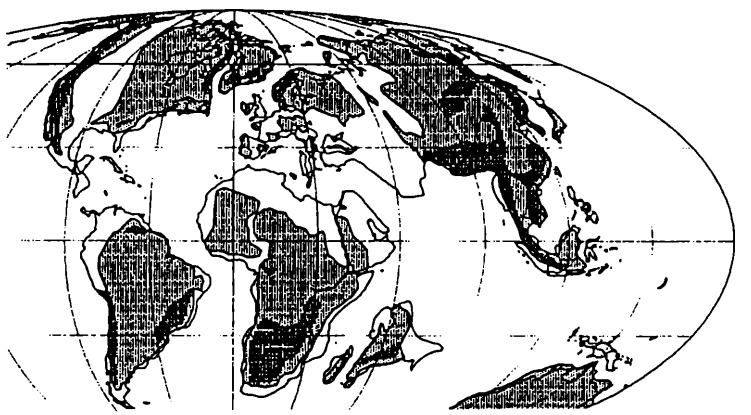

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CRETACEOUS AMMONITES OF BRAZIL

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INTRODUCTION

Ammonites and inoceramid bivalves are the biostratigraphically most important macrofossil groups in the marine Cretaceous of Brazil. However, limited exposures restrict their occurrences to a few basins along the north-eastern Brazilian margin; in addition a few scattered finds have been reported from boreholes in offshore basins. Most specimens come from the Albian, Cenomanian, Turonian, Coniacian and Maastrichtian stages. The aim of this contribution is to review and illustrate the Cretaceous ammonite succession of Brazil.

The reader is referred to PONTE & ASMUS (1978) for a short description of the geology and stratigraphy of the Brazilian marginal basins and to PETRI (1987) for a summary of the palaeogeographical development during the Cretaceous. Detailed accounts of the current state of stratigraphical knowledge of each marginal basin have recently been published by the Brazilian oil company PETROBRÁS (1995). Only a brief outline of the major ammonite-bearing basins is therefore given here.

GEOLOGICAL SETTING

The development of the Brazilian marginal basins is directly related to the break-up of Gondwana. Through the separation of South America from Africa, divergent continental margins of Atlantic-type were formed on both sides of the incipient South Atlantic. The evolutionary history of the marginal basins comprises four tectonosedimentary stages (e.g., ASMUS & BAISCH 1983): *pre-rift*, in the late Jurassic(?) to earliest Cretaceous, with crustal uplift, formation of marginal basins and deposition of a thick, non-marine clastic sequence; *rift*, in the earliest Cretaceous to early(?) Aptian, with the development of rift valleys and systems of tilted fault blocks and largely syntectonic, continental deposition; *transitional*, proto-marine, evaporitic, in the Aptian, with the first marine transgressions and deposition of evaporites and clastic sediments; *drift*, from late Aptian onwards, with open marine conditions and deposition of thick successions of carbonates and clastics.

Of the Brazilian marginal basins only the Potiguar, Pernambuco–Paraíba and Sergipe basins and, to a lesser extent, the Camamu Basin in the north-east (Fig. 1) contain significant exposures of ammonite-bearing Cretaceous rocks. Isolated finds of ammonites have been made

in the Barreirinhas, Alagoas and Camamu basins and in the Santos and Campos basins in the south-east.

Potiguar Basin. – The onshore Albian–Campanian sequence is subdivided into the clastic Açu Formation and the carbonate Jandaíra Formation, the latter an up to 600 m thick sequence of dominantly calcarenites (ARARIPE & FEIJÓ 1995). All ammonites come from outcrops of the Jandaíra Formation in the western part of the basin. Although this formation has been well dated offshore with microfossils, well-preserved stratigraphically diagnostic macrofossils are rare at outcrop.

