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TECTONO-STRATIGRAPHIC EVOLUTION OF THE UPPER JURASSIC-NEOCOMIAN RIFT SUCCESSION, ARARIPE BASIN, NORTHEAST BRAZIL

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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.

Keywords

Araripe Basin, Rift Basin, Continental Sequence Stratigraphy, Continental Deposional Systems

1. Introduction

In recent years, numerous studies have addressed the tectonic-stratigraphic evolution of the rift basin, focusing 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; Galthorper and Leeder, 2000; Morley, 2002; Kuchle & 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 9,000 km^2, consisting of one of more extensive interior basins of the Brazilian Northeast (Figure 1). As with the other interior basins, the origins of Araripe Basin are linked to the rifting and opening processes of the South Atlantic (Ghignone 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 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 sucession of the Araripe Basin. These results were obtained as part of a project intitled 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 5 to 90 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 S_0 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 (Ghignone 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 (Córdoba 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 to the Barbalha and Santana formations; and (b) Post-Rift Sequence II, equivalent to the Araripina and Exu formations.

The interval analysed in the present study includes the pre-rift and rift supersequences of the Araripe Basin, corresponding to the Brejo Santo, Missão Velha and Abaiara formations, which are grouped in the Cariri Valley Group (Grupo Vale do Cariri) (Ponte and Appi, 1990; Assine, 2007) (Table 1). The Brejo Santo Formation is predominantly made up of red, or more rarely green mudstones, rich in ostracod fossils. Sometimes, intercalated layers of fine grained sandstones are observed, mainly toward the top of the unit (Assine, 1990). The Brejo Santo Formation is interpreted as deposits of the shallow, broad and ephemeral lakes (Assine, 1990). The Missão Velha Formation is compound by fine to very coarse-grained sandstones, sometimes containing fossil trunks, intercalated with rare and discontinuous mudstones lenses. The Missão Velha Formation has been interpreted as braided fluvial channels deposits with a regional palaeoflow toward the SE (Assine, 1994). Finally, the Abaiara Formation is characterized by different litological types with a predominance of fine to medium-grained sandstones and mudstones. This unit has been interpreted as deposits of fluvial, deltaic and lacustrine depositional systems. According to Assine (1994), the fluvial and deltaic deposits of the Abaiara Formation show paleocurrents toward the SE.

In the present study, the stratigraphic data are presented and interpreted according to the commonly accepted hypothesis, in which the Brejo Santo Formation was deposited during the Neojurassic (Dom João Stage) (Coimbra et al., 2002, Assine, 2007). Meanwhile, 100 miles north of Araripe Basin are described reddish mudstones (Lavras da Mangabeira Formation) that are intruded by basic dikes aged of 185 Ma, as discussed by Jardim de Sá et al. (2010, 2011). The mudstones of the Lavras da Mangabeira Formation overly paleozoic sandstones, defining a stratigraphic context very similar to Brejo Santo Formation. As a result, Jardim de Sá (2010, 2011) raise the possibility that the lower part of the Brejo Santo Formation may be older than Neojurassic.

3. Sequence Stratigraphy of the Jurassic-Neocomian Succession

The UpperJurassic-Neocomian section of Araripe Basin can be subdivided into four depositional sequences. These sequences are designated, from the base to the top, as Sequences I, II, III and IV (Figure 2). The criteria used to identify unconformities in outcrops include: (1) an abrupt facies change, which may involve both a change in the depositional systems or modification of facies architecture within a specific depositional system; (2) an abrupt change in the texture and grain size across the unconformity; and (3) changes in the palaeocurrent patterns. The lithofacies description for each depositional sequence is shows in Table 1 and is based on the original table from Miall (1977).

3.1 Sequence I

Sequence I corresponds entirely to the Brejo Santo Formation. This sequence displays a thickness of approximately 400 m (Ponte and Appi, 1990; Assine, 1992). The lower and the upper boundaries of Sequence I comprise regional scale unconformities with the Mauriti and Missão Velha formations, respectively (Figure 2). Sequence I is composed of two distinct facies associations (Figure 3): (1) Fluvial Sheetflood Facies Association and (2) the Floodplain Facies Association.

3.1.1 Fluvial Sheetflood Facies Association

This facies association is characterised by fine to medium-grained sandstones, arranged in 1-5 m thick tabular bodies, that can be traced laterally more than 80 m (maximum outcrop extent). Fining-upward trends are common, with the tops of the cycles grading to mudstones of the floodplain facies association. The tabular bodies are bounded at the base by flat or slightly erosional surfaces that may eventually be marked by < 10cm thick lags of mud and carbonate intraclasts (Figure 3). Internally, sandstone bodies can be composed of a single lithofacies (Sm) or a sucession of the different lithofacies. In the latter case, the sandbodies are characterized at the base by massive (Sm), low-angle (Sl) and/or horizontal (Sh) laminated sandstones, which are succeeded by ripple cross-laminated sandstones (Sr). Trough cross-bedding sandstones (St) are isolated and rare (Figure 3). Measurements of the direction of the dip of the cross-strata display a unimodal pattern with a mean vector toward the SE (Figures 2 and 3).

The tabular bodies can be interpreted as the result of flash flood deposition in laterally extensive, unconfined sheets or poorly confined fluvial channels. The abundance of massive, low-angle or horizontally stratified sandstones suggests that flow events were short lived and of high intensity (Tunbridge, 1984; Hampton and Horton, 2007). The intercalation of these lithofacies within the same succession indicates variations in the concentration of sediments and in the flow velocity. The massive sandstones are the result of hyperconcentrated flows in which the concentration of sandy sediment in suspension inhibits the turbulence and separation of the flow, which are necessary for the embryonation of dunes (Allen and Leeder, 1980). The sediment is deposited *en masse* during the deceleration of the flow. In turn, the low-angle and horizontal stratified sanstones indicate more diluted flow conditions in which the sediments are predominantly transported by traction in high-flow regime (Allen and Leeder, 1980). The occurrence of ripple cross stratified sandstone in the upper portion of the tabular bodies is the result of waning flow velocity associated with flow termination or channel abandonment (Miall, 1996). Intraformational lags at the base of sheet sandstone bodies represent the reworking of deposits accumulated in the floodplain areas.

3.1.2 Distal Floodplain Facies Association

This facies association is characterized by up to 5 m thickness reddish mudstones intercalated occasionally with tabular sandstones (Figure 3). Mudstones are massive, with ostracod fossils, sometimes exhibiting layers of calcareous concretions. Sandstones are fine to medium-grained, well-sorted and deposited in tabular layers, 10 to 30 cm thickness, with planar and non-erosive basal contact. The sandstones commonly display ripple cross-lamination (Sr). Sometimes, horizontal lamination (Sh) can be observed.

This facies association is interpreted as floodplain deposits, which may represent two distinct depositional contexts: (a) overbank flooding resulting from unconfined flow originating from overtopped channels when they occur adjacent to lenticular sandbodies; or (ii) downslope, unconfined sedimentation associated with terminal flooding stages (Hampton and Horton, 2007; Spalletti and Piñol, 2005). Tabular sandstone beds composed of horizontal lamination and ripples cross-laminated are interpreted as the products of poorly developed traction currents during the waning stages of flood events (Hampton and Horton, 2007). Mudstones, in turn, must have been deposited by the gravitational settling of the particles in suspension during the final stages of flooding or in temporary lacustrine bodies that form on the alluvial plain. The levels characterised by carbonate nodules are interpreted as calcareous palaeosols (Ray and Chakraborty, 2002).

3.2 Sequence II

Sequence II is equivalent to the lower section of the Missão Velha Formation, bounded at the top and the base by unconformities (Figure 2 and 4). This sequence displays a thickness of between 20 and 30 m and it is composed of two distinct facies association (Figures 4 and 5): (1) Braided Fluvial Channel Belt and (2) Overbank Facies Association.

3.2.1 Braided Fluvial Channel Belt Facies Association

This facies association consists of fine to very coarse-grained sandstones, moderately sorted, sometimes containing fossil trunks, arranged in sandstones bodies, 5 to 15 m thick, that extend laterally for more than 300 m (maximum outcrop extent). The sandstone bodies are bounded at the base by erosive, slightly concave surfaces, which in some cases are marked by concentrations of granules and pebbles. Internally, the sandstone bodies exhibit a weakly developed fining upward pattern. The sandstones exhibit planar (Sp) and trough (St) cross-bedding, arranged in 0.2 to 1 m thick sets (Figures 4 and 5). Horizontal stratification (Sh) and low angle cross-stratification (Sl) sandstones are rare and normally restricted to isolated sets, 10 to 30 cm thick. Sometimes, it is possible to identify compound cross-strata, 2 and 3 m thick, which internally display sets of planar and trough cross-bedding bounded by inclined surfaces dipping in the same direction of the cross strata. The dipping of the bounding surfaces varies from 3^0 to 10^0, and those with a lower angle (3^0 to 5^0) are only visible in sections parallel to the dipping direction, where a smooth downlap of these surfaces can be identified over the basal surface of the compound cross-strata. Measurements of the direction of the dip of the cross-strata display a unimodal pattern with a mean vector toward the SE (Figures 2, 4 and 5).

The occurrence of sandstone bodies bounded at the base by erosive surfaces outlined by granules and pebbles lags and internally composed of sets of planar and trough cross-strata with a unimodal direction of the palaeocurrents indicate that this facies association represents fluvial channel deposits. The compound cross-strata can be interpreted as macroforms migrating in-channel. The fact that the cross-strata exhibit the same dip direction of the bounding surfaces allows for the conclusion that the compound cross-strata represent downstream accretion macroforms with superimposed, small-scale bedforms (Miall, 1996; Chakraborty, 1999; Jo and Choung, 2001). The sandstone bodies sheet geometry, prevailing coarse-grained nature of the deposits, common presence of the downstream macroforms, the weak development of the fining upward sucession and the low dispersion of the palaeocurrent data suggest low sinuosity, braided channel belt deposits (Scherer and Lavina, 2006; Miall, 1996).

3.2.2 Overbank Facies Association

This facies association is rare and occurs intercalated with braided fluvial channel-belt deposits, consisting mainly of red massive mudstone (Fm) (Figures 5). Individual bodies are decimetres thick (< 50cm) and extend laterally for less than 30 m, invariably truncated by the overlying sandstone bodies of the braided fluvial channel belt facies association.

The fine-grained deposits are interpreted as overbank deposits accumulated through gravitational settling of the suspended load within flooded areas surrounding braided channel belts (Miall, 1996).

