Natural Resources Canada | Ressources Naturelles Canada

This document was produced by scanning the original publication.

Ce document est le produit d'une numérisation par balayage de la publication originale.

Geological Survey of Canada | Commission géologique du Canada

GSC Open File 3458 (sheet 1 of 9)

EAST COAST BASIN ATLAS SERIES
GRAND BANKS OF NEWFOUNDLAND
BIOSTRATIGRAPHY AND MATURATION DATA 1

INTRODUCTION, LOCATION MAP, AND ZONATIONS

CONTRIBUTORS

R. A. Fensome, G. L. Williams, P. Ascoli, M. S. Barss, J. P. Bujak, E. H. Davies, P. H. Doeven, F. M. Gradstein, and B. Stam

Recommended citation: Fensome, R. A., Williams, G. L., Ascoli, P., Barss, M. S., Bujak, J. P., Davies, E. H., Doeven, P. H., Gradstein, F. M., and Stam, B. 1997. East Coast Basin Atlas Series: Grand Banks of Newfoundland, Biostratigraphy and maturation data 1: Introduction, location map, and zonations; Geological Survey of Canada, Open File 3458, 9 map sheets.

Additional copies of this map sheet may be obtained from the Geological Survey of Canada (Atlantic), P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2, Canada. Phone: 902-426-4386; FAX: 902-426-4648; e-mail: agc@agc.bio.ns.ca; website: http://agcwww.bio.ns.ca

PREAMBLE

These sheets comprise biostratigraphic and maturation information that was compiled in 1989 for publication in the Grand Banks of Newfoundland volume of the East Coast Basin Atlas Series. Publication was given priority at the Geological Survey of Canada because of the proposed release of these data. In response to renewed interest in the hydrocarbon resources of the Grand Banks of Newfoundland, GSC Atlantic has chosen to complete these sheets and distribute them as GSC Open File reports.

Although every effort has been made to bring appropriate details up to date, the authors have not incorporated post-1989 information. Internal GSC Atlantic reports exist for wells analyzed in the last few years, and information on the availability of these, including electronic accessibility, can be obtained by contacting the first author on sheet 1, or the Director of GSC Atlantic.

INTRODUCTION TO ALL SHEETS

Biostratigraphic analyses of 67 exploration wells on the Grand Banks and adjacent areas have been conducted the presence of Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary strata. Assemblages from the Dewonian, Carboniferous and most of those from the Triassic-Jurassic boundary beds and lowermost Cretaceous are nonmarine, consisting primarily of spores and pollen (miospores) from higher plants. Otherwise, assemblages are mostly marine and commonly contain an abundance of organic-walled microplankton (dinoflagellates and acritarchs), foraminifera and ostracods.

The rocks analyzed consist primarily of cuttings samples, though sidewall cores and, less commonly, conventional cores were sometimes available. Thus, since the majority of analyses are based on cuttings, which often contain contaminants caved from higher in the well, almost all palynological and micropaleontologic zonal schemes for the region are defined by first-appearance datums (LAD's) of selected taxa.

For the most part, micropaleontological and palynological zones reported in this section are applicable primarily, if not exclusively, to Eastern Canada or earth history as a whole. The correlation of individual zones and integrated zonal schemes from one locality to another within the region is the most meaningful application of the biostratigraphic data presented here. The zonation schemes formulated for offshore eastern Canada have been calibrated against the international standard zones with a high degree of confidence, since equivalent assemblages and ranges are not necessarily identical from basin to basin. This calibration, as well as the regional zonation itself, is subject to re-evaluation and refinement as new data from palynomorph, paleoecology and biostratigraphic ranges of the fossils improves.

The maturation studies discussed in this section include visual kerogen and vitrinite reflectance analyses. Organic matter thermostability, including kerogen type, was assessed by extract data and total C_{org} are presented under Geochemistry.

FOSSIL GROUPS AND HISTORICAL PERSPECTIVE

Biostratigraphically useful fossils in Grand Banks strata can be subdivided into two principal groups: palynomorphs and microfossils with inorganic walls.

Palynomorphs are organic-walled microfossils and form the material basis for the science of palynology. Palynomorphs are of varied biological affinity but are conveniently studied together since their organic-walls necessitate special rock-maceration techniques for extraction. Palynomorph groups which are biostratigraphically important on the Grand Banks are spores (pollen and spores), dinoflagellates and acritarchs.