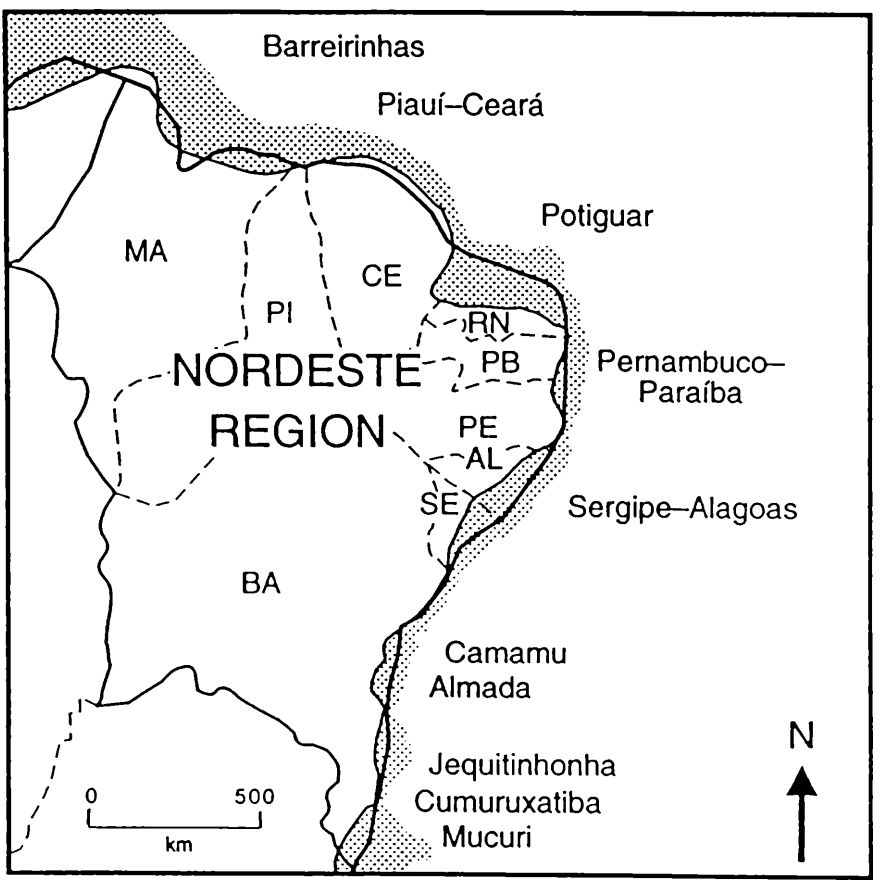

Fig. 1. Map of north-eastern Brazil (*Nordeste* region) showing marginal basins containing marine Cretaceous deposits.

Pernambuco–Paraíba Basin. – The base of the sedimentary sequence shows alternating marine and continental facies and consists of over 300m of grey sandstones, the Beberibe Formation. This part of the sequence remains poorly dated, with a dubious ammonite record (see below).

The Gramame Formation, which rests concordantly on the Beberibe Formation, consists of an over 40 m thick limestone sequence (FEIJÓ 1995a). The age is chiefly Maastrichtian, probably including Campanian near the base (e.g., MUNIZ 1993). Most ammonites come from the quarried upper parts of the Gramame Formation exposed south of

João Pessoa (Paraíba) and north of Recife (Pernambuco). In the latter area, an expanded sequence across the Cretaceous–Tertiary boundary is exposed.

Sergipe Basin. – The Alagoas Basin, south of the Pernambuco–Paraíba Basin, has yielded only a small number of Cenomanian ammonites from derived blocks of siliceous oolite (BENGTSON & NORDLUND 1987). By contrast, the southward extension of this basin, the Sergipe Basin, displays a well-developed marine Cretaceous sequence (e.g. FEIJÓ 1995b), from which numerous ammonites have been collected over the past decades (see BENGTSON 1983 and KOUTSOUKOS & BENGTSON 1993 for reviews).

The marine succession of Sergipe starts with the Aptian–Albian Riachuelo Formation, composed of approximately 500m of carbonates and calcareous clastics, which are locally oolitic/oncolitic. Ammonites have been collected from most levels of the formation.

