummerae Cushman

Textilina plummerae (Lalicker) - Spiroplectammina spectabilis (Grzybowski) Zone
Age: Paleocene-Early Eocene

Bathysiphon sp. 1
Spiroplectammina plummerae Cushman

5. Ostracod Zones

Fabanella batonica Oertli - Micropneumatocythere s.l. Zone
Age: Bathonian

Eoschuleridea batei Depêche
Klieana laevis Oertli
Micropneumatocythere falcata Sheppard
Micropneumatocythere quadrata Bate
Micropneumatocythere subconcentrice (Jones)
Oligocythereis ex. gr. O. fullonica (Jones and Sherborn)
Progonocythere polonica Blaszyk
Progonocythere aff. P. rugosa Bate

Lophocythere caesa Triebel - Lophocythere interrupta Triebel Zone
Age: Callovian

Eocytheropteron sp. 8
Eocytheropteron sp. 9
Nophrecythere cruciata (Triebel)
Progonocythere ex. gr. P. bicruciata Grekoff
Schuleridea sp. 1 Lütze 1960

Galliaecytheridea sp. 3 - "Procytheridea" gublerae (Bizon) Zone
Age:Oxfordian

Eocytheropteron decoratum (Schmidt) by Kilenyi 1969
?Fastigatocythere sp. 1
*Glabellacythere nuda Wienholz
?Hutsonia sp. 4
*Pleurocythere borealis carinata Whatley
Praeschuleridea caudata (Donze)
Pseudohutsonia aff. P. hebridica Whatley
Terquemula multicostata (Oertli)
*Tethysia reticulata (Peterson)
*Vesticytherura horrida Whatley

*Eocytheropteron decoratum (Schmidt) - Cytherelloidea weberi Steghaus - Schuleridea triebeli (Steghaus) Zone
Age: Kimmeridgian

Cytherelloidea paraweberi Oertli
Eocytheropteron sp. 6
Eocytheropteron purum (Schmidt)
*Galliaecytheridea sp. 2
?Hutsonia sp. 1
?Hutsonia sp. 6
?Nodophthalmocythere sp. 1
*Paranotacythere sp. 1 Ascoli 1976
*Procytheropteron sp. 1 Kilenyi 1969
Schuleridea sp. 5
Schuleridea sp. 6
Schuleridea strzalkowiensis Bielecka et al.

*Hutsonia ex. gr. H. collinsensis Swain and Brown - Galliaecytheridea postrotunda Oertli - Schuleridea sp. 1 Ascoli 1976 Zone
Age: Tithonian

Asciocythere sp. 5
Asciocythere ex. gr. A. amygdaloides (Cornuel)
*Cytherella index Oertli

Eocytheropteron sp. 10
Eocytheropteron aff. E. aquitanicum Donze
Eocytheropteron aff. E. brodiei (Jones)
*Galliaecytheridea sp. 1
Klieana alata Martin
Macrodentina maculata Malz
Protocythere bireticulata crassior Pokorny
Schuleridea sp. 2 Jansa et al. 1980

Schuleridea juddi Neale Zone
Age: Berriasian

Acrocythere constricta Donze
Acrocythere guydemalbosi Neale
Mandelstamia sexti Neale
Paranotacythere globosa Neale

Asciocythere sp. 1 Ascoli 1976 - Schuleridea aff. praethoerenensis Bartenstein and Brand by Ascoli 1976 Zone
Age: Valanginian

Acrocythere ex. gr. A. hauteriviana laeva Neale
Asciocythere sp. 2
Asciocythere ex. gr. A. albae Damotte
Cardobairdia sp. 1
Mandocythere frankei (Triebel)
Paranotacythere ex. gr. P. inversa (Cornuel)
Schuleridea aff. S. juddi Neale
Schuleridea pentagonalis Swain
Schuleridea praethoerenensis Bartenstein and Brand

*Macrodentina sp. 1 - Hechticythere hechti (Triebel) Zone
Age: Hauterivian

Cytherelloidea ovata Weber
Dolocytheridea sp. 1
Dolocytheridea sp. 2
Dolocytheridea sp. 3
Eocytheropteron aff. E. trinitiensis (Vanderpool)
*Hutsonia capelensis Kilenyi and Allan
Neocythere sp. 2
Neocythere sp. 3
*Paranotacythere diglypta (Triebel)
Rehacythereis aff. R. lamplughi (Kaye)
Rehacythereis ex. gr. R. senckenbergi (Triebel)
Schuleridea aff. S. thoerenensis (Triebel)
Schuleridea ex. gr. S. thoerenensis (Triebel)

Schuleridea aff. S. rhomboidalis Neale

Hutsonia sp. 3 Ascoli 1976 - Protocythere triplicata (Roemer) Zone
Age: Barremian

