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Unincised fluvial and tide-dominated estuarine systems from the Mesoproterozoic Lower Tombador Formation, Chapada Diamantina basin, Brazil

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ABSTRACT

The Mesoproterozoic Lower Tombador Formation is formed of shallow braided fluvial, unconfined to poorly-channelized ephemeral sheetfloods, sand-rich floodplain, tide-dominated estuarine, and shallow marine sediments. Lowstand braided fluvial deposits are characterized by a high degree of channel amalgamation interbedded with ephemeral, intermediate sheetflood sandstones. Sand-rich floodplain sediments consist of intervals formed by distal sheetflood deposits interbedded with thin layers of eolian sandstones. Tide-dominated estuarine successions are formed of tide-influenced sand-bed braided fluvial, tidal channel, tidal sand flat and tidal bars. Shallow marine intervals are composed of heterolithic strata and tidal sand bars. Seismic scale cliffs photomosaics calibrated with vertical sections indicate high lateral continuity of sheet-like depositional geometry for fluvial–estuarine successions. These geometric characteristics associated with no evidence of incised-valley features nor significant fluvial scouring suggest that the Lower Tombador Formation registers deposition of unincised fluvial and tide-dominated systems. Such a scenario is a natural response of the interplay between sedimentation and fluctuations of relative sea level on the gentle margins of a sag basin. This case study indicates that fluvial–estuarine successions exhibit the same facies distributions, irrespective of being related to unincised or incised-valley systems. Moreover, this case study can serve as a starting point to better understand the patterns of sedimentation for Precambrian basins formed in similar tectonic settings.

1. Introduction

It is widely recognized that Precambrian channel systems were braided in all environments (deltaic, tidal, alluvial, and fluvial) as a consequence of lack of vegetation and poor soils development, and that the sheet-like geometry of many pre-vegetation deposits indicates that flood channels on unconfined braid-plain systems were significantly wider than younger counterparts (Cotter, 1978; Fuller, 1985; Els, 1990; Rainbird, 1992; Miall, 1996; Long, 2004; Bose et al., 2012). Moreover, unincised lowstand alluvial deposits should be more common on the rock record than what is documented in the literature (Posamentier, 2001). On the other hand, the facies models for estuary and incised-valley environment have proliferated in the literature (Boyd et al., 2006; Dalrymple, 2010; Maynard et al., 2010).

The Lower Mesoproterozoic Tombador Fm. is exposed in Chapada Diamantina basin, Northeastern Brazil. This unit comprises thick successions that contain high resolution information about the evolution of fluvial and estuarine systems at the time of deposition. In spite of the very old age, the exposure and the preservation are exceptional, affording a unique opportunity to unravel processes that dominated fluvial and estuarine deposition and overall geometry during the Mesoproterozoic, as few such pristine data sets are available anywhere in the world for that time interval. Besides, that unit underwent localized very low grade metamorphism and the sedimentary rocks still exhibit many primary structures. Previous works have interpreted the deposits of the Tombador Fm. based on studies carried out on regional scale (Pedreira, 1994; Pedreira and De Waele, 2008; Guimarães et al., 2008; Loureiro et al., 2009) or detailed scale (Castro, 2003; Santana, 2009; Santos, 2009; Silva Filho, 2009; Araujo, 2012).

In this paper we present the findings of an integrated study based on facies analysis, supported by gamma ray logs and

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seismic scale photomosaic interpretation, that was carried out to identify the characteristics, understand the evolution, and to propose a paleogeographic reconstruction for the fluvial and tide-dominated estuarine systems from the Lower Tombador Fm. in Chapada Diamantina basin. Thus, the aim of this paper is threefold. First, we identify facies associations and their overall geometry. Second, we integrate those facies associations in depositional systems and propose a stratigraphic framework. Third, we recognize the unincised character of the lowstand fluvial and transgressive tide-dominated estuarine deposits. The data presented here suggest unincised fluvial–estuarine systems exhibit the same facies distribution found in estuaries related to incised-valley systems and offer an example to better understand the patterns of sedimentation for Precambrian basins placed in similar tectonic settings.