The overlying Cenomanian–Coniacian Cotinguiba Formation is dominated by calcilutites with rare clastic intercalations (BENGTSON 1983). The thickness of the formation ranges from 200 to locally over 1000m in the onshore part of the basin. Ammonites are common at all stratigraphical levels. In the Estância area in southern Sergipe only a thin Cenomanian sequence is present.

Upper Coniacian and Santonian appear to be missing at outcrop. The uppermost Cretaceous in Sergipe is represented by the clastic Calumbi Formation, which has yielded scarce Campanian ammonites.

Camamu Basin. – Most of the Cretaceous rocks in this basin are non-marine, but locally a succession of marine limestones is found in the uppermost part of the sequence. These are referred to the Algodões Formation, for which an age span of Albian–Turonian is given (MASCARENHAS *et al.* 1979; NETTO *et al.* 1995).

THE AMMONITE SUCCESSION OF BRAZIL

Study of the ammonite faunas of Brazil dates back to the past century, when HYATT (1870) described Albian to Turonian forms from the Sergipe Basin. Since then a number of publications on ammonites and other macrofossils have appeared, the majority in recent times dealing with biostratigraphical questions.

In this review the ammonite succession of Brazil is presented, substage by substage, exposing the stratigraphically most significant taxa. As yet, a working ammonite zonation exists only for the Sergipe Basin (KOUTSOUKOS & BENGTSON 1993), the only basin that contains a well-exposed stratigraphical succession from which ammonites can be collected in sequence.

Upper Aptian. – The *Epicheloniceras–Diadochoceras–Eodouvilleiceras* Zone of Sergipe has yielded *Epicheloniceras* sp., *Diadochoceras* sp., *Eodouvilleiceras horridum* (Riedel, 1937), *Eodouvilleiceras* sp. and "*Dufrenoyia*" cfr. *justinae* Hill, 1893.

Lower Albian. – In Sergipe the broad *Douvilleiceras* Zone has yielded *Douvilleiceras* ex gr. *mammillatum* (SCHLOTHEIM, 1813) and *Douvilleiceras inequinodum* (QUENSTEDT, 1849). The zone can probably be subdivided, for example, on the basis of *D. inaequinodum*, which occurs low in the zone.

Middle Albian. – In Sergipe the *Oxytropidoceras* Zone has yielded *Oxytropidoceras buarquianum* (WHITE, 1887) and *Oxytropidoceras* spp.

Upper Albian. – The upper Albian in Sergipe is subdivided into two ammonite zones, named after the genera *Elobiceras* and *Mortoniceras*. Correlation with the type areas is hampered by provincialism, and only a broad assignment to the standard *M. inflatum* Zone is possible. The uppermost Albian *Stoliczkaia dispar* Zone seems to be missing (as in Nigeria). The *Elobiceras* Zone has yielded *Elobiceras intermedium* Spath, 1922 and *Elobiceras* sp. A single find of an *Elobiceras bahiaense* Maury, 1925, from the Camamu Basin is referred to this zone. From the offshore Barreirinhas Basin on the northern coast an *Elobiceras* sp. was reported by PAMPLONA (1970); unfortunately, it has not been possible to locate this specimen. The *Mortoniceras* Zone of Sergipe has yielded *Mortoniceras* cf. *lastroensis* Maury, 1937, *Mortoniceras* spp. and *Neokentroceras* cf. *tectorium* (WHITE, 1887). From a borehole penetrating the Albian–Cenomanian Macaé Formation in the Campos Basin a *Mortoniceras* of the *inflatum* group belongs in this zone. Unfortunately, the exact provenance of the specimen is not known.

Lower Cenomanian. – The *Graysonites lozoi_Hypoturrilites betaitraensis* Zone in Sergipe (S. BENGTSON 1995) has yielded *Graysonites lozoi* YOUNG, 1958, *Sharpeiceras vohipalense* Collignon, 1964, *Sharpeiceras laticlavium nigeriense* Zaborski, 1985, *Hypoturrilites betaitraensis* Klinger & Kennedy, 1978, *Stoliczkaia (Shumarinaia) africana* Pervinquière, 1907, and *Forbesiceras brundrettei* (YOUNG, 1958).

