jurassic micropaleontology
of the grand banks

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Os foraminiferos jurássicos dos sedimentos marinhos do Grand Banks (cuja espessura atinge 3 km) definem oito associações biostratigráficas de idade Plissbachiano a Títonico. A sedimentação marinha, geralmente de pequena profundidade, seria equilibrada pela subsidência, que não ultrapassava cerca de 4 cm/10³ anos.

Durante o Jurássico superior a subsidência deixou de se fazer sentir no Grand Banks central; a região emergiu, tendo sido submetida a erosão até os tempos albianos.

As associações de foraminiferos jurássicos lembram bastante as do "Velho Mundo"; elas são o resultado de paleogeografia atlântica homogênea desde as bacias neríticas da Europa até à bordadura da América do Norte. As diferenças em relação às microfaunas jurássicas portuguesas resultam de simples diferenças de fácies.

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Les foraminifères jurassiques dans les dépots marins (3 km d'épaisseur) du Grand Banks constituent huit associations biostratigraphiques d'âge Plissbachien à Tithonique. La sédimentation marine était en équilibre avec la subsidence, de l'ordre de 4 cm/10³, et les dépôts marins sont généralement de petite profondeur. Pendant le Jurassique supérieur la subsidence s'arrêterait sur le Grand Banks central; la région était emergée et soumise à l'érosion jusqu'à l'Albien.

Les associations de foraminifères jurassiques ressemblent bien celles du "Old World"; elles représentent le résultat d'une paleogéographie atlantique homogène depuis les bassins neritiques de l'Europe jusqu'en bordure de l’Amérique du Nord. Les différences par rapport aux microfaunes jurassiques portugaises sont le résultat de différences de faciés sedimentaires.

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Jurassic foraminifera in the marine deposits (up to 3 km thick) of the Grand Banks of Newfoundland define eight biostratigraphic zones of Plissbachian through Tithonian age. Jurassic marine deposition (~4 cm/10³y) kept pace with subsidence resulting in a relatively continuous, shallow marine sedimentation pattern. Central Grand Banks subsidence ceased in Late Jurassic time and the area became emergent with erosion taking place until Albian time.

Grand Banks Jurassic foraminiferal assemblages are of a distinctly Old World affinity reflecting the contracted early Atlantic paleogeography. Compositional differences with Portuguese Middle-Late Jurassic microfauna are probably related to differences in depositional history of the Portuguese and Grand Banks Basin.
BIOSTRATIGRAPHY

Biostratigraphic studies of cuttings and side-wall core samples from eight exploratory wells on the Grand Banks of Newfoundland, Canada (fig. 1) demonstrate the presence of over 10,000 feet (3050 m) of predominantly marine Jurassic sediments.

The oldest Mesozoic sediments on the Grand Banks consist of red beds, evaporites and dolomites dated by pollen and spores as of Late Triassic through Sinemurian (?Early Pliensbachian) age (JANSA et al., 1975, 1977). This sedimentary sequence is devoid of foraminifers (except possibly in the uppermost carbonates), reflecting nonmarine to marginal marine conditions.

The overlying Jurassic strata made up of clastics and some carbonates contain a relatively rich record of diversified foraminiferal assemblages largely indicative of "shelf" conditions. Eight zones have been recognized of Pliensbachian through Tithonian age. Most of the zones are based on the stratigraphically highest occurrence of taxa and consequently lower zone boundaries are defined by the top of the immediately underlying zone. Details on the taxonomy and age assignment of the zones are in F. GRADSTEIN (1976). The Jurassic biostratigraphy of four individual wells is discussed in F. GRADSTEIN et al. (1975, 1976) and L. JANSA et al. (1975, 1977). The zones allow a detailed well to well correlation, vital to an understanding of regional geology. There is no lithostratigraphic framework available on which the zonation may be superimposed. This hampers a regional facies analysis.

The Jurassic micropaleontological record starts with the Involutina liassica zone (1) dated approximately Pliensbachian. Taxa which are restricted to the zone are Brizalina liassica TERQUEM, Involutina liassica (JONES), Lingulina tenera BORNEMANN, Marginulina prima prima d’ORBIGNY, Frondicularia bicostata d’ORBIGNY, Berthelinitella involuta (TERQUEM), Epistomina sp. 12 GRADSTEIN, 1976, and the ostracod Ogoconcha sp.

The zone (2) of Lenticulina d’orbignyi delineates Toarcian-Aalenian sediments. It is based on the stratigraphically highest occurrence of the zonal name species, and Nodosaria columnaris FRANKE and the ostracod Kinkelinella sp. 1 (APOSTOLESCU). Garantella aff. rudia KAPTARENKO only appears in the upper part of the zone. Other taxa recognized in this zone are Nodosaria regularis TERQUEM, Lenticulina sp. cf. L. toarcensis PAYARD, Citharinella sp. cf. C. deslonchampsi (TERQUEM), and the ostracods Kinkelinella sermoisensis (APOSTOLESCU) and Cytherella toarcensis BIZON.