Asciocythere sp. 3
?Cornicythereis aff. C. larivourensis (Damotte and Grosdidier)
Mandocythere villierensis (Stchepinsky)
Protocythere inornata Kaye
Protocythere strigosa Grosdidier
Schuleridea bernouilensis Grosdidier
Schuleridea aff. S. bilobata Triebel
Schuleridea extranea Grosdidier
Schuleridea rhomboidalis Neale

*Asciocythere ex. gr. A. brevis (Cornuel) - Neocythere ex. gr. N. mertensi (Oertli) Zone
Age: Aptian

Centrocythere ex. gr. C. gottisi Damotte and Grosdidier
Dolocytheridea hilseana (Roemer)
*Dolocytheridea intermedia Oertli
Platicythereis sp. 1 Damotte and Grosdidier
Protocythere tricostata Triebel
*Rehacythereis sp. Colin 1981
Rehacythereis bekumensis (Triebel)
Schuleridea derooi Damotte and Grosdidier
Schuleridea aff. S. derooi Damotte and Grosdidier

*Rehacythereis lamplughi (Kaye) - "Veenia" compressa Kaye - Protocythere aff. P. aptensis Oertli Zone
Age: Albian

Cytherelloidea knaptonensis Kaye
Mandocythere ornata Weaver
Neocythere sp. 1
Neocythere sp. 5
Neocythere lingenensis Mertens
Neocythere semilaeva Kaye
*Neocythere aff. N. vanveeni Mertens
Protoveenia ex. gr. P. florentinensis Damotte
Rehacythereis lürmannae (Triebel)
Saxocythere notera dividera Gründel
Saxocythere notera senilis Kemper

Schuleridea jonesiana (Bosquet) - Neocythere vanveeni Mertens Zone
Age: Early-Middle Cenomanian

Centrocythere sculpta (Cornuel)
Cornicythereis larivourensis (Damotte and Grosdidier)
Eocytheropteron sp. 7
Eocytheropteron trinitiensis (Vanderpool)
Mandocythere harrisiana (Jones)
Mandocythere ex. gr. M. harrisiana (Jones)
Protocythere derooi Oertli
Rehacythereis ex. gr. R. dentonensis (Alexander)
Rehacythereis semiaperta (Damotte and Grosdidier)
Schuleridea sp. 7
Schuleridea sp. 8

Rehacythereis reticulata (Jones and Hinde) - "Cythereis" aff. C. eaglefordensis Alexander by Ascoli 1976 Zone
Age: Late Cenomanian

Amphycytherura sp. 1
Cardobairdia sp. 2
Cornicythereis bonnemai (Triebel)
"Cythereis" simulonuda Swain
?Orthonotacythere sp. 3
?Pseudobythocythere sp. 1

Veenia aff. V. spoori (Israelsky) Zone
Age: Turonian

*Imhotepia ex. gr. I. marssoni (Bonnema)
*Xestoleberis ex. gr. X. planus Weaver

Schuleridea s.l. Zone
Age: Coniacian

Orthonotacythere hannai (Israelsky)
?Paracyprideis sp. 2
Schuleridea sp. 3
Schuleridea sp. 4
Veenia sp. 1-A
Veenia sp. 1-B
Veenia reticulata Hazel and Paulson

Moseaeleberis aff. M. sagena (Crane) Zone
Age: Santonian

Alatacythere aff. A. ponderosana (Israelsky)
Brachycythere nausiformis Swain

Cythereis sp. 2
Cythereis sp. 5
*Rehacythereis aff. R. dentonensis (Alexander)

*Physocythere annulospinata (Hazel and Paulson) - Brachycythere crenulata Crane Zone
Age: Campanian

Amphicytherura distincta Gerry and Rosenfeld
Brachycythere acuminata Hazel and Paulson
Cythereis dallasensis Alexander
Haplocythereidea aff. H. plummeri Alexander
*Mosaeleberis ex. gr. M. sagena (Crane)
Phacorhabdotus pokornyi Hazel and Paulson, forma "A"
Phacorhabdotus pokornyi Hazel and Paulson, forma "B"
Sphaeroleberis aff. S. pseudoconcentrica (Butler and Jones)
Veenia ozanana Israelsky
Veenia paratriplicata Swain
Veenia spoori (Israelsky)

*Phacorhabdotus simplex Hazel and Paulson - Veenia multipora (Skinner) Zone
Age: Maastrichtian

Ascetoleberis hazardi (Israelsky)
Brachycythere ledaforma erugata Crane
Brachycythere ovata (Berry)
Brachycythere rhomboidalis (Berry)
Brachcythere aff. B. rhomboidalis (Berry)
*"Cythereis" sp. A. Benson and Tatro 1964
Haplocytheridea bruceclarki (Israelsky)
Haplocytheridea globosa Alexander
*Phacorhabdotus tridentus (Israelsky)
Planileberis costatana (Israelsky)
Veenia arachoides (Berry)