3.3 Sequence III

Sequence III, 20 to 30 m thick, corresponds lithostratigraphically to the upper portion of the Missão Velha Formation (Fambrini et al., 2011). Due to similarity of the facies association (both are fluvial deposits), it is difficult to identify the unconformity surface between sequences II and III, defining a cryptic sequence boundary (terminology of Miall and Arush, 2001). Among the main criteria used for this identification, the following can be highlighted: (1) an increase in grain size through the unconformity, marked by the abrupt occurrence of sandy conglomerate deposits over medium to coarse-grained sandstones; (2) the presence of sandstone clasts and reworked fossil trunks of the Sequence II in basal conglomerate of sequence III; (3) a change in the direction of the fluvial palaeocurrents through the unconformity (Figure 2). The top of Sequence III is also marked by disconformity, marked by onlap of the fluvial and deltaic deposits of Sequence IV (Abaiara Formation) (Figures 2 and 6). Sequence III is composed of two distinct facies association (Figure 7): (1) Fluvial Sheetflood Facies Association and (2) *Braided Fluvial Channel Belt Facies Association.*

3.3.1 Fluvial Sheetflood Facies Association

This facies association is composed of sandy conglomerate and medium to very coarse-grained sandstones, moderately sorted, arranged in sheet-like sandstone bodies, 0.5 and 1.2 m thick. The conglomerates are clast-supported, massive and predominantly consist of granules and pebbles of quartz, granites, sandstones and muddy intraclasts (Gm). The sandstones, in turn, are massive (Sm) or, less often, display low-angle cross-stratifications (Sl). The sandstones commonly display granules or pebbles of granite or mud intraclasts, dispersed or concentrated along the stratification planes.

The dominance of massive conglomerates together with massive or horizontal to low-angle stratified sandstones, displayed in sedimentary bodies with sheet geometry, suggests that these deposits result from high-energy, sheetflood fluvial flows (Nemec and Postma, 1993; Blair, 2000, 2001). The succession of amalgamated sandstone and conglomerate beds may represent a series of flooding events that were deposited in wide shallow channels. Massive, clast supported conglomerate suggests deposition by high-density hyperconcentrated flows. Massive sandstone is interpreted as rapid deposition from heavily sediment-laden flow during waning floods hyperconcentrated flows. Low-angle cross-stratified sandstones are interpreted as plane bedforms produced near the upper to lower flow regime transition by unidirectional currents (Miall, 1996).

3.3.2 Braided Fluvial Channel Belt Facies Association

This facies association is made up of several sheet-like sandstone bodies, 2 to 7 m thick, bounded at the base by flat to concave-up erosional surfaces, sometimes marked by massive, granule to pebbled clast-supported conglomerate (Gcm), 10 to 20 cm thick. These deposits are succeeded by 0.2 to 0.4 m thick, trough (St) and planar (Sp) cross-stratified sandstones, and, rarely, by low-angle cross-stratified sandstones (Sl) (Figure 7). Sometimes, it can be observed compound cross-strata, 2 and 4 m thick, in which each set is bounded by inclined surfaces (5-8°) that dip in the same direction of the cross-strata. Measurements of the direction of the dip of the cross-strata indicate a paleocurrent toward the SW to NW (Figure 2).

These sandstone bodies are interpreted as deposits of fluvial channel, based on the presence of concave-up erosional lower boundaries and dominance of unidirectionally oriented decimetre-scale planar and trough cross-strata. The erosional lower boundary of the sandstone bodies may be interpreted as limits of the fluvial channels, equivalent to the 5th-order surface of Miall (1988, 1996). The downcurrent-dipping inclined strata represent downstream accretion of compound bars with superimposed, small-scale bedforms (DA architectural element of Miall, 1988, 1996). The sheet geometry of the sandstone bodies, dominantly coarse sand size of the deposits, absence of mudstone, locally developed downstream accretion macrofoms and low dispersion of the paleocurrent data collectively suggests that this facies association represents braided fluvial channel belt deposits (Miall, 1996; Ray and Chakraborty, 2002).

3.4 Sequence IV

Sequence IV is approximately 400 m thick and corresponds lithostratigraphically to the Abaiara Formation (Figure 2). It is bounded at the base by an unconformity marked by onlap of deltaic deposits over fluvial braided channel belt facies association of Sequence III (upper section of the Missão Velha Formation) (Figure 7). The upper contact of this sequence is marked by angular unconformity with the alluvial strata of the Barbalha Formation (Assine, 1990) or the Rio da Batateira Formation (Ponte, 1990), which compose the base of the Post-Rift Supersequence (Assine, 2007). Sequence IV is composed of four distinct facies association (Figures 2, 7 and 8): (1) the Prodelta/Deltaic Front, (2) Distributary Fluvial Channels, (3) Overbank Deposits and (4) Meandering Fluvial Channel Facies Association.

3.4.1 Prodelta / Delta Front Facies Association

This facies association is characterized by repetition of 2 to 10 m meter-scale coarsening-upward cycles (Figure 8). The base of the cycles is characterised by reddish to greenish color, massive (Fm) or laminated (Fl) mudstones, frequently exhibiting ostracod fossils. These mudstones interlayer upward with fine to very fine sandstones, 5 and 30 cm thick, which exhibit ripple cross-laminations (Sr) and, less commonly, low-angle cross stratifications (Sl). The transition between mudstones and sandstones beds is marked by soft-sediment deformations structures, including simple load, pendulous features, pseudo-nodules and balls and pillow structures. Some cycles can present at the top amalgamated layers of fine to medium sandstones with trough (St) and planar (Sp) cross-stratifications. The sandstones may also show indication of soft-sediment deformation, mainly oversteepened cross-stratification, convoluted folds and plate and pillar structures. Measurements of the direction of the dip of the cross-strata show a preferential direction within each cycles, though with high dispersion if different cycles are compared (Figures 2 and 8).

The lithology, coarsening-upward cycles organization and dominance of unidirectional current-generated structures suggest that these facies association represents progradation of river-dominated delta, similar to those described by Bhattacharya (1991) and Giosan and Battacharya (2005). The ostracod fossils present in the fine-grained deposits indicate a lacustrine context (Coimbra et al., 2002). The thickness of the cycles represents the minimum depth of the water level, which, in this case, varied from 2 to 10 m. The massive and laminated mudstones at the base of the cycles are interpreted as prodelta deposits. The lack of bioturbation in these deposits indicates that the sediment was rapidly buried, thus preventing the reworking of the substrate by organisms. The vertical increase in the frequency and thickness of the sandstones layers indicate progradational tendency of the deltaic front. The pronounced intercalation of sandstones and mudstones and the dominance of the unidirectional current-generated structures in the sandstones suggest that the sediments were supplied by intermittent unidirectional flows derived from fluvial systems. The presence of different types of soft-sediment deformation in the contacts between the sandstones and mudstones and within the sandstones layers must be linked to a high rate of sedimentation, which increases the water pressure in the pores, inducing the liquification of the sediment. The amalgamated sandstones that occur at the top of the coarsening-upward cycles must represent the proximal portions to the delta front, deposited by distributary mouth-bars (Battacharya, 2011).

3.4.2 Distributary Fluvial Channel Facies Association

This facies association is made up by fining-upward sucessions, 1.5 to 5 m thick, normally overlaying Prodelta / Deltaic Front Facies association (Figure 8). The base of the cycles is marked by an erosive surface, frequently capped by intraformational conglomerates rich in mudstone intraclasts. Internally, the cycles are characterised at the base by medium to coarse-grained sandstones, moderately sorted, with trough cross-stratifications (St), planar cross-stratifications (Sp) and low-angle cross-stratifications (Sl), which sometimes give rise toward the top to fine to very fine-grained sandstones with ripples cross-laminations (Sr).

The presence of fining upward cycles, bound by erosive surfaces capped by intraclast lags suggests deposits of fluvial channels. The fact that this association invariably covers prodelta/ deltaic front deposits indicates distributary fluvial channels of the deltaic plain (Hampson et al., 1999). The trough and planar cross-stratifications sandstones may be interpreted as deposits of 2D and 3D subaqueous dunes, respectively, which migrate over the bottom of the channel in response to unidirectional tractional flows. The fining-upward successions suggest a progressive decrease of the flow velocity, culminating in the abandonment of the channel. The lack of lateral accretion surfaces suggests fluvial channels with low sinuosity.

3.4.3 Overbank Facies Association

This facies association commonly occurs intercalated with distributary fluvial channel or meandering fluvial channels deposits. It is characterised by red or greenish (rare) mudstones occasionally interlayered with tabular sandstones, where deposits commonly exhibit a tabular geometry, ranging from 3 to 15 m thick (Figure 8). The mudstones are massive (Fm) or laminated (Fl), sometimes displaying calcareous concretions. The nodules vary from 1 to 20 cm in diameter, exhibiting shapes that range from highly irregular to vertically elongated and tabular. The sandstones are fine to medium-grained, well-sorted, arranged in tabular layers, with planar and non-erosive basal contact, internally compound by ripples cross-laminations (Sr). Sometimes, very fine to coarse-grained, bimodal sandstones, with low-angle cross-stratifications (Sl(e)), can be observed. Each lamina is inversely graded, 1 and 3 mm thick.

This facies association is interpreted as overbank deposits, which may have been accumulated both in the inter-distributary bays present in the deltaic plain or in the swampy regions of the fluvial floodplain. The mudstones have been deposited due to the gravitational settling of particles in suspension, while the sandstones with ripples cross-laminations represent the deposits of crevasse splays accumulated during river channel overbank flooding. The carbonate nodules horizons are interpreted as calcareous palaeosols (Ray and Chakraborty, 2002). The sandstones with low-angle cross-stratification, with inversely gradated laminae, are interpreted as aeolian sand sheet deposits formed by the migration and climbing of the aeolian ripples (Scherer & Lavina, 2005; Scherer et al., 2007). The presence of frequent carbonaceous palaeosols and aeolian deposits, indicates drier periods marked by a water table falling and subaerial exposure of the depositional surface.

3.4.4 Meandering Fluvial Channel Facies Association

This facies association is composed of sandstone bodies, 2 to 7 m thick, bounded at the base by erosive, concave upward surfaces, with reliefs varying from 1 to 3 m. Internally each sandstone body shows one large scale lateral accretion unit, characterized by sets of fine to medium-grained sandstones with trough cross-stratification (St) and/or ripples cross-lamination which are bounded by inclined surfaces (2 to 10°) that dip approximately perpendi cular to the direction of the cross-strata dip (Figure 9)

The presence of sandbodies with an erosive base and the predominance of unidirectional tractive structures allow to interpret this facies association as fluvial channel deposits. The occurrence of large-sized inclined strata indicates the presence of macroforms filling the fluvial channels. The fact that the cross-strata show palaeocurrents that are approximately transversal to the direction of the dip of the bounding surfaces suggests lateral accretion macroforms (Miall, 1996). The dominance of lateral accretion macroform suggests that this facies association represents high sinuosity fluvial channel (Ghazi and Mountney, 2010).