The Garantella zone (3), present with several species of this easily recognizable genus and many specimens, defines the overlying zone assigned a Bajocian-(early) Bathonian age. Characteristic taxa are Garantella amapa­ sindavaensis ESPITAU and SIGAL, G. aff. rudia KAPTARENKO, G. ornata HOFKER, G. sera PAZDRO and G. stellata KAPTARENKO. Another species restricted to the Garantella zone is Reinholdella episorcinoides KAPTARENKO; Globigerina balakhmatovae MOROZOVA and G. bathoniana PAZDROVA range through at least part of this zone and throughout the overlying one.

Fig. 1 — Location of eight exploratory wells on the Grand Banks of Newfoundland, Canada, which yielded Jurassic Foraminifera. The wells are Amoco IOE Murre G-67, and Eider M-75, Amoco Imp. Cormorant N-83, Bittern M-62 and Heron H-73, and Amoco Imp. Skelly Egret K-36 and Mallard M-45
Immediately overlying the Garantiella zone occurs the «Globigerina» bathoniana zone (4) with the zonal designator, G. balakhmatovae MOROZHOVA and Reinholdella media KAPTARENKO. The zone is based on the stratigraphically highest occurrence of these three taxa and has been dated as of (late) Bathonian age.

Epistomina coronata TERQUEM, E. mosquensis UHLIG, E. regularis TERQUEM, E. uhligi MIATLIUK and Lenticulina quenstedti (GUEMBEL) have their lower range in this interval or possibly in part in the Garantiella zone.

A Callovian age for Grand Banks sediments follows the recognition of the Reinholdella crebra var. zone (5) which has been based on the stratigraphically highest occurrence of the zone marker (a variety of R. crebra PAZDRO) and of Epistomina regularis TERQUEM, E. coronata TERQUEM, Frondicularia franconica GUEMBEL, Neoflabellina (?) deslongchampsi (TERQUEM), Saracenaria triquetra (GUEMBEL) and Globigerina oxfordiana GRIGELIS.

The highest stratigraphical occurrence of Epistomina mosquensis UHLIG, E. uhligi MIATLIUK, E. soldanii OHM, Gaudryina heersumensis LUTZE, Lenticulina quenstedti (GUEMBEL), Paalzowella feifeli (PAALZOW) and Valvulina meentzeni (KLINGLER) defines the Oxfordian-Kimmeridgian zone of E. mosquensis (6).

In several Grand Banks wells the uppermost Jurassic is in (very) shallow marine facies typified by some species of larger foraminifers. Two zones have been established:

The Pseudocyclammina jaccardi zone (7) and the Anchispirocyclina lusitanica zone (8). The Pseudocyclammina jaccardi zone of late Oxfordian-early Kimmeridgian age is based on the range of P. jaccardi (SCHRODT). Epistomina uhligi MIATLIUK also occurs. The zone correlates to the E. mosquensis zone which in the Murre G 67 well contains some specimens of E. uhligi, E. mosquensis, and P. aff. jaccardi.

The Anchispirocyclina lusitanica zone (8) has been based on the range in Grand Banks wells of A. lusitanica (EGGER). The Tithonian age interpretation of this zone (GRADSTEIN, 1976) has recently been further substantiated on the Grand Banks from the determination of late Tithonian calpionellid species which occur with the zone marker (P. Ascoli and H. Remane, pers. comm.).

REGIONAL STRATIGRAPHY

Jurassic sedimentation rates at the well sites are in the order of 4 to 10 cm/1000 yr, which is not particularly high for continental margins. From the relatively continuous Jurassic sedimentation (as far as known) and its inferred shallow water nature it follows that sedimentation kept pace with subsidence. However, as may be observed from figure 2 which displays the stratigraphic distribution in Grand Banks wells of sediments dated through foraminifers, part of Upper Jurassic and most or all of Lower Cretaceous sediments may be missing.

Seismostratigraphy shows that this hiatus corresponds to a conspicuous unconformity which separates folded Jurassic strata preserved in northeast-southwest trending «sub-basins» from an overlying succession of transgressive post-Aptian rocks (Amoco and Imperial, 1973; UPSHAW et al., 1974; GRADSTEIN et al., 1975). Grand Banks subsidence apparently ceased at the end of Jurassic time and the area emerged in the Tithonian to Albian period. In the East Newfoundland Basin, to the northeast of the Grand Banks, and to the southwest in the Scotian Basin, marine environments prevailed during that time, with locally thick sediments being accumulated. A transitional facies developed in the Egret K-36 well (figs. 1, 2), where Early Cretaceous and also Kimmeridgian sediments are of brackish water nature with a predominance of ostracods, Chara sporangia and few foraminifers.

BIOGEOGRAPHY

Jurassic foraminiferal assemblages from the Grand Banks and adjacent Scotian Shelf as well (the latter studied by P. ASCOLI, 1976) have strong affinities to coeval assemblages known from Europe and Africa. The Grand Banks has many species in common with the «Old World» that are not known from elsewhere in North America (GRADSTEIN, 1976).