BIOSTRATIGRAPHIC CORRELATION OF 51 WELLS

The composite zonation described here has been used in correlating all 51 wells studied. The results of this exercise are graphically represented in the zonation charts reported on Figs. 3-8, where the biostratigraphically examined sections of all studied wells (arranged in geographic order from SW to NE) are subdivided into foraminiferal, ostracod and calpionellid zones, related to corresponding ages and given upper and lower depth boundaries. These depths are in metres only (for recent wells) and in metres and feet (for earlier wells, whose depths were originally reported in feet). Different symbols (for explanation, see Fig. 3) depict the different kind of zones best represented and stratigraphically most instrumental for dating the various intervals of each well. Other symbols indicate the parts of the sections dated with the aid of conventional cores, those tentatively dated, those barren of microfossils and/or not datable, and those not examined at all. Missing parts of sections including those due to stratigraphic hiatuses, are also indicated, as are unconformities and uncertain zonal boundaries.

The zonal correlations presented here are by no means an attempt to provide a complete biostratigraphic picture of the 51 wells examined, but only an updated synthesis of all zonations and correlations so far effected for the examined section of these wells. This "examined section" is for most wells only a part of their total drilled section, and reflects the order of priority given by the Geological Survey of Canada to the biostratigraphic study of these wells whenever time or technical constraints (such as temporarily inadequate sample processing and/or microfossil picking support) prevented the completion of their biostratigraphic analysis.

The highest priority given by AGC regional geologists to the biozonation of the Middle-Late Jurassic - earliest Cretaceous sediments (where most of the Scotian Shelf and Grand Banks hydrocarbon-producing horizons are located) has therefore led to the completion of the biostratigraphic study of this part of the section for 48 wells.

A high priority has also been given to the biozonation of the whole Mesozoic section (22 wells examined), whereas the lower priority assigned to the study of the Tertiary sediments is reflected by

a lesser number of wells (13) being examined for this part of the section, whose zonation was not effected in detail. In the Mesozoic part of the section, by contrast, both Foraminifera and Ostracoda (and, whenever present, calpionellids) have been examined in detail to effect - whenever possible - a zonation at the stage level. Two exceptions are represented by some limited intervals of the Primrose A-41, N-50 and F-41 wells (Scotian Shelf) and by the Adolphus 2K-41 well (Jeanne d'Arc Basin of the NE Grand Banks), which have been analyzed on a reconnaissance basis.

Another exception is represented by the remaining nine wells (Terra Nova K-08 excluded) of the Jeanne d'Arc Basin, whose Ostracoda have been studied with much more detail than Foraminifera. Therefore, the zonation of these 9 wells is less detailed (particularly for the Late Cretaceous section, where ostracod occurrences are very sparse) than could have been achieved had Foraminifera been studied in as much detail as Ostracoda. In any case, the greatest limitation to establishing a detailed zonation is due to the persistent non-indigenous content in most of the cuttings samples and in some of the sidewall core samples analyzed. Many such samples contain caved microfossils (see p. 9), which often constitute the greatest proportion of the total faunal assemblage. Indigenous assemblages thus become masked. Rare microfossil stratigraphic marker species in place are in fact "hidden" among the profusion of caved microfossil specimens of younger age, becoming very hard to notice and to identify and thereby making it very difficult to assign their respective cuttings sample to a particular zone or biostratigraphic unit.

In conclusion, the position of all tops of zones or biostratigraphic units reported on Figs. 3-8, which were established exclusively on the basis of relatively widely spaced cuttings samples (for details see the author's individual biostratigraphic well reports), should be considered approximate, as should their corresponding ages. Examination of more abundant fossil material would in fact probably lead to the adjustment upwards of some tops of biostratigraphic units, thereby assigning them a slightly younger age as well.

This should be taken into account not only when making correlations among all zones and biostratigraphic units reported on Figs. 3-8, but also when comparing the age of micropaleontological zones with the ages of corresponding palynomorph zones (Barss et al., 1979).

Sidewall core material is more commonly available for palynological than for micropaleontological study, since less sample is required for the former. For micropaleontological studies, usually the only source of "in situ" samples is constituted by a few, very rare conventional cores; even when available, these cores are generally from the Jurassic-Early Cretaceous parts of the section only and consist of mostly hard, indurated rocks, from which washed residues for micropaleontological study can not be obtained.

The wells which provided the most detailed and reliable biostratigraphic zonation and the maximum amount of new biostratigraphic data (such as the "new" - for North America - calpionellid zonation) all had a substantial amount of sidewall and/or conventional core material available for micropaleontological study. Most notable among these are the COST No. G-2 (Georges Bank Basin), Mohican I-100, Oneida O-25, Cree E-35, Sable Island C-67 (Scotian Basin) and Bonnition H-32 (Carson Basin) wells.