Middle Cenomanian. – The *Acompsoceras spathi–Dunveganoceras* and *Acanthoceras jukesbrownei–Eucalycoceras pentagonum* zones of Sergipe correspond broadly to the middle Cenomanian standard *Acanthoceras rhotomagense* Zone. The *Acompsoceras spathi-Dunveganoceras* Zone has yielded *Acompsoceras spathi* BASSE, 1940, *Acompsoceras* aff. *renevieri* (SHARPE, 1857), *Dunveganoceras* sp., *Euomphaloceras (E.) meridionale*

(STOLICZKA, 1864) and *Turrilites scheuchzerianus* BOSC, 1801. The *Acanthoceras jukesbrownei-Eucalycoceras pentagonum* Zone has yielded *Acanthoceras jukesbrownei* (SPATH, 1926) and *Eucalycoceras pentagonum* (Jukes-Browne & Hill, 1896).

Upper Cenomanian. – The *Pseudocalycoceras harpax_Thomelites* aff. *sornayi* Zone of Sergipe has yielded *Pseudocalycoceras harpax* (STOLICZKA, 1864) and *Thomelites* aff. *sornayi* (THOMEL, 1967). From Alagoas an isolated fauna with *Pseudocalycoceras* cf. *harpax* and *Kamerunoceras* sp. probably belongs in this zone (BENGTSON 1987). The ensuing upper Cenomanian *Euomphaloceras septemseriatum* Zone of Sergipe can be correlated with the standard *Metoicoceras geslinianum* Zone. This zone has yielded *Euomphaloceras septemseriatum* (CRAGIN, 1893), *Pseudaspidoceras pseudonodosoides* (CHOFFAT, 1899), *Vascoceras gamai* CHOFFAT, 1899 and *Thomasites gongilensis* (WOODS, 1911).

Above the *septemseriatum* zone, correlation with the "standard zonation" becomes difficult, in particular the position of the Cenomanian–Turonian boundary. On the basis of associated species, the *Vascoceras harttii–Pseudaspidoceras footeanum* ammonite zone is tentatively correlated with the standard Cenomanian *Neocardioceras juddii* Zone and the lower part of the Turonian *Watinoceras* spp. Zone. The *Vascoceras harttii_Pseudaspidoceras footeanum* Zone has yielded *Pseudotissotia nigeriensis* (WOODS, 1911), *Pseudotissotia gabonensis* LOMBARD, 1931, *Vascoceras harttii* (HYATT, 1870), *Pseudaspidoceras footeanum* (STOLICZKA, 1864) and *Wrightoceras* sp.

Lower–middle Turonian. – This interval in Sergipe corresponds to the zones of *Watinoceras amudariense–Kamerunoceras seitzi* and *Mammites nodosoides–Kamerunoceras turoniense*. The position of the lower–middle Turonian boundary is uncertain, as diagnostic taxa are missing.

The *Watinoceras amudariense-Kamerunoceras seitzi* Zone has yielded *Watinoceras amudariense* (ARKHANGEL'SKIJ, 1916), *Kamerunoceras seitzi* (RIEDEL, 1932) and *Mitonia reesidei* (MAURY, 1937).

The *Mammites nodosoides-Kamerunoceras turoniense* Zone has yielded *Mammites nodosoides* (SCHLÜTER, 1871), *Kamerunoceras turoniense* (d'Orbigny, 1850), *Fagesia bomba* Eck, 1909 and *Romaniceras deverianum* (D'ORBIGNY, 1841).

From the Mossoró area in the Potiguar Basin poorly preserved specimens of the genera *Mammites*, *Hoplitoides* and *Coilopoceras* have been described (BEURLEN 1964; OLIVEIRA 1969; MUNIZ *et al.* 1984) from what appears to be lower or middle Turonian beds.

