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Cretaceous ammonite zonation of the Sergipe Basin, northeastern Brazil

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ABSTRACT

A biostratigraphic zonation scheme based on ammonites is presented for the Cretaceous of the Sergipe Basin in northeastern Brazil. The marine beds range from the upper Barremian to the Maastrichtian, of which the Aptian–Coniacian and Campanian successions have yielded ammonites. The historical development leading to the current ammonite zonation is illustrated schematically. For each of the 22 biozones, the most important taxa are listed. Correlation with the "standard zonation" for ammonites remains largely tentative as a result of provincialism of the faunas.

1. Introduction

Among the sedimentary basins bordering the South American margin of the South Atlantic Ocean, the Sergipe Basin in northeastern Brazil (Fig. 1) contains the most extensively exposed Mesozoic succession. The rocks yield a rich, dominantly Cretaceous fauna comprising non-marine and marine micro- and macrofossils, a fact that renders the basin a key role in the Cretaceous geology and biostratigraphy of the region. The faunas represent a predominantly shallow-water biota of the early stages of development of the South Atlantic. Ammonites occur abundantly throughout the marine succession, in particular in the well-exposed Aptian to Coniacian interval. Because of their arguably de-facto standard for the biostratigraphically based global chronostratigraphy, they form a particularly significant fossil group. Consequently, during the past century, the ammonites of the continental margin basins of Brazil have received considerable attention. Based on extensive work in the Sergipe Basin, in particular during the past decades, it is now possible to establish a detailed ammonite zonation. This zonation should be integrated with corresponding ammonite zonations for the eastern margin of the South Atlantic to form a reference zonation for the central Atlantic (northern South Atlantic) region, thus providing a solid framework for interpretation and reconstruction of the opening and early evolution of the South Atlantic Ocean.

2. Geological setting

The continental margin basins bordering the South Atlantic were formed as a result of the break-up of Gondwana, through the separation of South America from Africa. The evolutionary history of the basins comprises four tectonosedimentary stages (e.g., Ojeda, 1982): (1) pre-rift (late Jurassic to earliest Cretaceous), with crustal uplift and deposition of non-marine clastic sediments; (2) rift (earliest Cretaceous to Barremian), with development of rift valleys and systems of tilted fault blocks and largely syntectonic, continental sedimentation; (3) transitional (late Barremian–Aptian), proto-marine, evaporitic, with the first marine transgressions and deposition of evaporites and clastic sediments; and (4) drift (late Aptian onwards), with open-marine conditions and deposition of thick carbonate and clastic sediments. Strictly speaking, the Sergipe Basin is a sub-basin of the larger Sergipe-Alagoas Basin, comprising the Cabo, Alagoas, Sergipe and Jacuípe basins (Souza-Lima et al., 2002), which in turn were parts of the large Brazil-Angola Basin enclosed between the Rio Grande Rise-Walvis Ridge barrier in the

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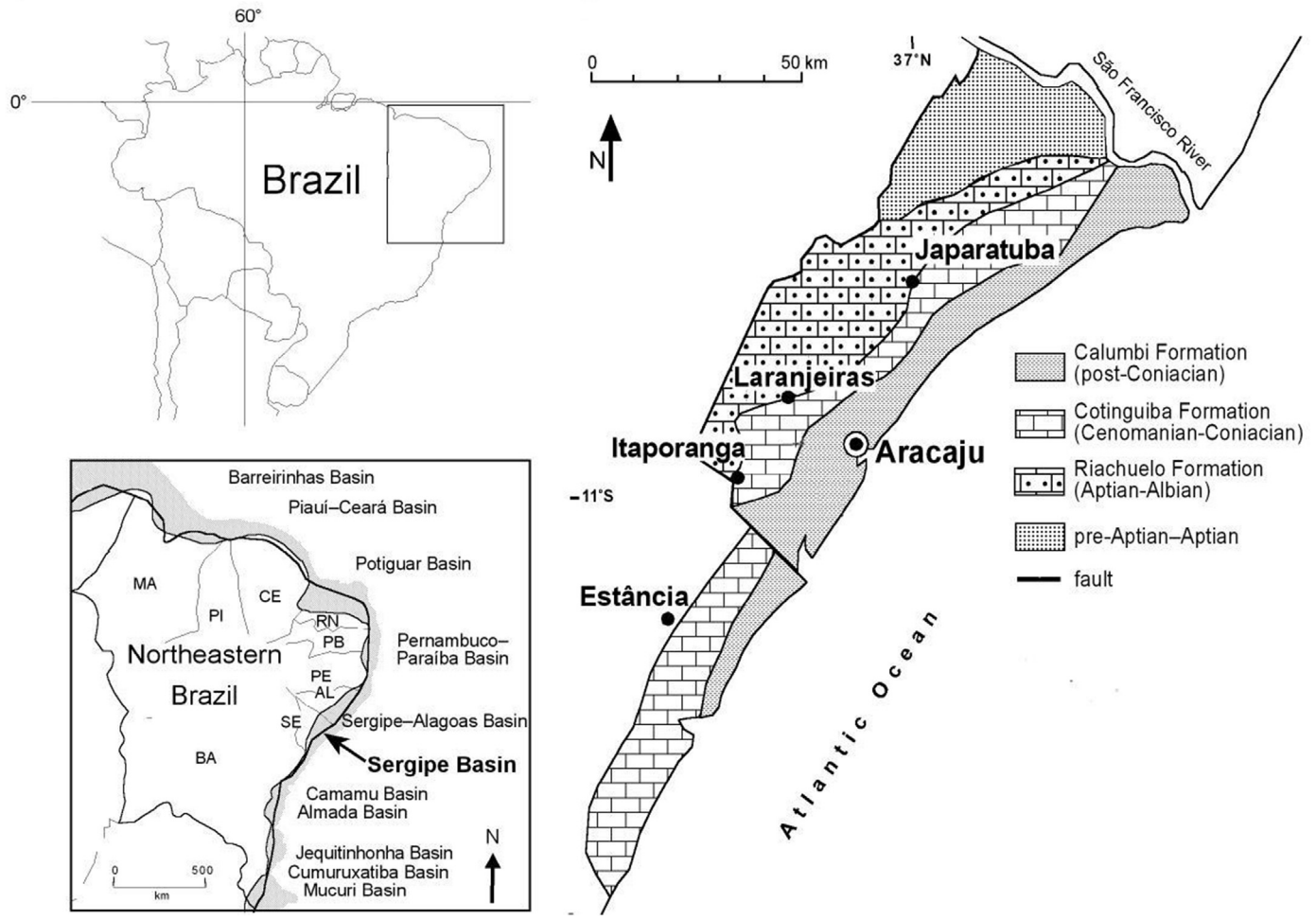