In contrast, the recent wells drilled in discovery areas such as the Venture and the Hibernia fields, have no sidewall cores utilizable for micropaleontological examination and conventional core is available for only that limited part of the section which corresponds to the reservoir rocks. As a consequence, the biostratigraphic zonation of these wells could not be effected with a degree of reliability comparable to that of the intensly cored COST NO. G-2, Oneida O-25 or Bonnition H-32 wells.

This is most disappointing, considering the importance that a detailed and reliable zonation would have in enabling to effect precise biostratigraphic subdivisions and paleoecologic reconstructions of hydrocarbon-producting horizons in these basins.

It is hoped that future wells drilled in these areas might at least have a considerable number of sidewall core samples available and utilizable for micropaleontological study for the entire pre-Turonian section. The availability of such "in situ" material should in turn allow the establishment of a considerably more detailed and reliable micropaleontological zonation for these wells, which could best be applied in dating and correlating the source and reservoir rocks not only of these, but also of future wells, thereby offsetting by far the slight additional cost required for the coring operation.

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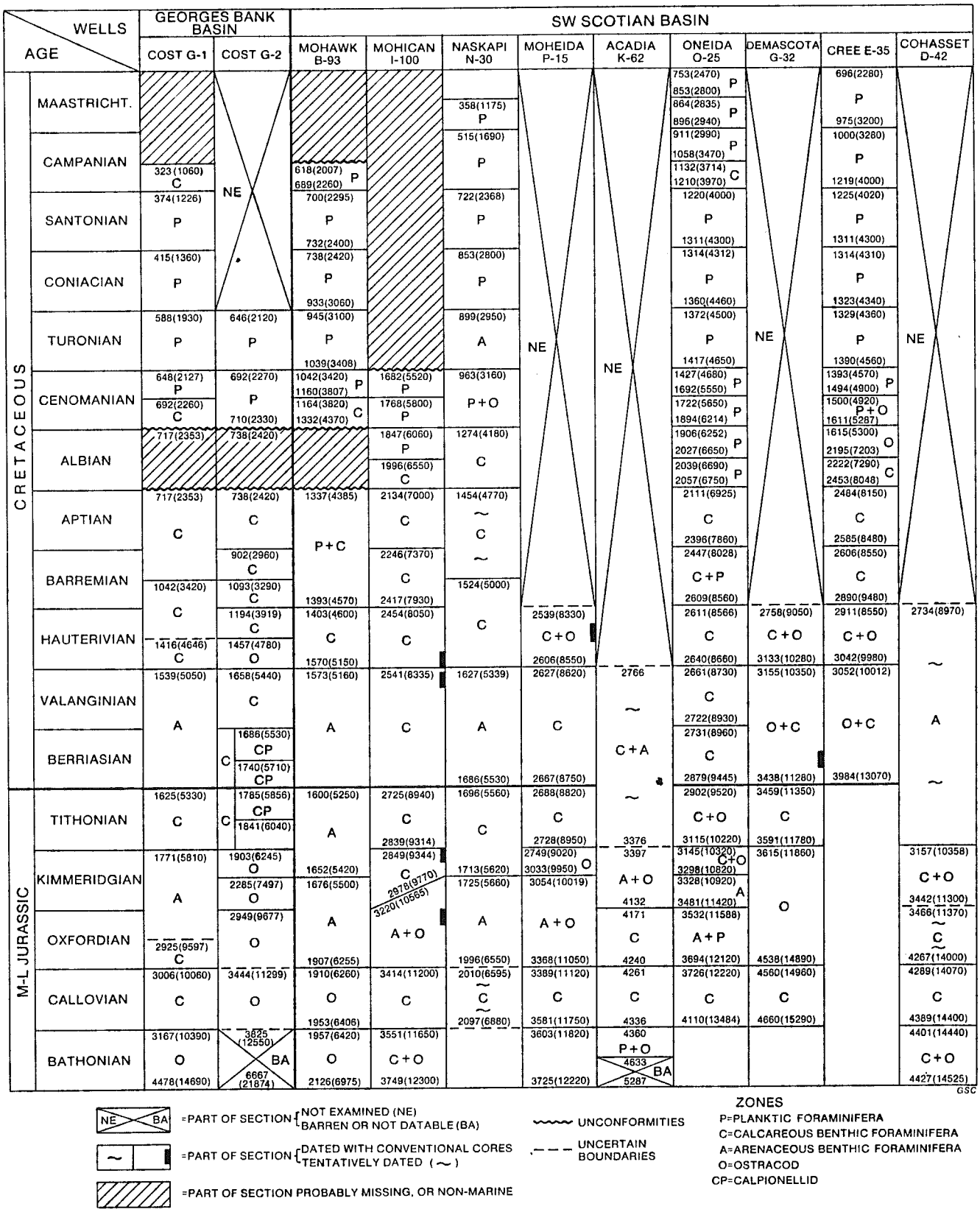

Figure 3. Stratigraphic correlation of Mesozoic microfossil zones in wells of the Georges Bank and SW Scotian Basins.