3. Stratigraphic evolution

The Neo-Jurassic-Neocomian succession of the Araripe Basin consists of four depositional sequences bound by unconformities (Figure 2). Sequence I corresponds lithostratigraphically to the Brejo Santo Formation and can be interpreted as the distal portion of an aluvial plain that developed in an arid to semi-arid climatic context. This sequence is composed of floodplain and fluvial sheetflood facies associations that flow toward the SSE (Figure 2 e Figure 11a). This depositional context suggests that the basin extends toward the north, where the proximal sub-environments of Sequence I would be positioned. Therefore, the entire depositional system can represent a distributary fluvial or terminal fans systems that occupied an area much larger than the one circumscribed within the current erosive limits of the Araripe Basin, as claimed by Kuchle et al. (2011).

Sequence II, corresponding to the lower portion of the Missão Velha Formation, is characterized by multi-storey and multi-lateral, amalgamated, sheet sandstone bodies with rare preservation of fine-grained, overbank deposits, interpreted as the deposits of braided fluvial channel-belt system, with palaeocurrents toward the SE (Figure 2 e Figure 11b). The disconformity that separates Sequences I and II is easily observed in outcropps, marked by grain-size increase and by abrupt change in depositional style, from an ephemeral fluvial system of Sequence I to a braided fluvial channel-belt system of Sequence II. The change in the depositional style reflects change in the discharge regime of the fluvial systems, which is probably associated with the more humid climatic conditions in Sequence II. Although there is a change in the depositional systems of sequences I and II, both units have palaeocurrent to SE. This suggests that the source area and proximal deposits of the sequences I and II were northwest of the study area.

Sequence III, corresponding to the upper interval of the Missão Velha Formation, is composed, at its base, of fluvial sheetflood facies association that passes upward to braided fluvial channel belt facies association, the latter displaying facies architecture similar to that of the fluvial deposits of Sequence II, though with characteristically distinct palaeocurrents (Figure 11c). The fluvial strata of Sequence II exhibit palaeocurrents toward the SE, while the fluvial deposits of Sequence III display a palaeocurrent pattern predominantly toward the SW and NW (Figure 2). So, the unconformity between Sequences II and III marks significant rearrangement in the depocenters of the basin. The presence of sandstones clasts and reworked coniferous trunks of the sequence II at the base of the Sequence III indicates uplift of the basin, exposing the sequence II deposits to erosion. This fact, combined with the change in the fluvial palaeocurrent vectors, must be associated with tectonic movements that changed the morphology of the basin, causing a change in the drainage system.

Sequence IV, equivalent to the Abaiara Formation, is characterised by a thick succession deposited by deltaic and fluvial systems, that display high dispersion in the palaeocurrents (Figure 2 and 10), suggesting that the sedimentation occurred within a restricted basin with sedimentary supply from different flanks of the basin (Figure 11d). The onlap of the deltaic deposits of Sequence IV over the fluvial sandstones of Sequence III (Figure 7) confirms the restructuring of the basin with consequent reduction of the depositional area.

4. Tectonic-Stratigraphic Context

In recent years, different studies have discussed the tectonic-stratigraphic evolution of rift basins, identifying different evolutionary stages (Morley, 2002). The first stage is characterised by incipient extensional efforts that generate a basin that has a broadly synclinal geometry. The thickening toward the basin center is achieved by expansion of section across numerous rotational and nonrotational normal faults. These faults are of similar displacement and no dominant fault trend is apparent. This large basin was established before the development of the half graben system. Thus, this stage is characterized by a wide synclinal depression, larger than the subsequent rift trough, associated to the low rate, continuous and uniformly distributed tectonic activity (Morley, 2002; Kinabo et al., 2007; Kuchle et al., 2011). Although different authors (*e.g*., Prosser, 1993; Bosence,1998; Gawthorpe and Leeder, 2000) visualise the beginning of the rift in the form of smaller-sized half graben basins bounded by small normal faults, some actual and ancient examples corroborate the synformal basin geometry to early rift stage (Morley, 2002; Kinabo et al., 2007; Kuchle et al., 2011). In turn, the second stage would be marked by the formation of half-grabens. The development of half-grabens would occur through the nucleation of the main border fault by linkage of smaller faults. In the initial phase of the process, the mechanical subsidence is still reduced, as a result of the small slip faults (Gawthorpe and Leeder, 2000). Accordingly, the fault scarps are underdeveloped, reducing the occurrence of conglomerate wedges (Prosser, 1993; Bosence,1998; Gawthorpe and Leeder, 2000). When the fault linkage occurs, forming a continuous border fault along the half-graben, there is an increase in the subsidence favouring the development of large and deep lakes, as now occurs in the rift system of East Africa. As the rate of accommodation creation tends to be greater than the rate of sedimentary influx, the sedimentary succession displays retrogradational stacking pattern (Prosser, 1993; Kuchle and Scherer, 2010). Finally, there is the final filling stage of the half-graben, in which the movement of the border fault is significantly reduced. Therefore, there is a decrease in the ratio between the rate of accommodation creation and the rate of sedimentary influx, resulting in a progradational stacking pattern (Prosser, 1993; Kuchle and Scherer, 2010).

The Jurassic-Neocomian section of the Araripe Basin exhibits distinct stratigraphic signatures, which allow for the identification of different evolutionary stages. Sequences I, II e III, equivalent to Brejo Santo and Missão Velha formation, show depositional systems distribution and palaeocurrent pattern indicating that this units occupied a depositional area much larger than the one circumscribed within the current erosive limits of the Araripe Basin. This suggests that sequences I, II and III were deposited in a large sedimentary basin connected to the initial stage of the Neocomian rifting (Kuchle et al., 2011). Previous studies (e.g. Estrela, 1972; Garcia et al., 2005; Kuchle et al., 2011) have suggested that Brejo Santo and Missão Velha formations were accumulated on the northern flank of the one large endorheic basin, named of Afro-Brasilian Depression. However, the difference of the fluvial palaeocurrent between sequences II and III marks a regional rearrangement of the drainage system possibly related to tectonic activity. These tectonic movements may have compartmentalised the large endorheic basin, defining more localised drainage basins separated by internal highs, as observed in other basins of the Brazilian Northeast (Kuchle et al., 2011).

Because the deposits of Sequences I, II and III are linked to the initial rifting stages, it is inadvisable to use the term pre-rift to designate the tectonic stage in which this entire sedimentary section is inserted, as has been employed in previous studies (Ponte and Appi, 1990; Assine, 1990,1992; Ponte, 1992; Assine, 1994; Ponte and Ponte Filho, 1996; Assine, 2007). The term pre-rift is used to designate rocks that are completely unrelated to the rifting process, consisting of the sedimentary basement upon which the taphrogenic processes will act (Prosser, 1993; Bosence, 1998). Normally, the pre-rift strata are tens to hundreds of millions of years older than the deposits accumulated during the rifting event (Bosence, 1998). The most appropriate term for this initial phase of accumulation would be the Early Rift Stage (Morley, 2002) or the Initial Rift Tectonic Systems Tract (Kuchle and Scherer, 2010). Sequence IV, in turn, is characterised by a thick succession of fluvial-deltaic-lacustrine deposits, indicative of a context with a high rate of accommodation generation. Beside, the high variation in the palaeocurrent direction and the fact that Sequence IV strata onlap deposits from Sequence III are consistent with the implantation of half-grabens (Bosence, 1988; Prosser, 1993; Galthorpe and Leeder, 2000). According Prosser (1993) the sedimentary influx of the half-grabens occurs from different regions (e.g., flexural margin, faulted margin and axial influx), resulting in a high dispersion of palaeocurrents trends when different sectors or stratigraphic intervals in the basin are analyzed, similar to what can be observed in the deposits of Sequence IV. The presence in outcrops of growth faults affecting deposits of Sequence IV corroborates the idea of intense extensional tectonics concomitant with sedimentation (Aquino, 2009). Thus, Sequence IV may be considered the record of the Half-Graben Stage (Morley, 2002) or of the Half Graben Develop to Rift Climax Tectonic SystemsTracts (Kuchle and Scherer, 2010).

5. Conclusions

It was possible to individualise four depositional sequences in the Jurassic-Neocomian section of the Araripe Basin. Sequence I, equivalent to the Brejo Santo Formation, is composed of deposits from sheet floods and of floodplains. Sequences II, correspondent to the lower portion of Missão Velha Formation, is characterised by braided fluvial channels belt amalgamated sandbodies intercalated with rare and discontinuous floodplain deposits. Sequence III, correspondent to the upper portion of Missão Velha Formation, is composed of fluvial sheetflood deposits, which are overlain by braided fluvial channel belt deposits. Sequence IV, equivalent to the Abaiara Formation, is composed of fluvial-deltaic-lacustrine deposits.

The sequences were accumulated during different rift tectonic stages. Sequences I and II were deposited over a large basin, similar to a syneclise, though linked to the initial stages of rifting. The change in the direction of the palaeocurrents of Sequence III (toward the SW or NW) in relation to that of the palaeocurrents of Sequences I and II (toward the SSE) is associated with tectonic movements related to the beginning of the implantation of internal highs and grabens in an important structural reorganisation of the basin. Sequence IV, in turn, was accumulated in well-defined half-graben systems with the development of lacustrine environment, including fluvial and deltaic systems. The sedimentary influx of the half-grabens occurs from different regions (e.g., flexural margin, faulted margin and axial influx), as attested by high dispersion of palaeocurrents trends of the Sequence IV.

From the results of this work it is possible to visualize the evolution of the different stratigraphic stages of rifting. Corroborating propositions of Morley (2002), Kinabo et al. (2007) and Kuchle et al. (2011), the first stage of rifting (sequences I and II) is characterized by the development of a wide basin, unlike the model of Prosser (1993), Bosence (1998), Gawthorpe and Leeder (2000) that suggest the existence of small grabens isolated at the beginning of rifting. This large basin has a relatively low rate of subsidence (low A / S ratio), and does not record extensive lacustrine facies. The development of half-graben system occurs at a later stage. Firstly, there is the subdivision of large basin into incipient graben (Sequence III), even with low rate of subsidence. After, from the linkage of fault segments occurs an increase in the subsidence (increase in A/S ratio) and full development of half graben systems, allowing the development of deep and extensive lakes (Sequence IV).

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Figure Captions

Table 1: Stratigraphic nomenclature table of the Araripe Basin (according Assine, 2007)

Table 2: Summary of facies description and interpretation.

Figure 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.

Figure 2: (A) Stratigraphic cross-section based on log correlation, displaying the depositional sequences, their bounding surfaces and facies association (datum: regional flooding surface at the base of the Abaiara Formation). (B) Explanation of symbols used in the sedimentological logs of this paper.

Figure 3: (A) Sedimentological log showing litofacies, facies association and facies succession of the Sequence I. See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Lithofacies Sr. Ripple cross-laminated, fine-grained sandstone. Pencil: 0.15m. (C) Lithofacies Fm. Massive mudstone. Coin: 20mm.

Figure 4: (A) Sedimentological log showing the basal and the top unconformities of the Sequence II. See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Low relief, basal unconformitie marked by abrupt contact between floodplain (Sequence I) and braided fluvial channel (Sequence II) facies associations. Person: 1.7 m. (C) Sandy conglomerate with sandstones clasts

(Lihofacies Gm) of the Sequence III covering braided fluvial channel sandstones of Sequence II. Observe erosive nature of the contact. Hummer: 0.3 m.