Upper Turonian. – The *Subprionocyclus–Reesidites* zone of Sergipe has yielded *Subprionocyclus* sp., *Reesidites* sp. and *Paralenticeras leonhardianum* (KARSTEN, 1858).

A single ammonite has been found in a Petrobrás drill core penetrating the Cenomanian–Maastrichtian Itajaí-Açu Formation of the offshore Santos Basin, southern Brazil. Although preservation is not the best, it appears to be a *Subprionocyclus (Reesidites)* sp.

Lower Coniacian. – The *Barroisiceras onilahyense–Forresteria* Zone of Sergipe has yielded *Barroisiceras (B.) onilahyense* BASSE, 1948, and *Forresteria* sp..

Middle Coniacian. – The *Solgerites armatus–Prionocycloceras lenti* zone of Sergipe has yielded *Solgerites armatus* (SOLGER, 1904), *Prionocycloceras lenti* (GERHARDT, 1897), *Prionocycloceras guayabanum* (STEINMANN, 1897), *Heterotissotia* sp., *Bostrychoceras indicum* (STOLICZKA, 1865), and *Peroniceras* spp.

Upper Coniacian. – From the Potiguar Basin two ammonites have been described from a quarry near Mossoró and referred to *Protexanites* cf. *bourgeoisianus* (D'ORBIGNY, 1850) and *Gauthiericeras* sp., respectively (MUNIZ & BENGTSON 1987).

Campanian. – One of the sparse outcrops of the Calumbi Formation in Sergipe has yielded a small number of ammonites and inoceramids. Preliminary identification suggests *Pseudoschloenbachia* sp. and *"Axonoceras"* sp., which together with inoceramid and foraminifer data indicate a late Campanian age.

From the Beberibe Formation in the Pernambuco–Paraíba Basin a few ammonites have been reported in the literature but never described or figured. One of the specimens appears to be a weakly ornamented *Pseudoschloenbachia* sp., probably of Campanian age.

The base of the overlying Gramame Formation has yielded *Axonoceras* spp., *Baculites* sp. and *Sphenodiscus* sp., which are also referred to the Campanian (MUNIZ 1993).

Maastrichtian. – Numerous ammonites have been collected from the Gramame Formation in the Pernambuco–Paraíba Basin. The fauna is dominated by Pachydiscidae, notably *Pachydiscus (P.) neubergicus* (VON HAUER, 1858); *Sphenodiscus* sp., *Pseudophyllites* sp. and *Diplomoceras* sp. also occur.

The upper parts of the Jandaíra Formation in the Potiguar Basin have yielded poorly preserved ammonites described by OLIVEIRA (1957) as *Pachydiscus* sp. and *Sphenodiscus* sp. and presumed to be of Campanian–Maastrichtian age.

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REFERENCES

ARARIPE, P.T. & FEIJÓ, F.J. 1995 [for 1994]. Bacia Potiguar. *Boletim de Geociências da Petrobrás 8(1)*, 127-141.

ASMUS, H.E. & BAISCH, P.R. 1983. Geological evolution of the Brazilian continental margin. *Episodes 1983(4)*, 3-9.

BENGTSON, P. 1983. The Cenomanian–Coniacian of the Sergipe Basin, Brazil. *Fossils and Strata 12*, 1-78.

BENGTSON, P. 1987. Mid-Cretaceous acanthoceratid ammonites from Alagoas, Brazil. *In* P. Bengtson & U. Nordlund: The ammonite fauna and genesis of a mid-Cretaceous siliceous oolite from the Alagoas Basin, Brazil. *Cretaceous Research 8(4)*, 310-317.

BENGTSON, P. & NORDLUND, U. 1987. The ammonite fauna and genesis of a mid-Cretaceous siliceous oolite from the Alagoas Basin, Brazil. *Cretaceous Research 8(4)*, 305-333.