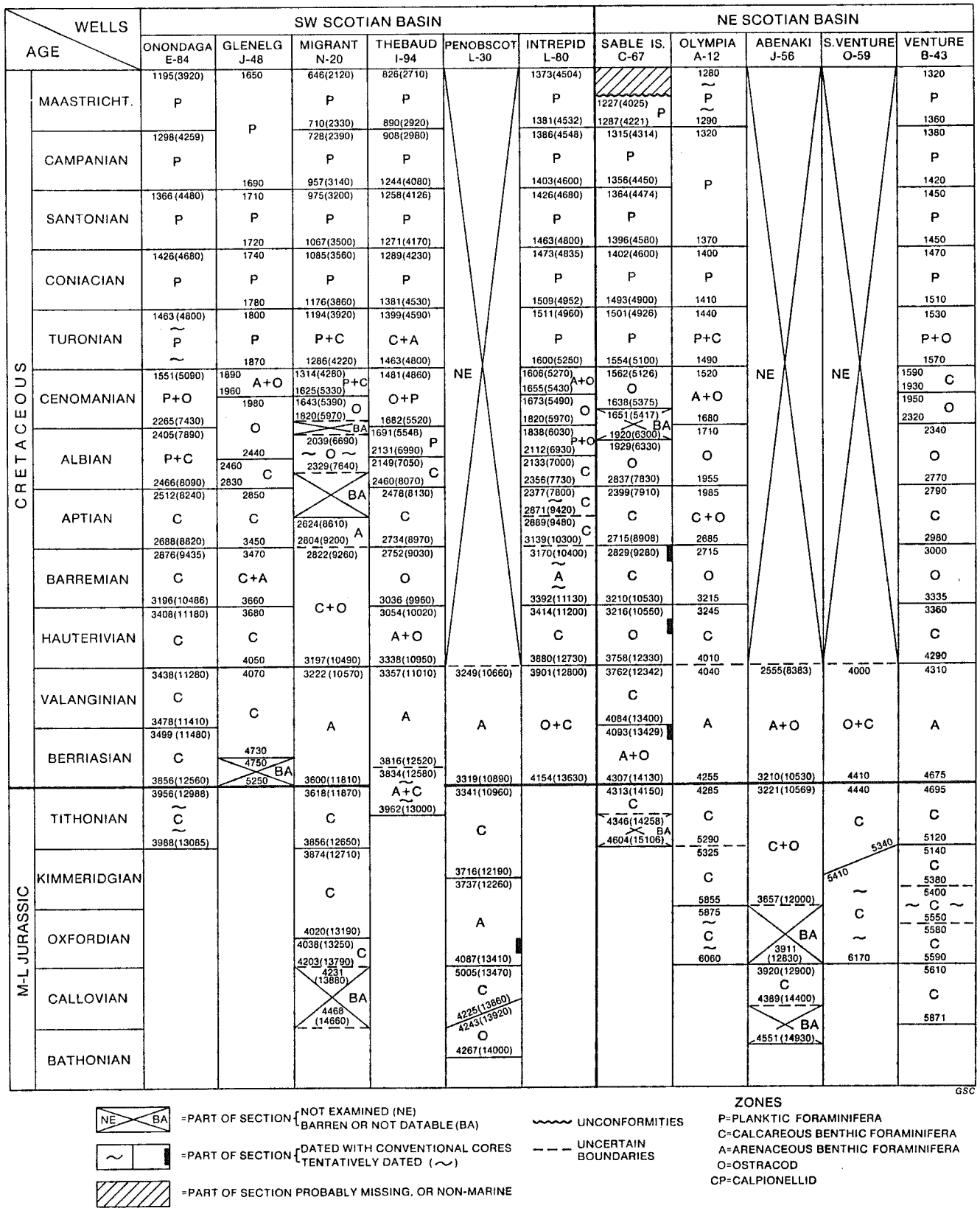

Figure 4. Stratigraphic correlation of Mesozoic microfossil zones in wells of the SW and NE Scotian Basin.