Lower Paleozoic rocks have been demonstrated by acritarch assemblages in Phalarope P-62 in the Whale Basin and Linnet E-63 in the East Newfoundland Basin. The presence of Devonian and Carboniferous strata have been proven by miospores from wells on the Burin Platform (Hermine E-94), the Whale Basin (Gannet O-54, Sandpiper J-27 and Phalarope P-62), and the East Newfoundland Basin (Linnet E-63 and Blue H-28).

Palynomorphs have been used extensively to date and zone Mesozoic-Cenozoic strata in the Grand Banks and adjacent areas. Several palynomorph groups have been employed, although emphasis has been placed on the dinoflagellates. The first palynozonation for the report area was proposed by Jansa et al. (1974) and Williams (1975). This scheme is outlined and described in a series of publications by Williams and Bujak (1977, 1978, 1979) and Bujak and Williams (1977-Jurassic, 1979-Cretaceous). The resulting composite zonation constituted the framework against which 67 wells from offshore eastern Canada (including many from this region) were analyzed and reported in Barss et al. (1979). Subsequent work by palynologists of the Geological Survey of Canada and by contractors to the GSC have led to refined (but not fully described) palynological zonations for selected areas and parts of the section [see Bujak - Davies Group Ltd. (1988), Williams et al. (1990)] and zonation charts in this work.

Inorganic-walled microfossils which have been used to date and zone Mesozoic-Cenozoic strata in the Grand Banks and adjacent areas are foraminifera, ostracods, nannoplankton (coccolithophorids and discoasters) and calpionellids.

A threefold foraminiferal zonation, using planktonic, calcareous benthic and agglutinated benthic foraminifera, for the Scotian Shelf was initially proposed by Ascoli (1976). This zonation was subsequently extended and refined for the Grand Banks by Ascoli (1981, 1984), Ascoli et al. (1986) and Williams et al. (1990). Gradstein and Berggren (1982) dated the Tertiary in six wells of the Scotian Basin on the basis of analyses of foraminiferal assemblages. Three of these wells are located on the northeastern edge of the Scotian Basin, within the area of the present sheets. Williamson (1987) carried out a quantitative foraminiferal biostratigraphic analysis of 13 East Newfoundland Basin wells. Apart from their stratigraphic value, benthic foraminifera are diagnostic of certain marine environments related to water depth.

Ascoli (1976, 1981, and *in* Williams et al., 1990) has proposed a zonation based on ostracods for Middle Jurassic to Cretaceous strata of the Scotian Shelf and Grand Banks; ostracods are too sparse in Cenozoic sediments to provide the basis for a practical zonation.

Nannoplankton have been used widely in industry for biostratigraphic analysis of offshore eastern Canadian strata, and would appear to have much potential for subdividing the Cenozoic of the Grand Banks. However, to date, only one report has been published (Doeven, 1983). Doeven analyzed Albian-Maastrichtian nannofossils from Hermine E-94, Osprey H-84 and Adolphus D-50 and applied a zonation of 14 zones. Calpionellids are useful as zonal indexes primarily in Jurassic-Cretaceous boundary beds. A detailed zonation has been established for Mediterranean Tethyan strata of Late Tithonian to Valanginian age (Allemann et al., 1971). In offshore eastern Canada this zonation has been applied in only one well: Bonnition H-32 on the eastern Grand Banks (Jansa et al., 1980). However, Jansa et al. also reported poorer assemblages from Puffin B-90 and Kittiwake P-11.

For a detailed historical review and full discussion of the biostratigraphy of offshore eastern Canada, see Williams et al. (1990).

MATURATION STUDIES

The visual kerogen analyses of wells in the area covered by this atlas have included typing of the kerogen and determination of the thermal alteration index (TAI). Bujak et al. (1977a, b) presented such data on 13 Grand Banks wells. The four kerogen types recognized were: amorphogen, phyrogen, hylogen and melanogen. Amorphogen comprises unorganized, structureless organic material, which may be finely disseminated or coagulated into fluffy masses; it is equivalent to the amorphous kerogen of other authors, including Baylss (1975). Phyrogen comprises all nonopaque, recognizable plant matter that is not of a woody origin and includes plant cuticles, spores and dinoflagellate cysts; it is equivalent to the herbaceous kerogen of other authors. Hylogen includes nonopaque fibrous plant material of woody origin and is more commonly referred to as woody kerogen. Melanogen comprises all opaque organic material and equates with the coaly kerogen of other authors (Bayliss, 1975).

Bujak et al. (1977a, b) visually determined the relative percentage of each of the four kerogen types and graphically illustrated these percentages for 13 Grand Banks wells. Subsequently, Barss et al. (1980) gave the relative percentages for the four visual kerogen types in 22 Grand Banks wells.