Figure 5: (A) Sedimentological log showing litofacies, facies association and facies sucession of the sequence II. See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Lithofacies Sp. Planar cross-bedded sandstones. Hummer: 0.3 m. (C) Lithofácies St. superimposed sets of trough cross-bedded sandstones. Hummer: 0.3 m. (D) Mud intraclasts concentrated at the base of cross-bedded set (lithofacies St). Hummer: 0.3 m.

Figure 6: (A) Sedimentological log showing litofacies, facies association and facies succession of the sequence III. See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Lithofacies Gm. Massive conglomerate composed of mudstones and sandstones intraformacional clasts held within a medium to coarse sand matrix. (C) Lithofacies Sp. Planar cross-bedded sandstones. Pencil: 0.15 m.

Figure 7: Onlap of the prodelta to delta front deposits of the Sequence IV over braided fluvial channel sandbodies of the Sequence III. See Figure 2 for position of the sedimentological panel.

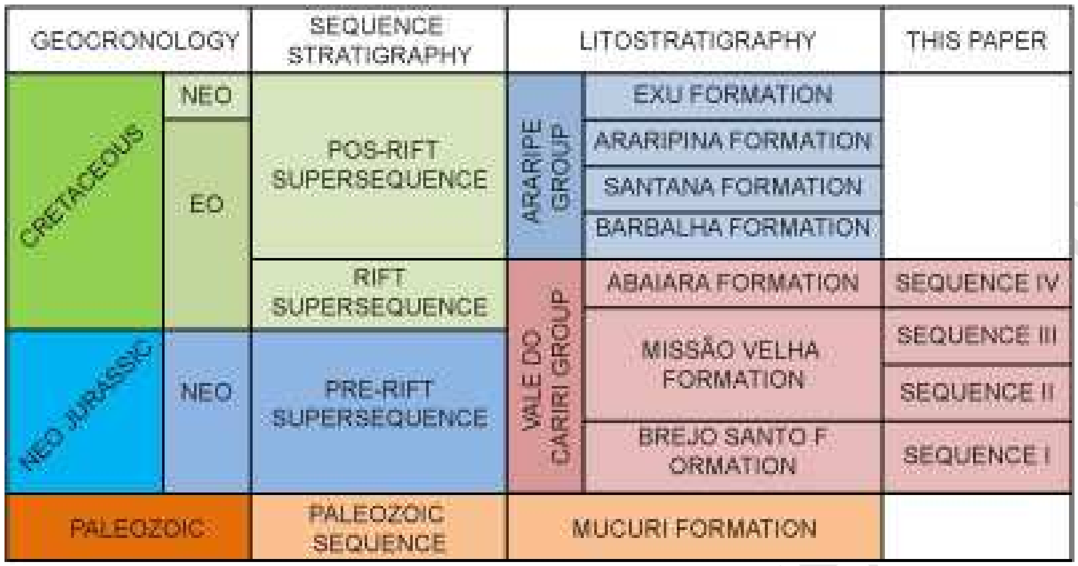
Figure 8: (A) Sedimentological log showing litofacies, facies association and facies succession of the outcrop 5 (sequence IV). See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Facies sucession of the distributary channel and overbank facies association. (C) Heterolithic deposits of the overbank facies association characterized by intercalation of the massive sandstones (Sm) and massive mudstones with mud cracks (Fm). (D) and (E) Coarsening upward facies succession of the prodelta and delta front facies association. Person: 1.6 m.

Figure 9: (A) Sedimentological log showing litofacies, facies association and facies succession of the outcrop 1(sequence IV). See Figure 2 for explanation of symbols and position of the logs. See Table 1 for facies code. (B) Outcrop panel showing lateral accretion surface in meandering fluvial channel sandstone bodies.

Figure 10: Rose diagrams showing cross-bedding dip directions of the prodelta /delta front and distributary channel facies association of the Sequence IV. *n*= 105.

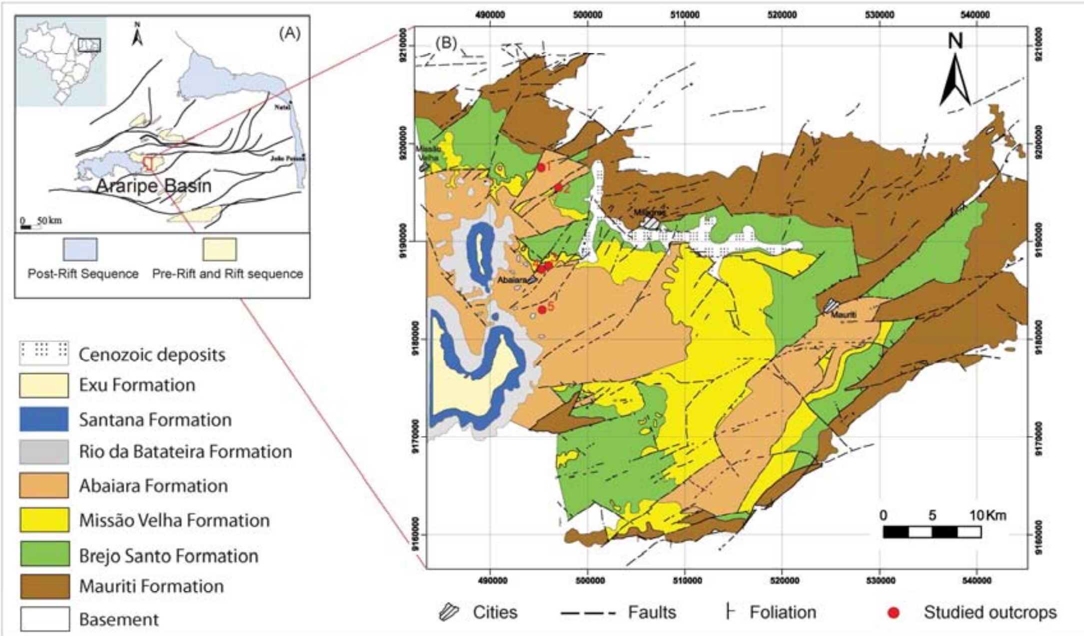
Figure 11: Depositional models depicting the temporal evolution of the upper jurassic-neocomian rift succession of the Araripe Basin, representing four distinct sequences accumulated during different rift tectonic stages. See text for discussion.

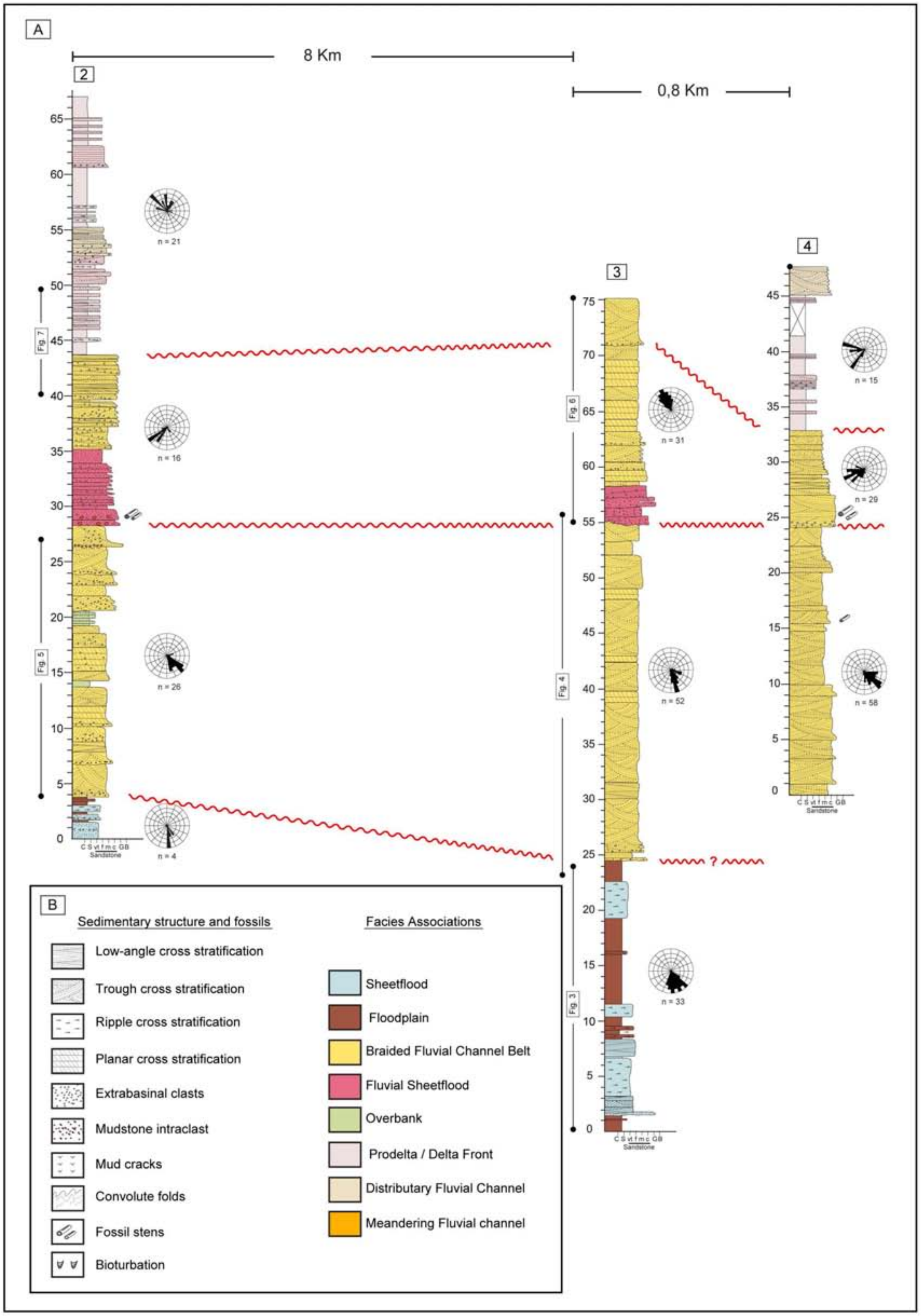
Figure 11: Continued.