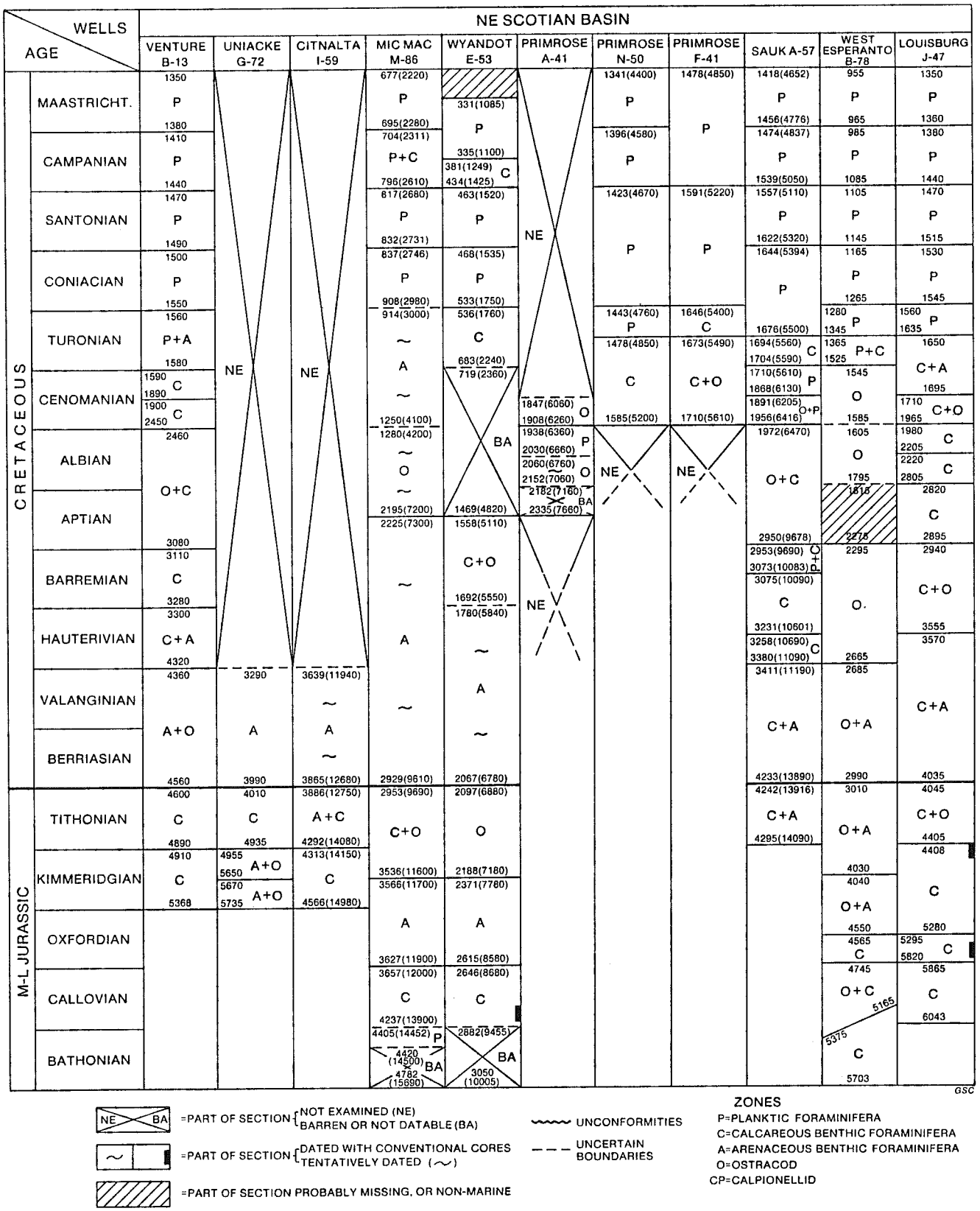

Figure 5. Stratigraphic correlation of Mesozoic microfossil zones in wells of the NE Scotian Basin.