The thermal alteration indices for the same wells were presented in Bujak et al. (1977a, b) and Barss et al. (1980). The scale (in use as that of Staplin (1969) and Bayliss (1975). The postulated temperatures between kerogen type and TAI, as presented by Bayliss (1975), was given in Bujak et al. (1977a, b). The thermal values of the TAI scale are listed in the following:

2. Amorphogen forms fluid hydrocarbons, phyrogen produces only minor amounts of thermally derived gas and little or no liquid hydrocarbons - hylher hylogen nor melanogen yields thermally derived hydrocarbon products.

2 +. All four kerogen types contribute to hydrocarbon formation, although the nature of the generated hydrocarbons varies with organic type.

3. Upper boundary of the oil window, amorphogen is the last organic type to stop sourcing oil.

3 + and above. All the kerogen types have the potential for sourcing only thermally derived methane.

Bujak et al. (1977a, b) concluded that the kerogen type and TAI data indicated that the Jurassic-Lower Cretaceous source rocks of the central Grand Banks (Eider M-75) and eastern Grand Banks (Flying Foam I-13) contained sufficient amorphogen with a TAI of 2 or higher, to source oil.

Cassou et al. (1977) compared maturation with apparent subsidence and temperature for the following Grand Banks wells: Puffin B-90, Eider M-75, Murre G-67 and Adolphus DK-41. They found that all the wells contained sections within the oil window.

Levine (1980) provided a major synthesis of the maturation data for the Grand Banks. He developed a hydrocarbon generation model based on observed hydrocarbon occurrences, quantity and type of organic material, maturation and geology. This model indicated that significant quantities of liquid hydrocarbons have been generated in the upper Jurassic sediments since the end of the Cretaceous. Parameters utilized in Levine's study were the Time Temperature Index (TTI), Vitrinite Reflectance, Thermal Alteration Index (TAI), geothermal gradient and degree of fluorescence. Grant et al. (1986) gave a comprehensive review of the geochemistry of the Grand Banks, including information on the visual kerogen.

LOCATION MAP AND ZONATIONS

Figure 1 shows the location of all offshore wells mentioned in these Biostratigraphy and Maturation Data sheets.

PALYNOLOGICAL ZONATIONS

Figure 2 shows the GSC palynological zonation for the Mesozoic-Cenozoic strata of the offshore south-eastern Canada as developed by Williams (1975), Williams and Bujak (1977), Bujak and Williams (1977, 1978) and Barss et al. (1979). It also shows the type or reference sections of the zones. The calibration of the Early and Middle Jurassic zones was based on dinoflagellate biologic scale of Sarjeant (1974) as modified by Bujak et al. (1980). The age names are those used in Harland et al. (1990) except for Callovian, which is used in Figure 2 as the youngest Jurassic age.

The zonation scheme given in Figure 2 is the same as that illustrated by Barss et al. (1979, table 1) except for the revision of ages noted above. The names of many individual zones have changed, in some cases because the name of the nominate species has been recombined with another genus: thus *Hystrichosphaeridium chonaphorum* is now *Melitasphaeridium chonaphorum*, *Adnatosphaeridium reticulense* is now *Nematosphaeropsis reticulensis*; *Cerebropsis* is now *Cerodinium speciosum*, *Cordosphaeridium trunclgerum* is now *Pervosphaeridium truncigerum*, *Spiniferites* cf. *S. ventusm* is now called *S. ventusm*, *Chlamydophorella* cf. *ventilum*, *Systematophora schindewolfi* is now *Cleistosphaeridis schindewolfi*, *Aptea attadazica* is now *Circulodinium attadazicum*, *Chytroeisphaeridia anaphrissa* is now *Pseudocolaconema anaphrissum*, *Cleistosphaeridis ancyrea* is now *Dichadogonyaulax pannea*, *Gonyaulacysta flapicata* is now *Rhynchodiniopsis cladophora*, *Gonyaulacysta hyalodermopsis* is now *Dichadogonyaulax flapicata* and *Glaphyrocysta meyeriana* is now *Cordylodinium meyeriana*. In other cases, an informally-named species is now assigned to a formally established species; thus *Aptea*dinium sp. A is now *Aptea*dinium *attadazicum* and *Cassiculosphaeridia* sp. A is now *Reticulotaspora actinocoronata*. In a third type of situation, the species originally named in the zonation has been taxonomically synonymized with another species whose name has nomenal priority; thus *Chlamydophorella dispersum* is now circumscribed by *Chlopsteridium galea* and *Compositosphaeridium costatum* by *Compositosphaeridium polonicum*. Finally, specimens from offshore eastern Canada which were originally assigned to the Australasian species *Cleistosphaeridium* (now *Kiokansium*) *polypes* have now been reassigned to *Kiokansium williamsi* and specimens from the early Oligocene referred to as *Amosphaeridium arcuatum* are now known to belong to an undescribed species, *Glaphyrocysta* sp.