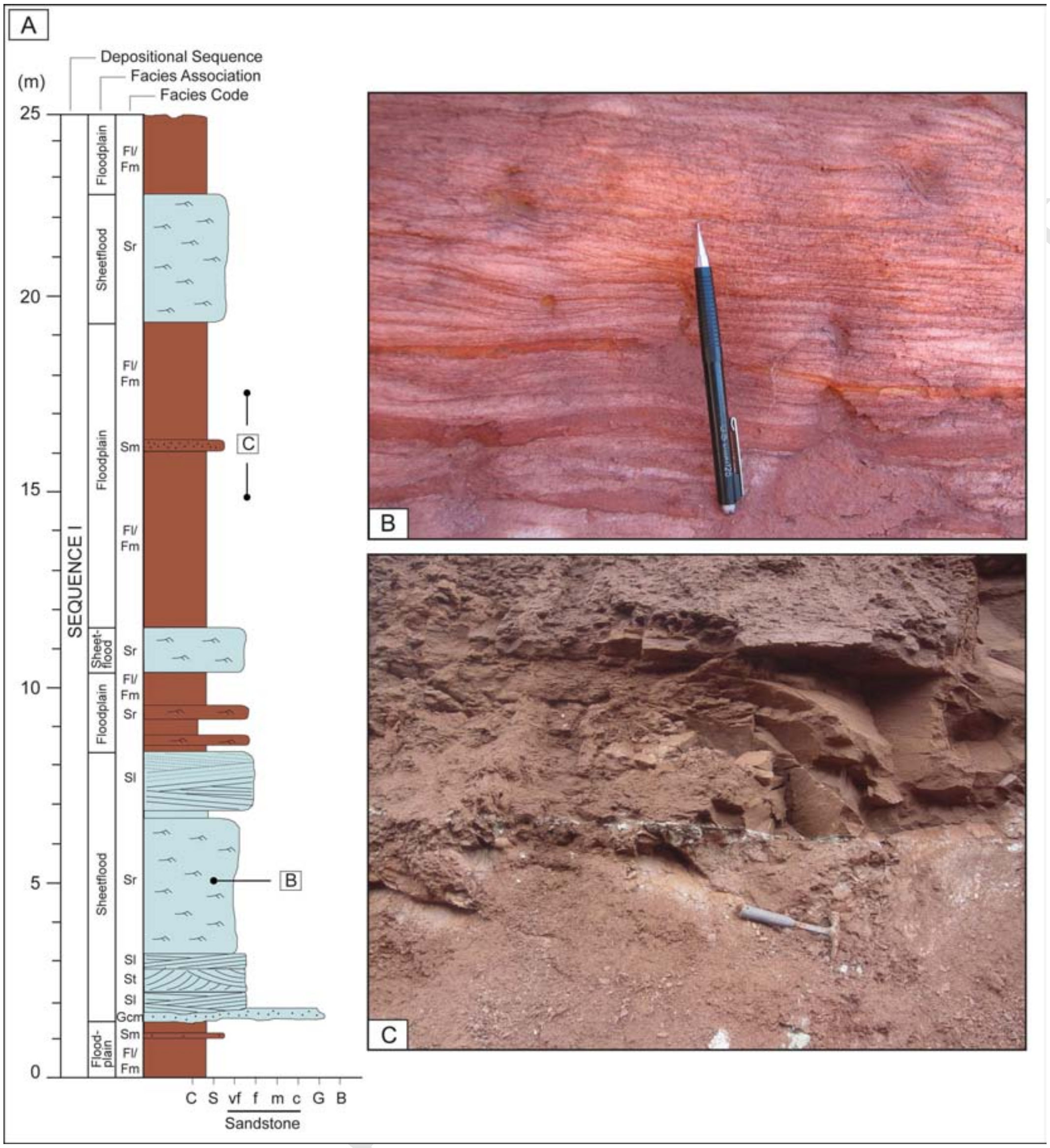
GEOCRONOLOGY
SEQUENCE STRATIGRAPHY
LITOSTRATIGRAPHY
THIS PAPER
CRETACEOUS
NEO
EO
POS-RIFT SUPERSEQUENCE
ARARIPE GROUP
EXU FORMATION
ARARIPINA FORMATION
SANTANA FORMATION
BARBALHA FORMATION
RIFT SUPERSEQUENCE
VALE DO CARIRI GROUP
ABAIARA FORMATION
SEQUENCE IV
MISSÃO VELHA FORMATION
SEQUENCE III
SEQUENCE II
NEO JURASSIC
NEO
PRE-RIFT SUPERSEQUENCE
BREJO SANTO F ORMATION
SEQUENCE I
PALEOZOIC
PALEOZOIC SEQUENCE
MUCURI FORMATION

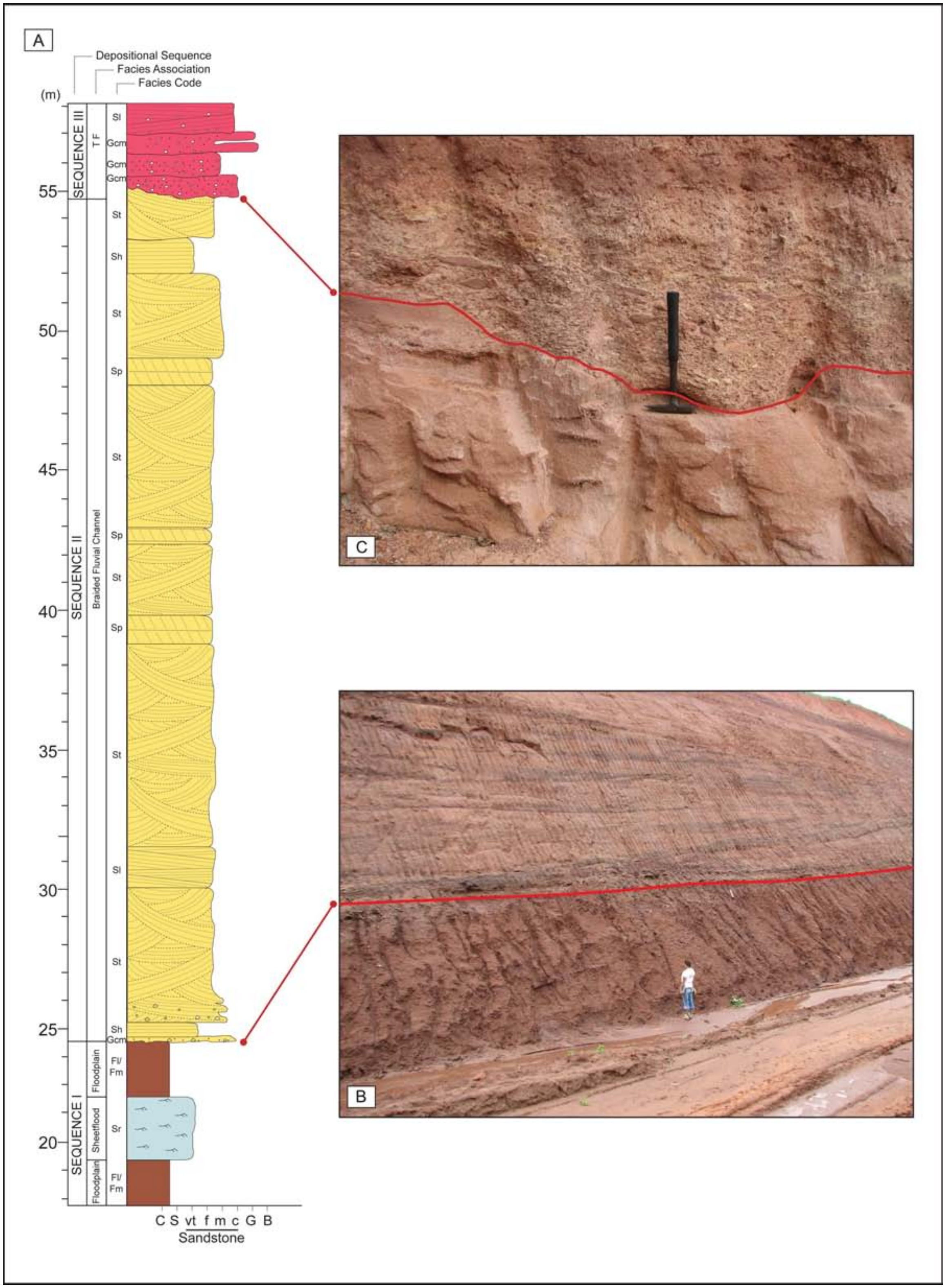
Facies	Description	Interpretation
Gcm	Sandy conglomerate; granule to pebble clasts; massive; intraformacional clasts of mudstones and sandstones; rare extrafromacional clasts of granite, gneiss, quartizite.	Pseudoplastic debris flow
Gt	Sandy conglomerate; granule to pebble clasts; extraformacional clasts of granite and quartz; coarse to granular sandstone matrix, vaguely to well stratifies; 10 to 40 cm thick sets; trough cross-stratified sets	3-D gravel dunes
Sm	Fine to coarse-grained sandstones; moderated to well sorted; massive; 20 to 40 cm thick beds.	Rapid deposition from heavily sediment-laden flows during waning floods or intense fluidization
St	Fine to coarse-grained sandstones; moderated sorted; rare extraformacional granule and pebble clasts of granite and quartz; 20 cm to 1m thick sets; trough cross-stratification. Sometimes soft sediment deformation.	3-D subaqueous sand dunes (lower flow regime)
Sp	Fine to coarse-grained sandstones; moderated sorted; rare extraformacional granule and pebble clasts of granite and quartz, dispersed or parallel to stratification; 10 to 50cm thick sets; planar cross-stratification. Sometimes soft sediment deformation.	2-D subaqueous sand dunes (lower flow regime)
Sl	Fine to coarse-grained sandstones; moderated sorted; common extraformacional granule and pebble clasts of granite and quartz; cross-stratification dips <10^0 with respect to bedding; 20 to 40 cm thick bed .	Washed-out dunes and humpack dunes (transition between subcritical and supercritical flows)
Sl(e)	Fine- to medium-grained sandstones; well sorted with well-rounded and highly spherical grains; low angle cross-lamination composed by inversely graded laminae, up to 10 mm thick.	Subcritical climbing translatent strata formed by the migration of wind ripples under conditions of net sedimentation.
Sh	Fine to coarse-grained sandstones; moderated sorted; common extraformacional granule and pebble clasts of granite and quartz; flat parallel lamination; rare parting lineations on bedding plane; 10 to 40 cm thick bed.	Planar bedded deposition under upper plane-bed flow condition
Sr	Fine to coarse-grained sandstones; ripple cross-lamination, supercritical to subcritical climbing angle; 1 to 5 cm thick sets that may form up to 1.5 m thick cosets.	2D- or 3D- ripples (lower flow regime); climbing ripple formation during periods of rapid sedimentation.
Fl	Mudstones to very fine-grained sandstones; flat parallel lamination; rare small-scale ripple cross-lamination (<1cm).	Suspension fallout with very weak current;
Fm	Mudstone; massive; desiccation cracks; carbonate palaesols.	Suspension setting over flood plains; later modified by desiccation