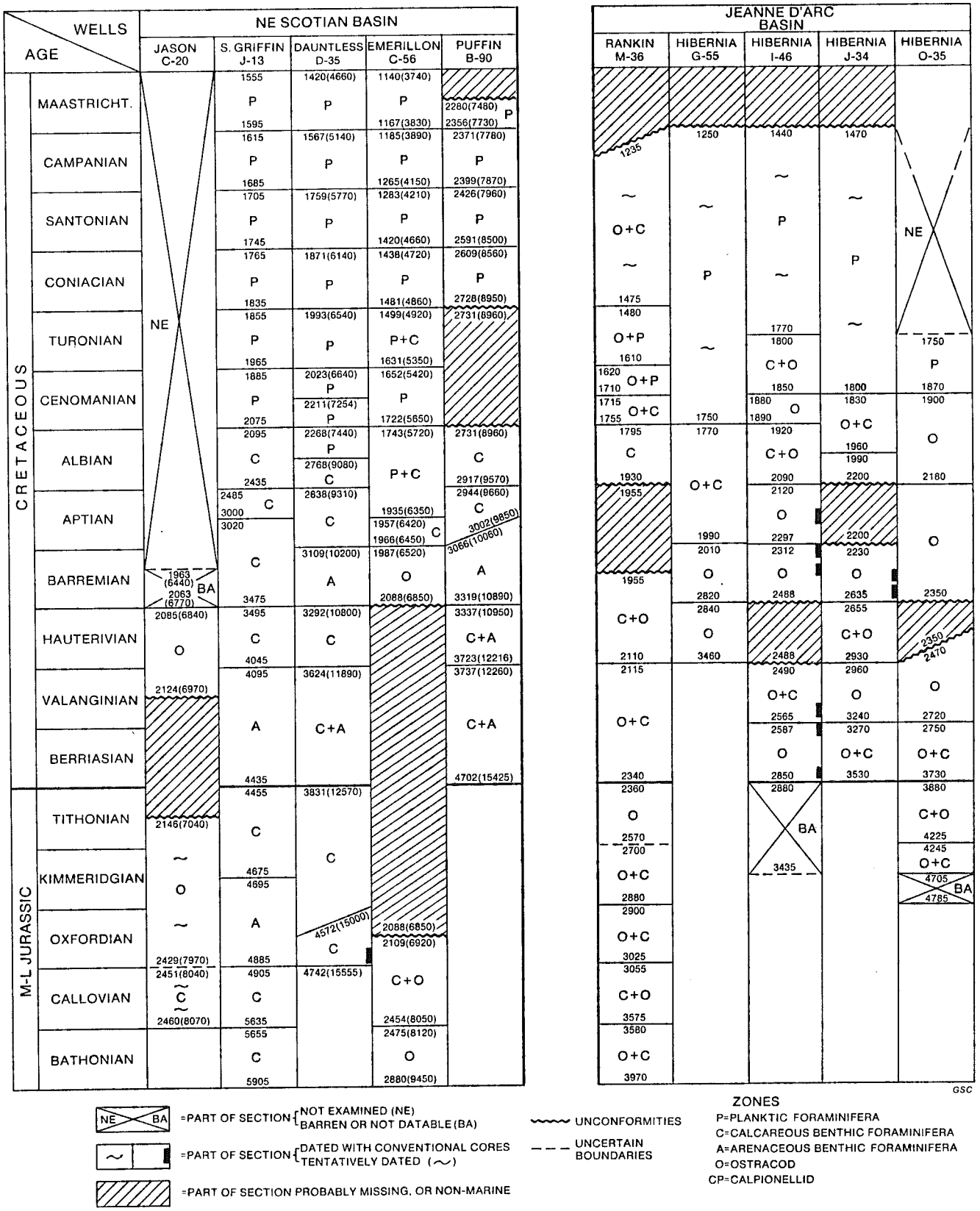

Figure 6. Stratigraphic correlation of Mesozoic microfossil zones in wells of the NE Scotian and western Jeanne d'Arc Basins.