Figure 3 shows a zonation by E. H. Davies which was initially developed for the Hibernia wells but was later applied to other wells in the region. An earlier version of this zonation was first outlined in Williams et al. (1990).

Figure 4 shows the eastern Canadian zonation for Late Paleozoic miospores as provided in Williams et al. (1990) is based on earlier work by Barss and Hacquebard (1967), Hacquebard (1972) and Utting (1980). This zonation was erected principally for the Sydney Basin. The occurrence of Paleozoic rocks in Grand Banks wells is sporadic. In the area of this atlas, formal elements of this zonation have been reported only from Hermine E-94 and Sandpiper J-27.

In the alphanumeric codes for the palynological zones "D" represents Doeven (1983) for which the GSC zonation was originally intended, "CP" represents the Canada-Britain Geochronology Project, and "NP" represents Nannofossil palynology. "Z" represents Late Paleozoic. "P" represents Jansa, [Williams] note that the first "Jurassic" zone is indicated in Figure 2 as extending below the Triassic-Jurassic boundary). "C" represents Cretaceous, "T" represents Tertiary, and "ID" represents zones proposed by E. H. Davies. The zones are numbered from bottom to top within each geologic period. Subzones are indicated by a suffixed letter.

NANNOPLANKTON ZONATION

Figure 5, the zonation of Doeven (1983) based on nannofossils (coccoliths and discoasters), is the only scheme for this fossil group yet published for offshore eastern Canada. Doeven applied fourteen zones, all previously described from other regions, to the Albian-Maastrichtian sections of Hermine E-94, Osprey H-84 and Adolphus D-50 at depths in metres from the rotary table of the Kelly bushing.

Utting, J. 1980. Palynology of the Windsor Group (Mississippian) in a borehole at Shediac, Southeastern Basin, Nova Scotia; Canadian Journal of Earth Sciences, v. 17, p. 1031-1045.

Williams, G. L. 1975. Dinoflagellate and spore stratigraphy of the Mesozoic-Cenozoic, offshore eastern Canada; *in* Offshore Geology of Eastern Canada, Volume 2, Regional Geology, W. J. M. van der Linden and J. A. Wade (eds.); Geological Survey of Canada, Paper 74-30, v. 2, p. 107-161.

Williams, G. L., Ascoli, P., Barss, M. S., Bujak, J. P., Davies, E. H., Fensome, R. A. and Williamson, M. A. 1990. Biostratigraphy and related studies; Chapter 3 in Geology of the Continental Margin of Eastern Canada, M. J. Keen and G. L. Williams (eds.); Geological Survey of Canada, Geology of Canada, no. 2 (also Geological Society of America, The Geology of North America, v. I-1).

Williams, G. L. and Bujak, J. P. 1977. Cenozoic palynostratigraphy of offshore eastern Canada; in Contributions of Stratigraphic Palynology (with emphasis on North America), Volume 1, Cenozoic Palynology, W. C. Elsik (ed.); American Association of Stratigraphic Palynologists, Contributions Series, no. 5A, p. 14-47.

Williamson, M. A. 1987. A quantitative foraminiferal biozonation of the Late Jurassic and Early Cretaceous of the East Newfoundland Basin; Micropaleontology, v. 33, p. 37-65.