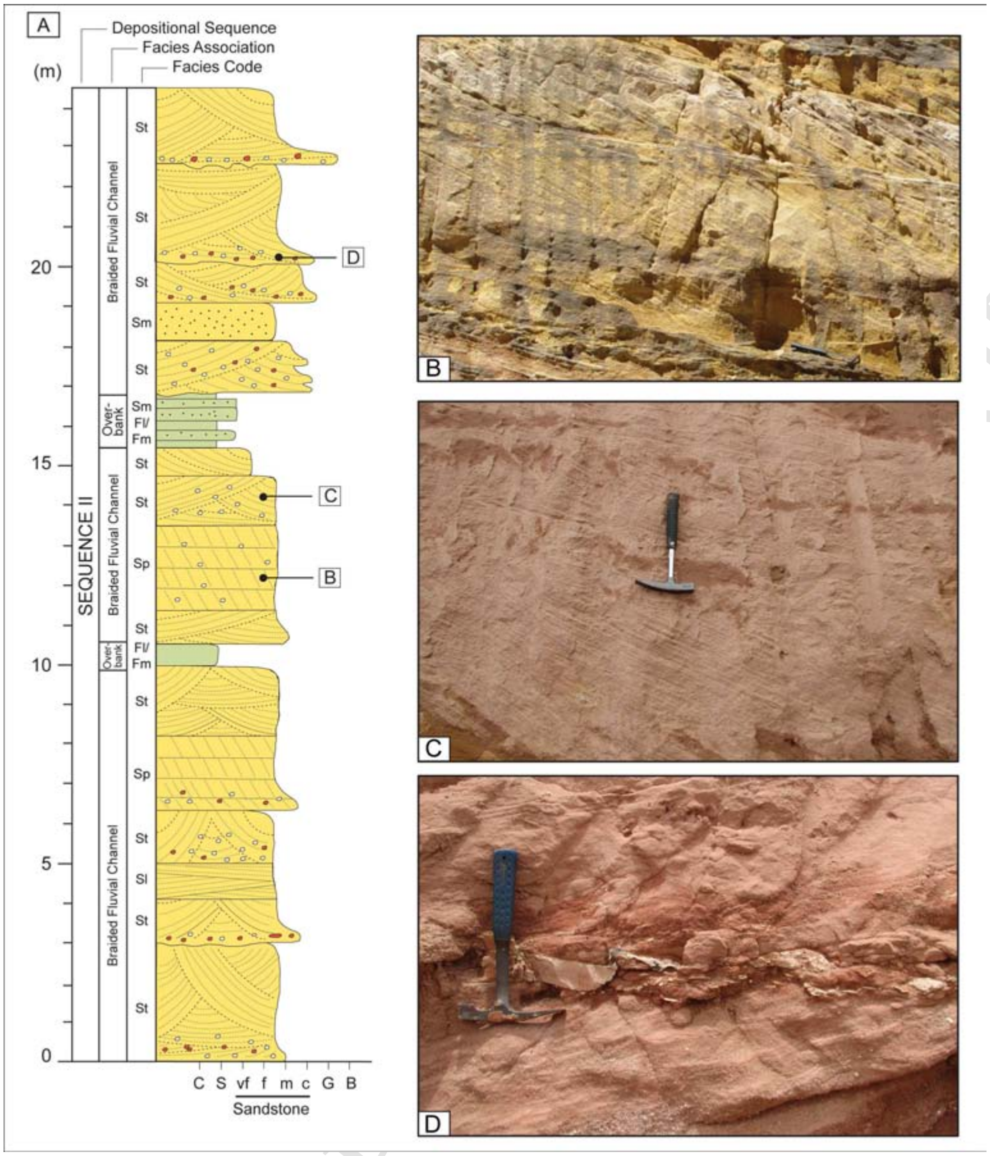

(A)
Araripe Basin
Natal
João Pessoa
0 50 km
Post-Rift Sequence
Pre-Rift and Rift sequence
Cenozoic deposits
Exu Formation
Santana Formation
Rio da Batateira Formation
Abaiara Formation
Missão Velha Formation
Brejo Santo Formation
Mauriti Formation
Basement
(B)
N
Missão Velha
Milagres
Abaiara
Mauriti
490000
500000
510000
520000
530000
540000
9210000
9200000
9190000
9180000
9170000
9160000
0 5 10 Km
Cities
Faults
Foliation
Studied outcrops



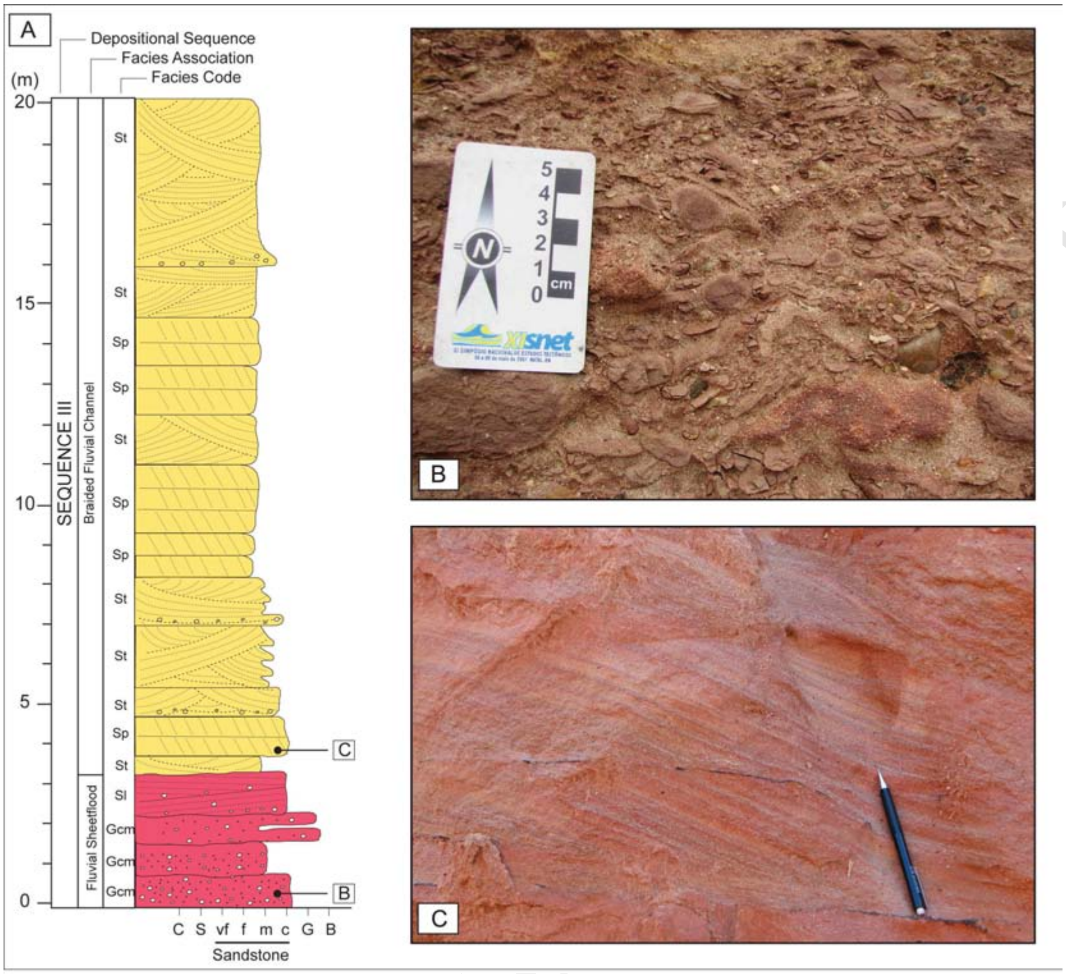
A
8 Km
0,8 Km
2
3
4
n = 21
n = 16
n = 26
n = 4
n = 31
n = 52
n = 33
n = 15
n = 29
n = 58
Fig 7
Fig 5
Fig 6
Fig 4
Fig 3
C S vf f m c GB
Sandstone
B
Sedimentary structure and fossils
Low-angle cross stratification
Trough cross stratification
Ripple cross stratification
Planar cross stratification
Extrabasinal clasts
Mudstone intraclast
Mud cracks
Convolute folds
Fossil stens
Bioturbation
Facies Associations
Sheetflood
Floodplain
Braided Fluvial Channel Belt
Fluvial Sheetflood
Overbank
Prodelta / Delta Front
Distributary Fluvial Channel
Meandering Fluvial channel

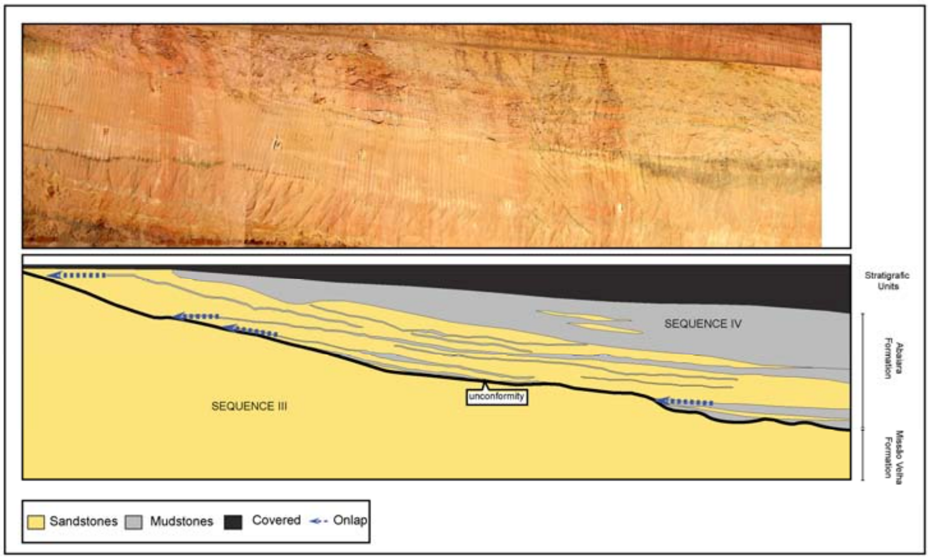

A
Depositional Sequence
Facies Association
Facies Code
(m)
25
20
15
10
5
0
SEQUENCE I
Floodplain
Sheetflood
Floodplain
Sheet-flood
Floodplain
Sheetflood
Flood-plain
Fl/Fm
Sr
Fl/Fm
Sm
Fl/Fm
Sr
Fl/Fm
Sr
Sl
Sr
Sl
St
Sl
Gcm
Sm
Fl/Fm
C
B
C S vf f m c G B
Sandstone
B
C


A
Depositional Sequence
Facies Association
Facies Code
(m)
SEQUENCE III
T F
Sl
Gcm
Gcm
Gcm
55
St
Sh
St
50
Sp
St
45
Sp
St
40
Sp
SEQUENCE II
Braided Fluvial Channel
35
St
Sl
30
St
25
Sh
Gcm
Floodplain
Fl/
Fm
SEQUENCE I
Sheetflood
Sr
20
Floodplain
Fl/
Fm
C S vt f m c G B
Sandstone
C
B

