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Tectono-stratigraphic evolution of the Upper Jurassic–Neocomian rift succession, Araripe Basin, Northeast Brazil

Claiton Marlon dos Santos Scherer [a,*], Emanuel Ferraz Jardim de Sá [b], Valéria Centurion Córdoba [b], Debora do Carmo Sousa [b], Mayara Martins Aquino [c], Fátima Maria Canelas Cardoso [d]

[a] UFRGS, Instituto de Geociências, P.O. Box 15001, CEP 91501-970 Porto Alegre, RS, Brazil
[b] UFRN, Centro de Ciências Exatas e da Terra, Departamento de Geologia, Laboratório de Geologia e Geofísica de Petróleo, Programa de Pós-Graduação em Geodinâmica e Geofísica, Natal-RN, Brazil
[c] Petróleo Brasileiro S.A., E&P – EXP/IABS/PN, Rio de Janeiro, Brazil
[d] Universidade de Coimbra, Centro de Geociências, Ciências da Terra FCTUC, Coimbra, Portugal

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ABSTRACT

The rift succession of the Araripe Basin can be subdivided into four depositional sequences, bounded by regional unconformities, which record different palaeogeographic and palaeoenvironmental contexts. Sequence I, equivalent to the Brejo Santo Formation, is composed of fluvial sheetflood and floodplain facies association, while Sequence II, correspondent to the lower portion of the Missão Velha Formation, is characterised by braided fluvial channel belt deposits. The fluvial deposits of Sequences I and II show palaeocurrents toward SE. The Sequence III, correspondent to the upper portion of Missão Velha Formation, is composed of fluvial sheetflood deposits, which are overlain by braided fluvial channel deposits displaying a palaeocurrent pattern predominantly toward SW to NW. Sequence IV, equivalent to the Abaiara Formation, is composed of fluvio–deltaic–lacustrine strata with polimodal paleocurrent pattern. The type of depositional systems, the palaeocurrent pattern and the comparison with general tectono-stratigraphic rift models led to the identification of different evolutionary stages of the Araripe Basin. Sequences I, II and III represent the record of a larger basin associated to an early rift stage. However, the difference of the fluvial palaeocurrent between sequences II and III marks a regional rearrangement of the drainage system related to tectonic activity that compartmentalised the large endorheic basin, defining more localised drainage basins separated by internal highs. Sequence IV is associated with the renewal of the landscape and implantation of half-graben systems. The high dispersion of palaeocurrents trends indicate that sedimentary influx occurs from different sectors of the half-grabens.

1. Introduction

In recent years, numerous studies have addressed the tectonic–stratigraphic evolution of the rift basin, focussing on the influence of the tectonic on basin geometry and on accommodation and sediment supply ratio (A/S ratio) during the different stages of rifting (Prosser, 1993; Bosence, 1998; Gawthorpe and Leeder, 2000; Morley, 2002; Kuchle and Scherer, 2010). However, there are few studies detailing the facies architecture and depositional dynamics associated with each of the evolutionary stages of rifting, especially with regard to the initial stages of rifting, where depocenters are difficult to identify and fill patterns are diverse and yet poorly understood (Kinabo et al., 2007; Morley, 2002; Kuchle et al., 2011).

The sedimentary deposits of the Araripe Basin cover an area larger than 9000 km^2, consisting of one of more extensive interior basins of the Brazilian Northeast (Fig. 1). As with the other interior basins, the origins of Araripe Basin are linked to the rifting and opening processes of the South Atlantic (Guignone et al., 1986; Assine, 2007). Geometry and evolution of these basins are strongly conditioned by structures of the Precambrian/Neopalaeozoic basement, whose reactivation controlled the arrangement of depocenters over time. The Mesozoic stratigraphic record of the Araripe Basin reflects different stages of subsidence related to three main phases (Ponte and Ponte Filho, 1996): (a) the "Pre-Rift" phase, characterised by regional subsidence produced by visco-elastic lithospheric stretching; b) the Rift

* Corresponding author.
E-mail addresses: claiton.scherer@ufrgs.br (C. Marlon dos Santos Scherer), emanuel@ccet.ufrn.br (E.F. Jardim de Sá), vcordoba@ufrnet.br (V.C. Córdoba), debora@geologia.ufrn.br (D.doC. Sousa), Mayara_aquino@petrobras.com.br (M. M. Aquino), fatima.cardoso18@hotmail.com (F.M. Canelas Cardoso).

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phase, with accentuated mechanical subsidence, forming graben and/or half-graben systems; and c) the Post-Rift phase, characterised by the predominance of thermal subsidence. The main objective of this paper is to detail the stratigraphic architecture of the section corresponding to "pre-rift" and rift phases, aiming at understanding the depositional geometry, the fill patterns and main controls on sedimentation and accumulation of different evolutionary stages of rifting. Its specific goals include: (1) to identify and correlate unconformities that permit the recognition of different depositional sequences; (2) to analyze the facies architecture and the palaeocurrent pattern of each of the depositional sequences proposed; and (3) to reconstruct the tectono-sedimentary evolution of the rift succession of the Araripe Basin. These results were obtained as part of a project entitled Interior Basins of the Northeast (*Bacias Interiores do Nordeste*) (PETROBRAS/UFRN/PPGG), whose preliminary results were presented in graduate MSc (Garcia, 2009; Aquino, 2009; Cardoso, 2010; Costa, 2012) and at scientific meetings (Jardim de Sá et al., 2009, 2010, 2011; Cardoso et al., 2009, 2010).