An example of the «Old World» affinity is provided by Middle and Upper Jurassic foraminifers belonging in the genera «Globigerina», Garantiella, Reinholdella, Epistominia and the Jurassic complex arenaceous foraminifers. The Jurassic globigerinids, the earliest planktonic foraminifers, might be expected to have a wide dispersal in the Jurassic seaways. Garantiella, Reinholdella, and Epistominia are bottom-dwellers, as are the complex arenaceous foraminifers. The latter are confined to shallow and very shallow marine environment.

This group of foraminifers which occurs with many species and abundant individuals in Grand Banks Middle
and Upper Jurassic deposits, are well known from Europe and also Africa to some extent, but not elsewhere from North America (fig. 3). An exception is the occurrence of a few taxa of complex arenaceous foraminifers and one or two Epistomina species in the Upper Jurassic of the Gulf Coast and Caribbean region.

The well known predrift reconstruction of the circum-Atlantic region in Jurassic time (e.g. WILSON, 1975, fig. 4) indicates a slightly lower-latitude position of the Grand Banks and a geographic proximity of the area to the Mediterranean region (Tethyan realm). The Tethyan and «Old World» affinity of the Grand Banks fauna may be explained, to a large extent, from this Jurassic paleogeography. The land-mass of the Appalachian and the adjacent Canadian Shield west of it delineate the western margin of the Jurassic Grand Banks marine realm.

The inferred juxtaposition in Jurassic time of the Grand Banks and Portugal, possibly without much of an incipient deep basin in between (WILSON, 1975) might lead to the speculation of substantial agreement in composition of coeval foraminiferal faunas. On the contrary, preliminary interpretation based on a comparison of literature data from the Jurassic of Portugal (ZBYSZEWSKI et al., 1966; RUGET and SIGAL, 1970; RAMALHO, 1971; RAMALHO and REY, 1975), indicates a substantial difference in foraminiferal fauna composition in Middle and to a lesser extent in Late Jurassic time.

No globigerinids and very few epistominids, abundant in Grand Banks Middle Jurassic strata, are known from Portugal, whereas the Grand Banks Middle-Upper Jurassic sediments have about five times less complex arenaceous taxa and few or no algae. Early Jurassic faunal similarities at present are subject of a detailed investigation by J. Exton, England, and the author.

ACKNOWLEDGEMENTS

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REFERENCES


Mr. BOUILLOT — La courbe de subsidence que vous avez présentée pour le Grand Bank de Terre Neuve suggère: a) une subsidence exponentielle (refroidissement lithosphérique) de l'Hettangien à l'Oxfordien inférieur; b) un arrêt de la subsidence (2e rift?) de l'Oxfordien supérieur à l'Albien inférieur; c) une nouvelle subsidence exponentielle à partir de l'Albien (refroidissement lithosphérique). Pouvez vous préciser cette évolution, d'un très grand intérêt pour les comparaisons avec la marge ouest-portugaise?

Mr. GRADSTEIN — La courbe du subsidence présentée n'est pas complète. Il faut ajouter des données d'autres sondages, particulièrement pour le Trias supérieur et le Crétacé inférieur. En général la courbe pour le «shelf» canadien est une courbe exponentielle non interrompue. L'arrêt du Jurassique supérieur au Crétacé inférieur est un phénomène local du Grand Bank Central.

Mr. MOUGENOT — Je suis surpris que dans les forages du Grand Bank vous ne trouviez pas, comme au Portugal, une discontinuité entre le Callovien et l'Oxfordien.

Mr. GRADSTEIN — La discontinuité du Grand Bank est située entre le Jurassique sup. (Callovien-Tithonique) et le Crétacé moyen (Albien). Nous n'avons pas trouvé l'évidence d'une discontinuité dans le Jurassique supérieur comparable à celle du Bassin Lusitanien.

Mr. PALAIN — Sur une de vos diapositives donnant la succession stratigraphique vous avez indiqué par un figuré ondulé, signe de disconformité, le contact entre l'Hettangien et ce qui est dessous. A quoi correspond ce contact? Puisque nous sommes sur le problème de la base de la série du Mésozoïque, pourriez-vous nous dire si vous avez trouvé de la microfaune et dans le cas contraire pourquoi ces fossiles manquent?

Mr. GRADSTEIN — 1) C'est le contact des sédiments dévonien immédiatement superposés par dolomites du Jurassique inférieur.

2) La première indication de conditions marines normales est dans la zone à Involutina liassica, interprétée comme d'âge Pliensbachien. Il n'y a pas de foraminifères au dessous dans le Grand Bank.
DOCUMENTAÇÃO FOTOGRAFICA
PLATE 1

Three foraminiferal species from the Garantella zone (Middle Jurassic) in Amoco JOE Eider M-75, Grand Banks.

Figure 1 — *Garantella ornata* (HOFLER); × 150
Figure 2 — Idem
Figures 3, 4 — *Garantiella stellata* KAPTARENKO; × 150
Figures 5, 6 — «*Globigerina* bathoniana» PAZDROVA; × 500