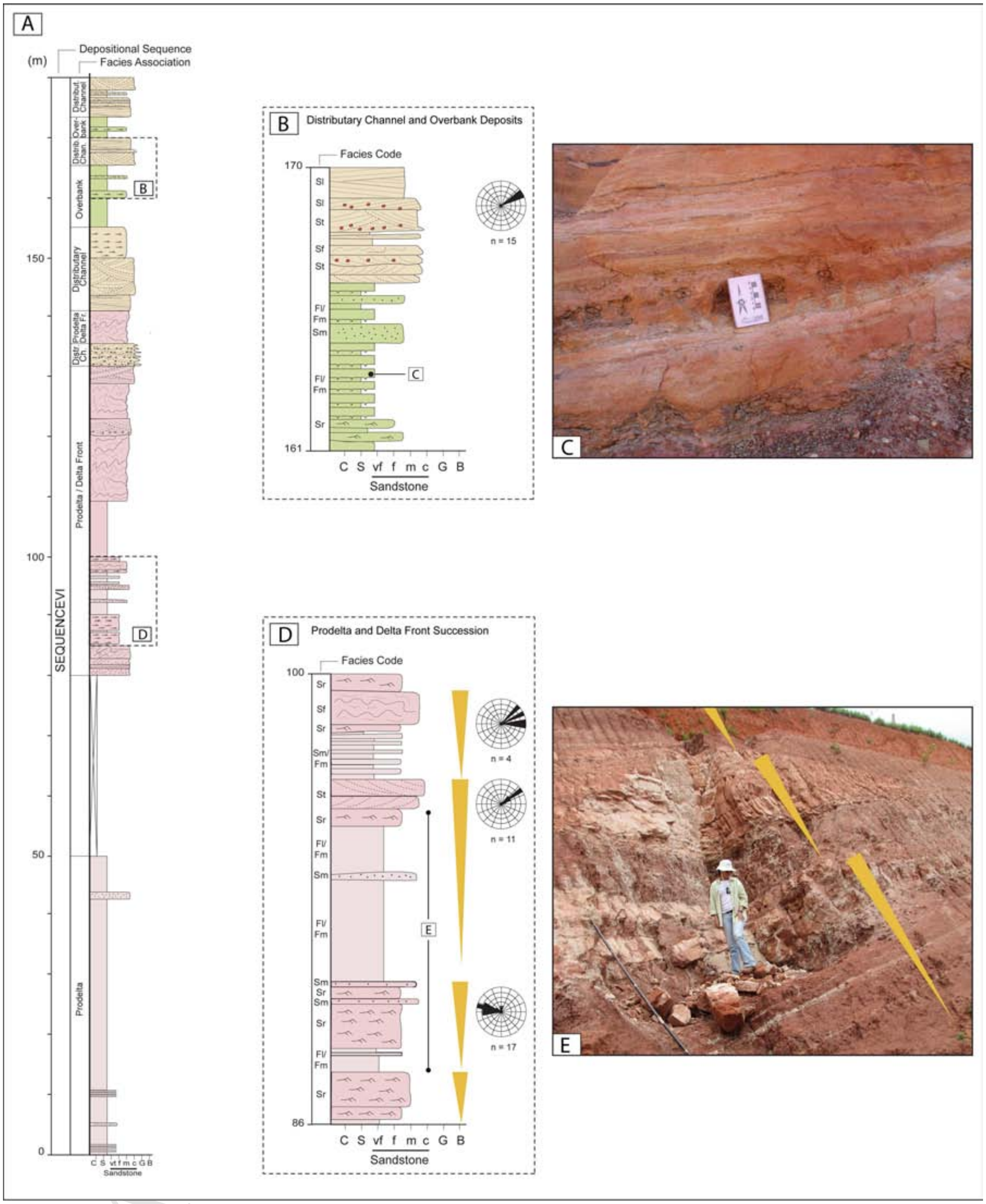


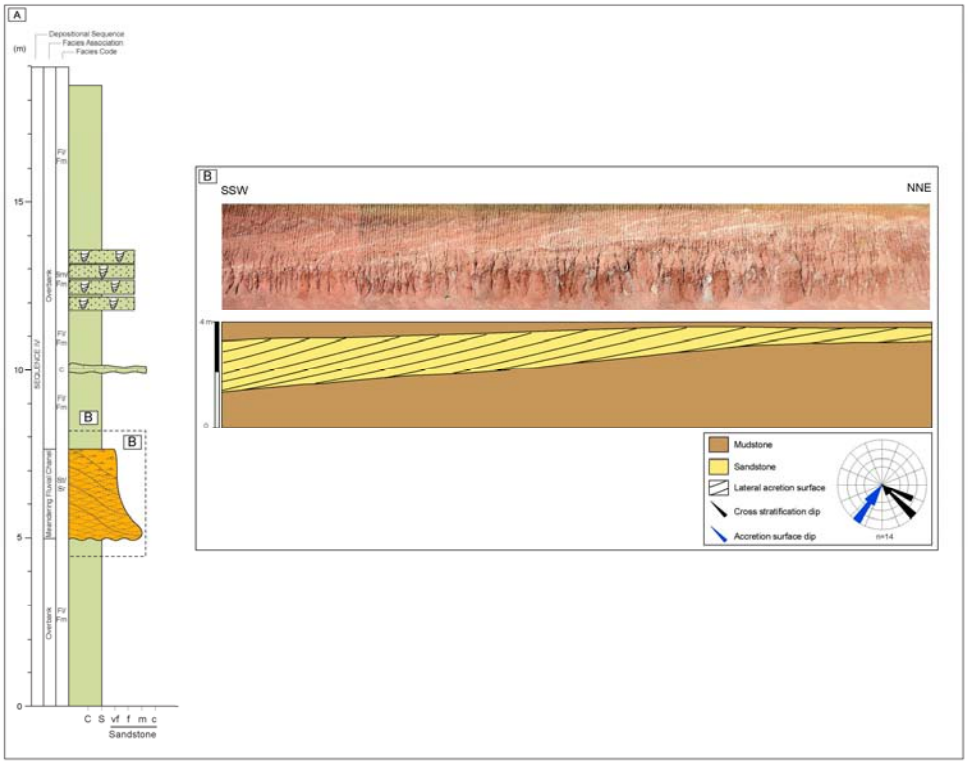
A
Depositional Sequence
Facies Association
Facies Code
(m)
SEQUENCE II
Braided Fluvial Channel
Over-bank
Braided Fluvial Channel
Over-bank
Braided Fluvial Channel
St
St
St
Sm
St
Sm
Fl/
Fm
St
St
Sp
St
Fl/
Fm
St
Sp
St
Sl
St
St
20
15
10
5
0
D
C
B
C S vf f m c G B
Sandstone
B
C
D

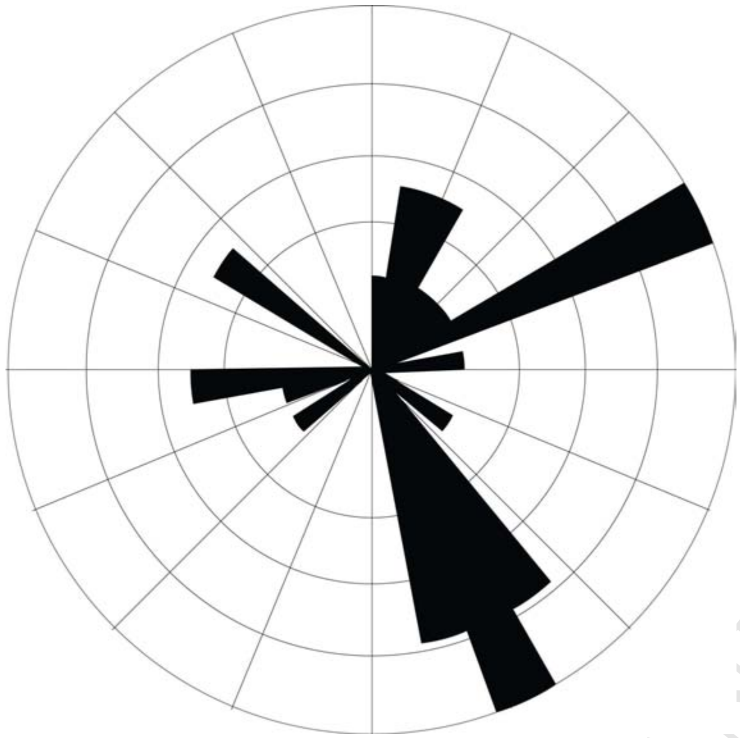

A
Depositional Sequence
Facies Association
Facies Code
(m)
20
15
10
5
0
SEQUENCE III
Braided Fluvial Channel
Fluvial Sheetflood
St
St
Sp
Sp
St
Sp
Sp
St
St
St
Sp
St
Sl
Gcm
Gcm
Gcm
C
B
C S vf f m c G B
Sandstone
B
5 4 3 2 1 0
cm
N
XIsnet
C