BENGTSON, S.I. 1995. *Lower Cenomanian ammonites from Sergipe, Brazil*. 75 pp., 6 pls. M.Sc. Thesis; Institutionen för geovetenskap/paleontologi, Uppsala universitet.

BEURLEN, K. 1964. A fauna do Calcário Jandaíra da região de Mossoró (Rio Grande do Norte). *Coleção Mossoroense, C 13*, 1-215. Ed. Pongetti, Rio de Janeiro.

FEIJÓ, F.J. 1995a [for 1994]. Bacia de Pernambuco–Paraíba. *Boletim de Geociências da Petrobrás 8(1)*, 143-147.

FEIJÓ, F.J. 1995b [for 1994]. Bacias de Sergipe e Alagoas. *Boletim de Geociências da Petrobrás 8(1)*, 149-161.

HYATT, A. 1870. Report on the Cretaceous fossils from Maroïm, province of Sergipe, Brazil, in the collection of Professor Hartt. *In* C.F. Hartt: *Geology and Physical Geography of Brazil*, 385-393. Fields, Osgood & Co., Boston, Massachussetts.

KOUTSOUKOS, E.A.M. & BENGTSON, P. 1993. Towards an integrated biostratigraphy of the upper Aptian-Maastrichtian of the Sergipe Basin, Brazil. *Documents du Laboratoire de Géologie de Lyon 125*, 241-262.

MASCARENHAS, J.F., PEDREIRA, A.J.C.L., GIL, C.A.A., NEVES, J.P. DAS, OLIVEIRA, J.E. DE, SILVA FILHO, M.A. & MARINO, M.M. 1979. Geologia da região centro oriental da Bahia. *Departamento Nacional da Produção Mineral, Série Geologia 11, Seção Geologia Básica 8*, 1-128, 8 maps.

MUNIZ, G.C.B. 1993. Novos moluscos da Formação Gramame, Cretáceo superior dos estados da Paraíba e de Pernambuco, Nordeste do Brasil. *Departamento de Geologia da Universidade Federal de Pernambuco, Publicação Especial 1*, 1-203, [Pls. 1-16].

MUNIZ, G.C.B. & BENGTSON, P. 1987 [for 1986]. Amonóides coniacianos da Bacia Potiguar, Brasil. *Anais da Academia Brasileira de Ciências 58*, 445-455.

MUNIZ, G.C.B., DINIZ, R.F. & OLIVEIRA, M.I.M. de 1984. Um outro cefalópode procedente do Estado do Rio Grande do Norte, Formação Jandaíra, Cretáceo do Nordeste. *Departamento de Geologia da Universidade Federal de Pernambuco, Estudos e Pesquisas 6/7*, 57-60.

NETTO, A.S.T., FILHO, J.R.W. & FEIJÓ, F.J. 1995 [for 1994]. Bacias de Jacuípe, Camamu e Almada. *Boletim de Geociências da Petrobrás 8(1)*, 173-184.

OLIVEIRA, P.E. de 1957. Ocorrência de cefalópodos no Cretácico do Estado do Rio Grande do Norte. *Anais da Academia Brasileira de Ciências 29(2)*, 243-248.

OLIVEIRA, P.E. de 1969. Nôvo amonoide do Cretáceo do Ceará. *Instituto de Geociências, Universidade Federal do Rio de Janeiro, Boletim Geológico 4*, 5-9.

PAMPLONA, H.R.P. 1970 [for 1969]. Litoestratigrafia da Bacia Cretácea de Barreirinhas. *Boletim Técnico da Petrobrás 12(3)*, 261-290.

PETRI, S. 1987. Cretaceous paleogeographical maps of Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology 59(13)*, 117-168.

[PETROBRÁS (ed.)] 1995 [for 1994]. [Cartas estratigráficas das bacias sedimentares brasileiras.] *Boletim de Geociências da Petrobrás 8(1)*, 1-249.

PONTE, F.C. & ASMUS, H.E. 1978. Geological framework of the Brazilian continental margin. *Geologische Rundschau 67(1)*, 201-235.