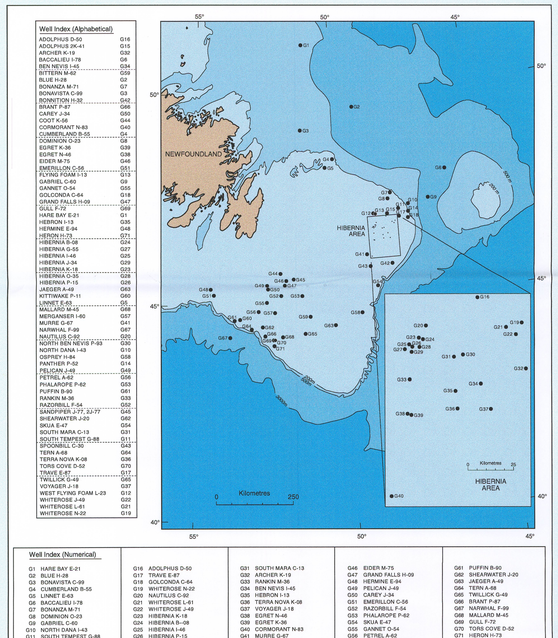

FIGURE 1. Well location map and index

FIGURE 5. Nannoplankton zonation

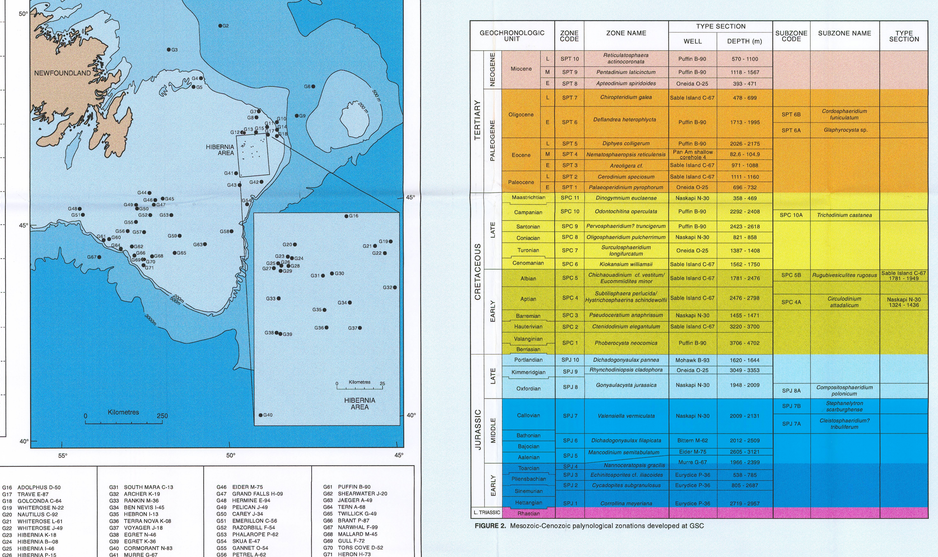

FIGURE 6. Foraminiferal, ostracod and calpionellid zonation

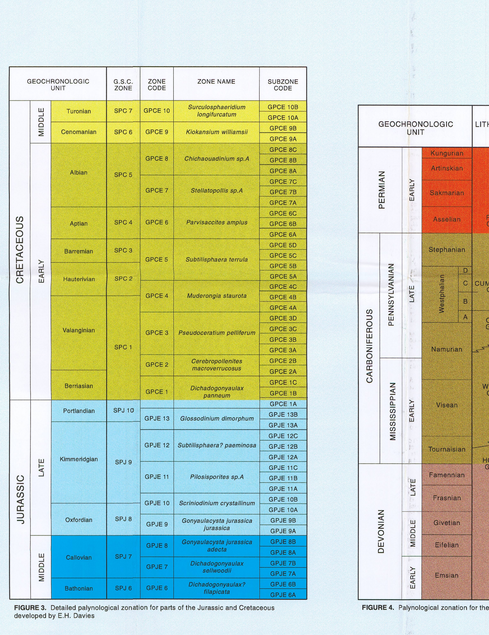

FIGURE 3. Detailed palynological zonation for parts of the Jurassic and Cretaceous developed by E.H. Davies

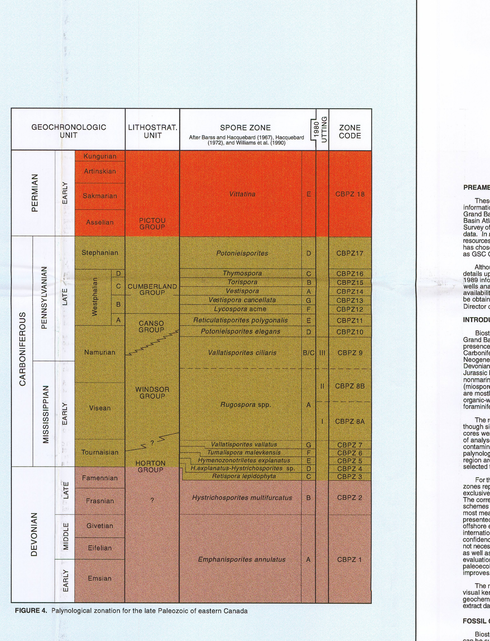

FIGURE 4. Palynological zonation for the late Paleozoic of eastern Canada

FIGURE 7. Foraminiferal zonations for Jurassic strata on the Grand Banks

Canada