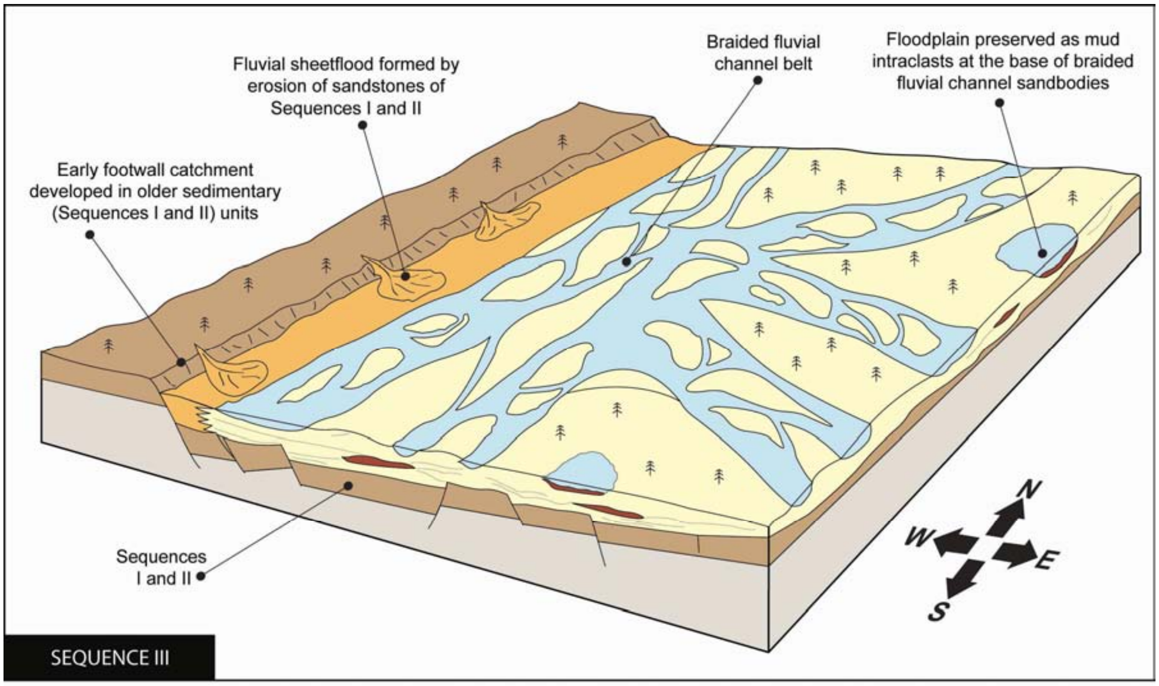


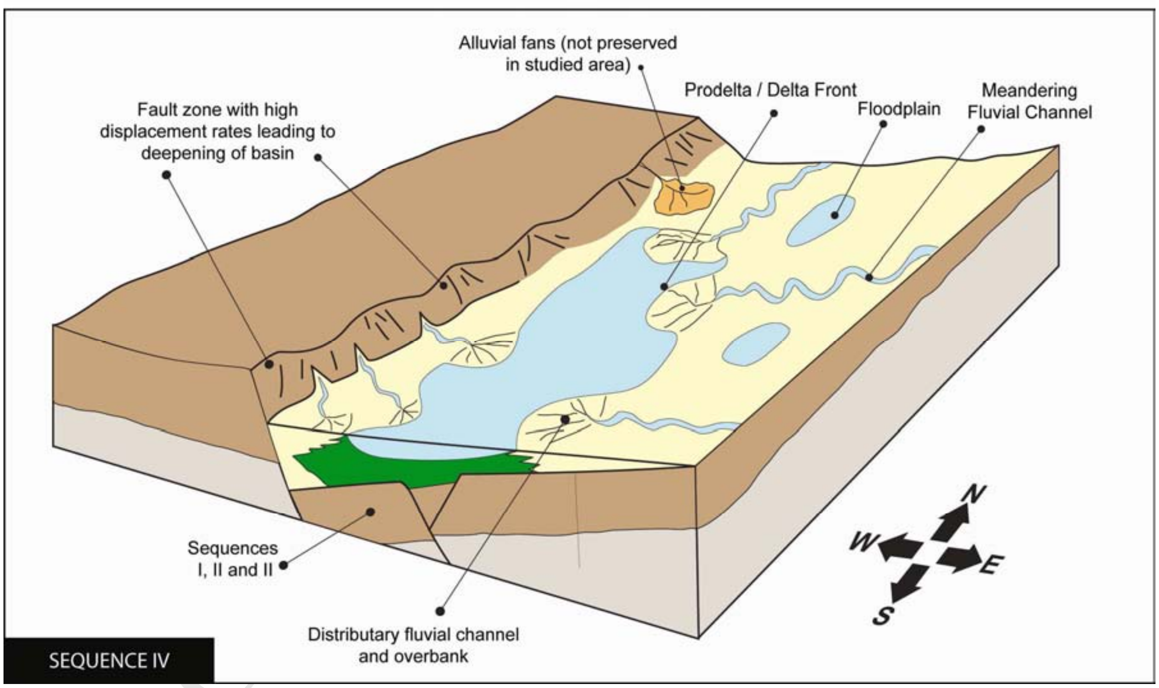
Stratigrafic Units
SEQUENCE IV
Abaiara Formation
unconformity
SEQUENCE III
Missão Velha Formation
Sandstones
Mudstones
Covered
Onlap

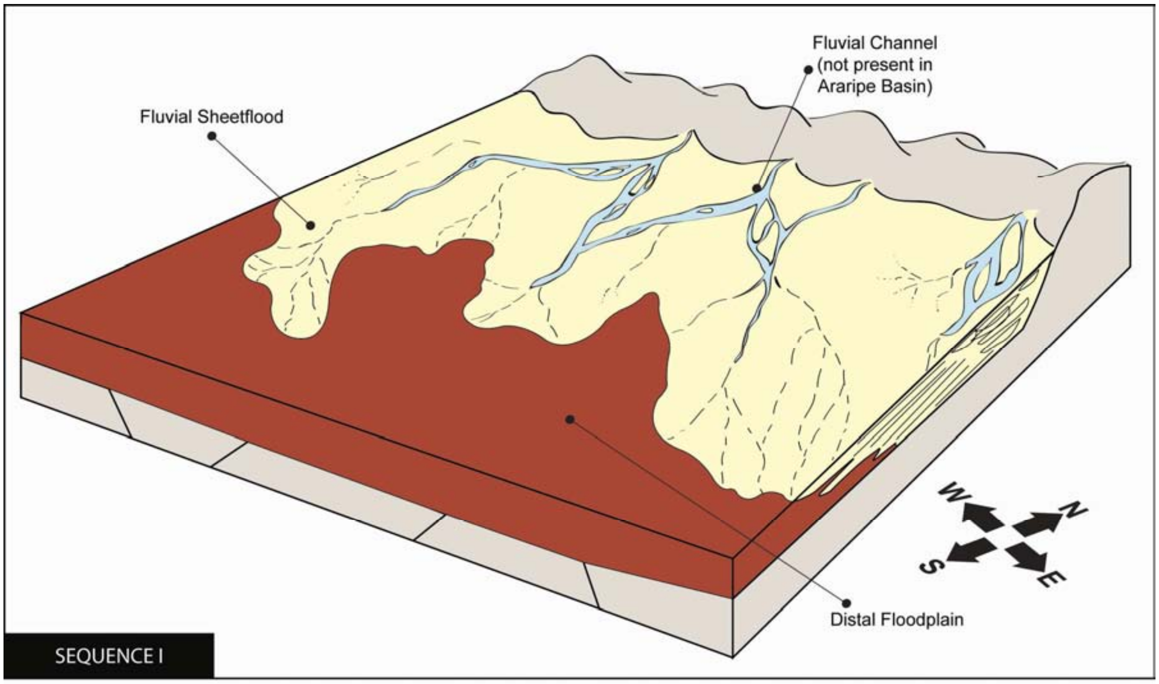

A
(m)
Depositional Sequence
Facies Association
Distribut. Channel
Over-bank
Distrib. Chan.
Overbank
B
150
Distributary Channel
Prodelta Delta Fr.
Distr. Ch.
Prodelta / Delta Front
100
D
SEQUENCEVI
50
Prodelta
0
C S vf f m c G B
Sandstone
B
Distributary Channel and Overbank Deposits
Facies Code
170
Sl
Sl
St
Sf
St
Fl/ Fm
Sm
C
Fl/ Fm
Sr
161
C S vf f m c G B
Sandstone
n = 15
C
D
Prodelta and Delta Front Succession
Facies Code
100
Sr
Sf
Sr
Sm/ Fm
St
Sr
Fl/ Fm
Sm
Fl/ Fm
Sm
Sr
Sm
Sr
Fl/ Fm
Sr
86
C S vf f m c G B
Sandstone
E
n = 4
n = 11
n = 17
E

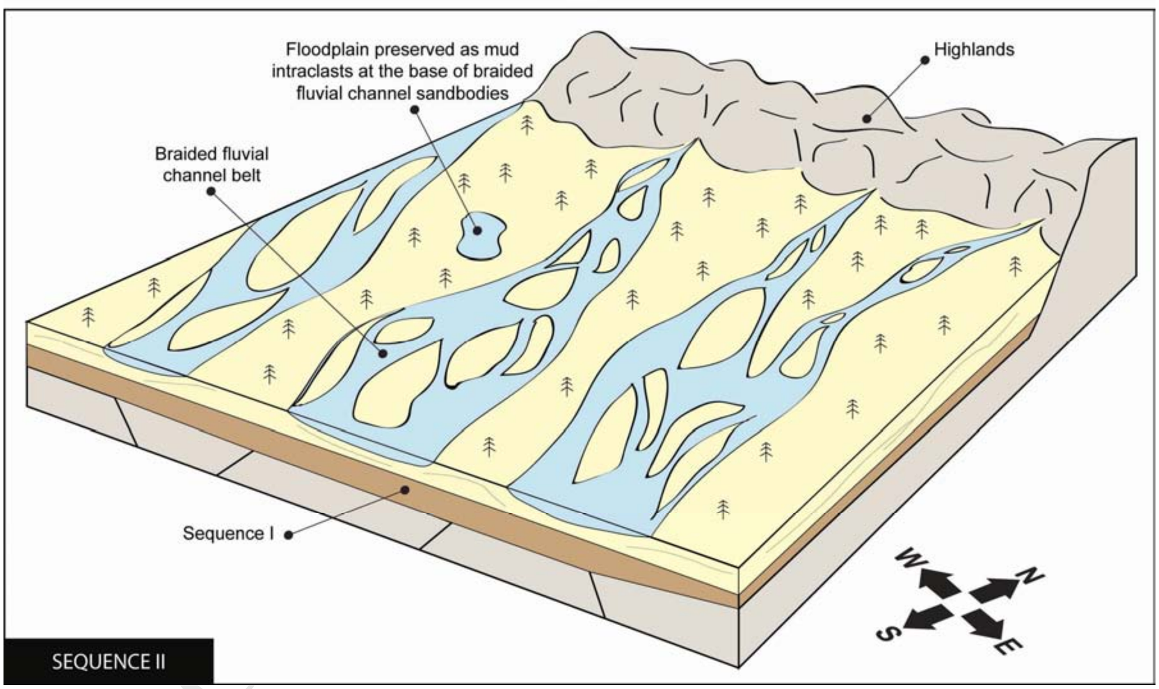

A
Depositional Sequence
Facies Association
Facies Code
(m)
15
10
5
0
Fl/
Fm
Sm/
Fm
C
St/
Sr
SEQUENCE IV
Overbank
Meandering Fluvial Chanel
B
C S vf f m c
Sandstone
B
SSW
NNE
4 m
0
Mudstone
Sandstone
Lateral acretion surface
Cross stratification dip
Accretion surface dip
n=14




Braided fluvial
channel belt
Floodplain preserved as mud
intraclasts at the base of braided
fluvial channel sandbodies
Fluvial sheetflood formed by
erosion of sandstones of
Sequences I and II
Early footwall catchment
developed in older sedimentary
(Sequences I and II) units
Sequences
I and II
N
W
E
S
SEQUENCE III


Alluvial fans (not preserved
in studied area)
Prodelta / Delta Front
Floodplain
Meandering
Fluvial Channel
Fault zone with high
displacement rates leading to
deepening of basin
Sequences
I, II and II
Distributary fluvial channel
and overbank
N
W
E
S
SEQUENCE IV


Fluvial Channel
(not present in
Araripe Basin)
Fluvial Sheetflood
Distal Floodplain
W
N
S
E
SEQUENCE I


Floodplain preserved as mud
intraclasts at the base of braided
fluvial channel sandbodies
Highlands
Braided fluvial
channel belt
Sequence I
W
N
S
E
SEQUENCE II

- Rift section of the Araripe Basin can be subdivided into four depositional sequences.
- These sequences record different different evolutionary stages of Araripe Basin.
- Sequences I, II and III represent a record of a larger basin associated to early rift stage.
- Sequence IVwas accumulated in well-defined half-graben systems.