Fig. 1. Location of continental margin basins in northeastern Brazil and onshore geology of the Sergipe Basin below the non-marine Cenozoic cover (adapted from P. Bengtson, 1983a).

south and the equatorial fracture zone in the north (Koutsoukos et al., 1991, fig. 15; Néraudeau and Mathey, 2000, fig. 2). The onshore portion of the Sergipe Basin occupies a narrow coastal strip, approximately 15–50 km wide and 200 km long, with a sedimentary fill reaching thicknesses between 1 and 3 km onshore and up to 8 km offshore (Ponte et al., 1980).

The marine portion of the succession spans the upper Barremian to Maastrichtian interval (Fig. 2) and is subdivided into (1) the Morro do Chaves Formation, consisting of up to c. 300-m-thick, Barremian, dominantly non-marine coquinoid limestones and shales with intermittent marine intercalations; (2) the Muribeca Formation, consisting of variably thick, Aptian siliciclastics, carbonates and evaporites; (3) the Riachuelo Formation, consisting of a c. 500-m-thick Aptian–Albian mixed carbonate-siliciclastic and evaporitic platform system; (3) the Cotinguiba Formation, consisting of a c. 200-m-thick, locally exceeding 1000 m, Cenomanian–Coniacian succession of dominantly fine-grained deep-water limestones; (4) the Calumbi Formation, consisting of up to and exceeding 2000 m of Santonian–Holocene, open-marine siliciclastics. Onshore, a stratigraphic gap comprises the upper Coniacian to lower Campanian interval, and outcrops of Maastrichtian age have not been confirmed. It should be noted that on the basis of sequence stratigraphic analyses some authors include the lower and middle Cenomanian in the Riachuelo Formation (Campos Neto et al., 2008). However, as there is no lithological support for this lithostratigraphic reassignment, the original definition of the formation (e.g., Schaller, 1970, p. 55, but see p. 79; Feijó, 1995) is maintained here.

Although the marine Cretaceous of the basin is extensively exposed, stratigraphically controlled sampling is hampered by the scarcity of laterally continuous outcrops. Most quarries and road cuttings expose only up to a few metres of section. The few existing larger quarries have yielded sizeable samples of ammonites; however, as the material was collected mainly by quarry workers, the relative position in sequence of most of the specimens is unknown. Position in sequence of laterally discontinuous outcrops was inferred mainly on the basis of regional dip and altitude of the beds exposed. The true lowest occurrence and the true vertical distribution of the diagnostic taxa are still in part uncertain.

3. History of research

Study of the ammonite faunas of Brazil dates back to the late 19th century, when Hyatt (1870) described a few Albian and Turonian forms from the Sergipe Basin. The pioneer work describing ammonites and associated macrofossils was by White (1887). On the basis of White's (1887) descriptions, Haug (1911, pp. 1295–1296) assigned the Sergipe ammonites to the lower Cenomanian (erroneously, for Albian) and the lower Turonian,