To reach these objectives, 5 stratigraphic sections, each 20–180 m thick, were measured and analysed in detail (Fig. 1). High-resolution sedimentary logs were measured in order to define the main sedimentary elements of the studied interval. In addition to detailed facies analysis of logged sections, architectural panels were made to define the two-dimensional (2D) geometries of the deposits. Facies were defined mainly on the basis of grain-size and sedimentary structures. Palaeocurrent orientations were measured from cross-stratified beds. Paleocurrent readings were corrected to the horizontal surface based on the S0 depositional surface (Tucker, 1996). Unconformities surfaces were identified within the main outcrops and correlated between sedimentary logs (the sections), allowing the individualisation of different depositional sequences.

2. Regional stratigraphic framework

The Araripe Basin, similar to other basins that occur in the interior of Northeast Brazil, is associated with the Neocomian rift event that resulted in the separation of the South American and African continents, specifically, in the opening of the East Brazilian continental margin (Guignone et al., 1986; Assine, 2007). Geometry and evolution of these basins are strongly conditioned by structures of the Precambrian/Neopalaeozoic basement, whose reactivation controlled the arrangement of depocenters over time. As discussed by Ponte and Appi (1990), Chang et al. (1992), Matos (1992, 1999) and other authors, this event included a range of onshore aborted rift basins, which extend from Recôncavo-Tucano-Jatobá grabens system to the Potiguar graben, all of which were controlled by a principal NW extension. Alternative models have been proposed by other authors (e.g., Françolin et al., 1994), though the kinematics of the NW extension is supported by recent studies (Cordoba et al., 2008; Aquino, 2009; Cardoso, 2010; Jardim de Sá et al., 2010, 2011).

In the case of the Araripe Basin, the tectonic rift affected the Precambrian granite-gneiss and Paleozoic sedimentary basements. Studies by Matos (1992, 1999), Aquino (2009) and Cardoso (2010) describe half-grabens controlled by normal faults in the NE direction that are commonly tilted to the SE and associated with strike slip faults that define a conjugate pair (E–W sinistral and NE dextral), which also agrees with the NW distension.

According to the studies by Ponte and Appi (1990), Assine (1990, 1992) and Ponte and Ponte Filho (1996), the Araripe Basin may be subdivided into sequences bound by regional unconformities that reflect distinct tectonic stages in the basin. Assine (2007) integrated these different proposals, identifying four large units limited by unconformities: (1) the Palaeozoic Sequence, represented by the alluvial sedimentation of the Mauriti Formation and interpreted as the residual deposits of a large intracratonic basin; (2) the Pre-Rift Supersequence (Neojurassic), corresponding to the Brejo Santo and Missão Velha formations; (3) the Rift Supersequence (Neocomian), equivalent to the Abaiara Formation; and (4) the Post-Rift Supersequence. The latter may be subdivided into two higher-frequency sequences: (a) Post-Rift Sequence I (Aptian–Albian), corresponding

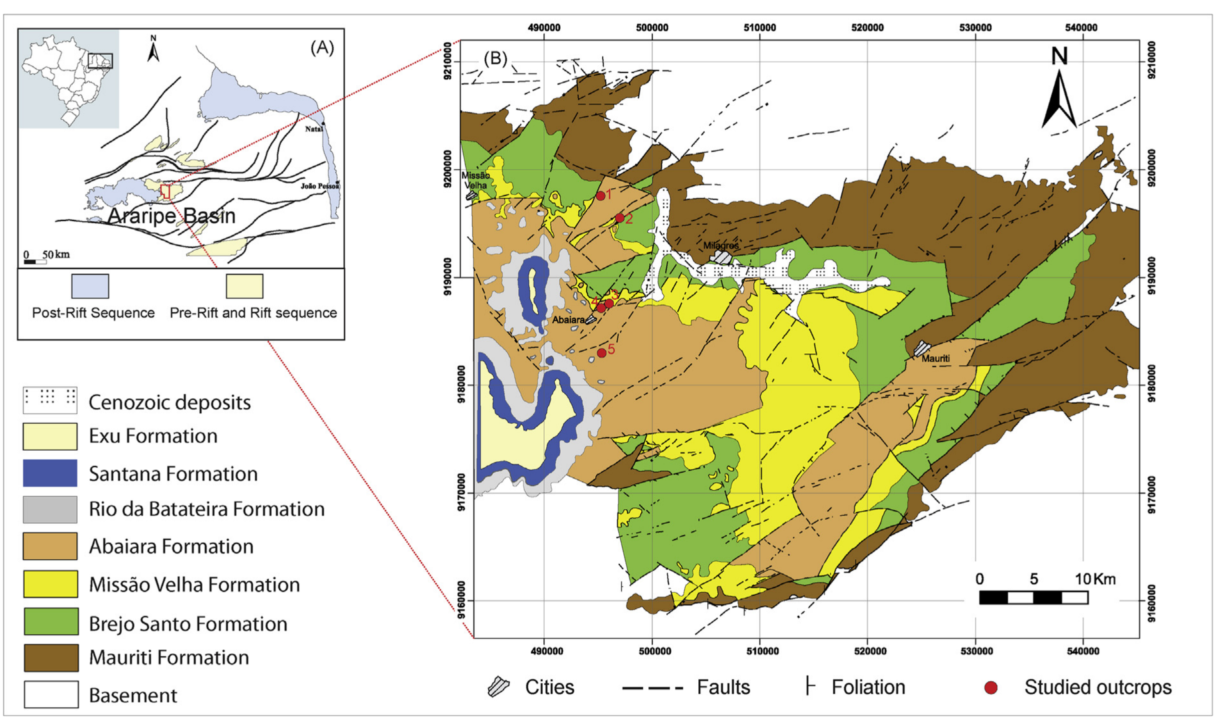

Fig. 1. (A) Regional geological setting of the Araripe Basin. (B) Simplified geological map of the studied area showing the location of eight logged sections, which represent the study localities discussed in this paper.