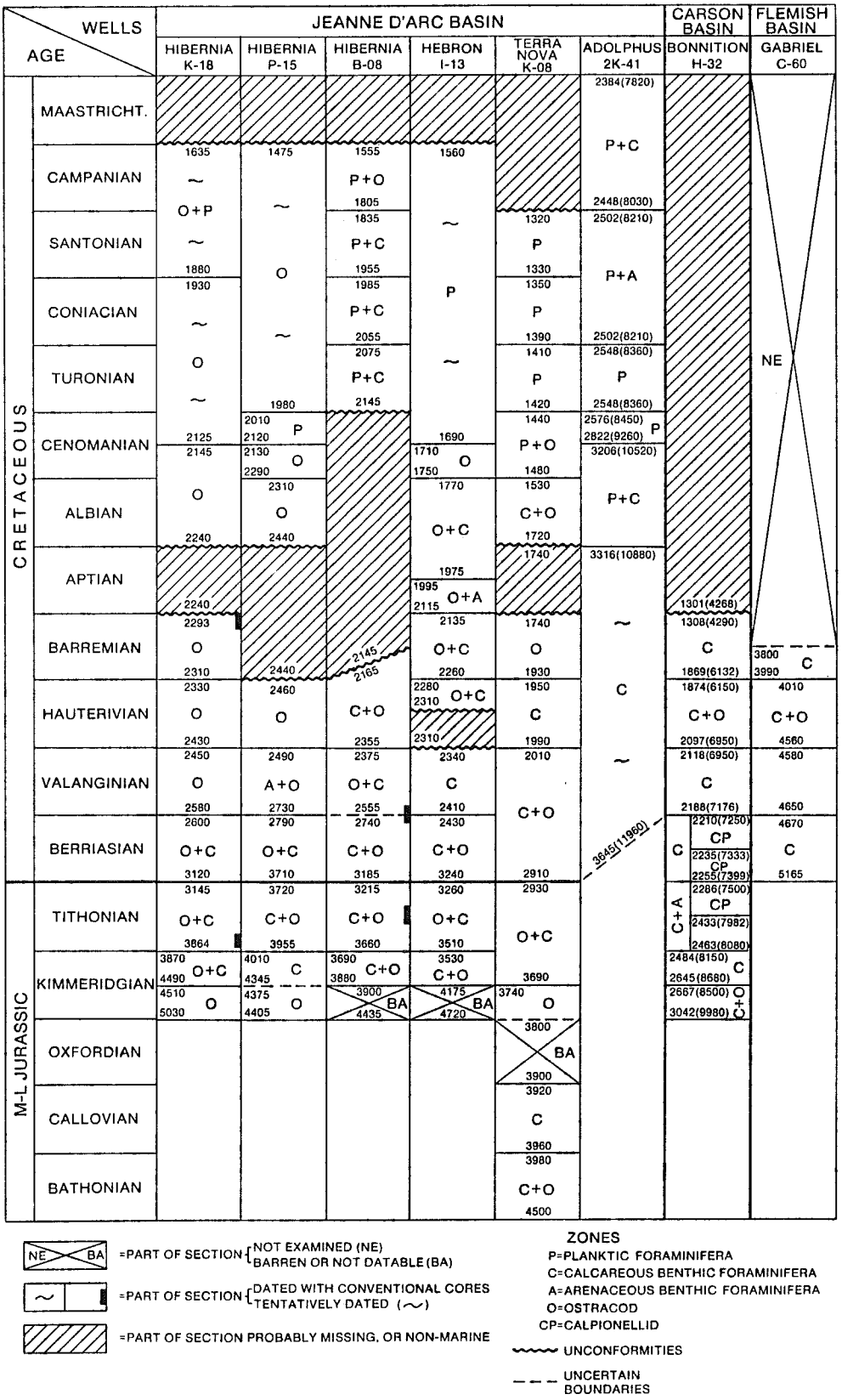

Figure 7. Stratigraphic correlation of Mesozoic microfossil zones in wells of the eastern Jeanne d'Arc, Carson and Flemish Pass Basins.

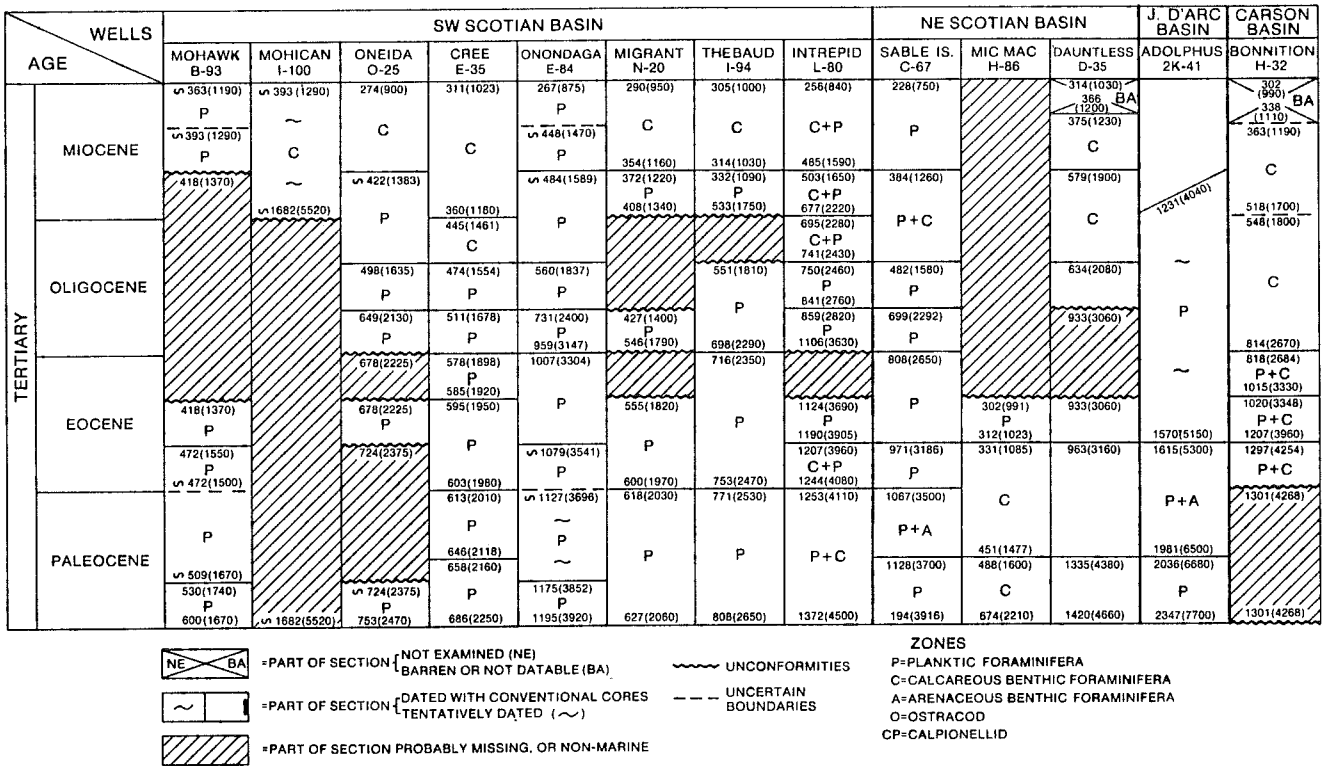

Figure 8. Stratigraphic correlation of Tertiary microfossil zones in wells of the Scotian, Jeanne d'Arc and Carson Basins.