2. Regional setting

Chapada Diamantina is located in the São Francisco craton (Fig. 1). The São Francisco and Congo cratons are stable Archean/Paleoproterozoic blocks (Almeida, 1977). Some authors argue that the craton represents a fragment of the Rodinia supercontinent assembled at 1.0 Ga (Brito Neves et al., 1999; Campos Neto, 2000; Alkmim and Martins-Neto, 2001; Brito Neves, 2003) while others suggest it does not (Kröner and Cordani, 2003; Pisarevsky et al., 2003). This once coherent landmass broke up in Cretaceous during the opening of the Atlantic Ocean (Pedreira and De Waele, 2008). The evolution of Paleo to Mesoproterozoic sedimentary cover in the São Francisco craton started with the Statherian intracratonic extensive regime, between 1.8 and 1.6 Ga, that promoted continental rifting and ensuing bimodal volcanism suite

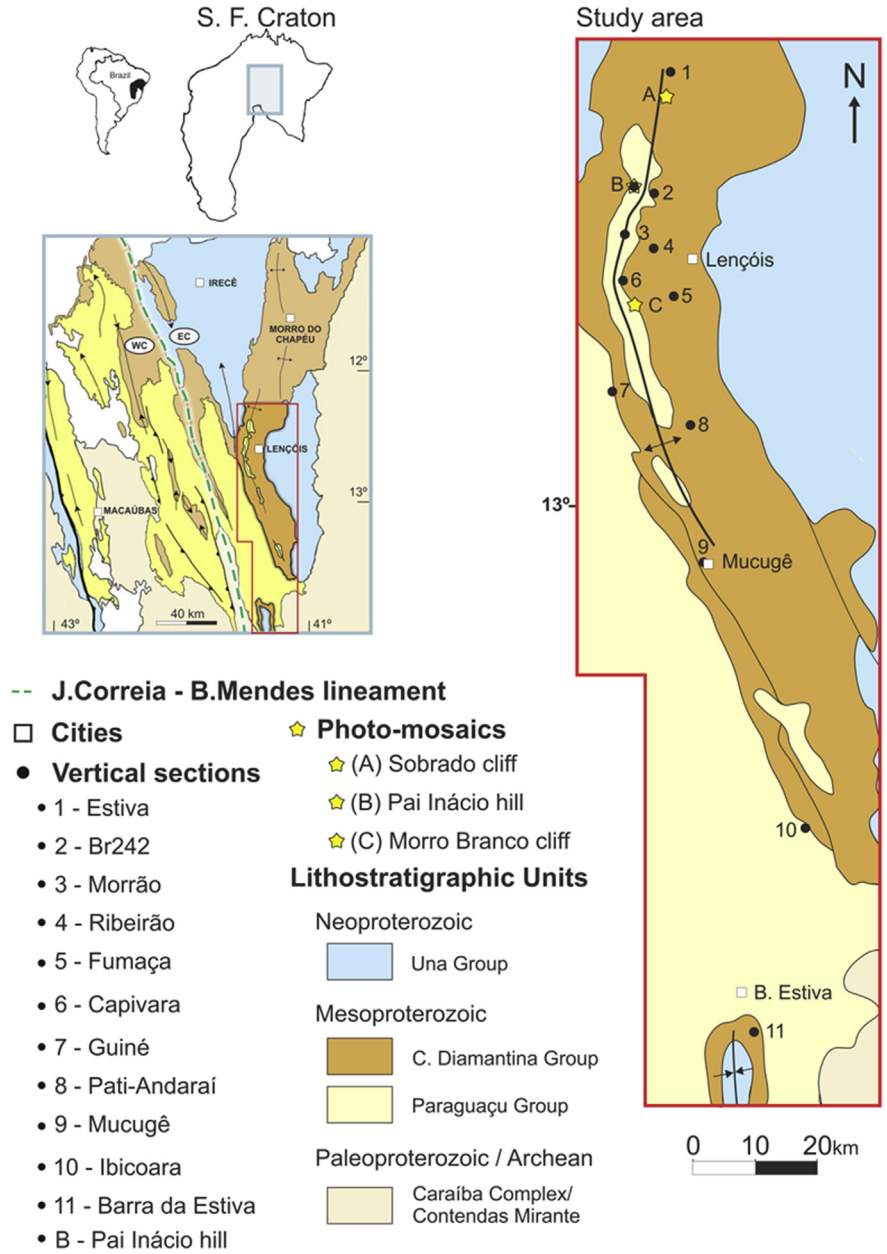

Fig. 1. Simplified geological map of the Chapada Diamantina. The study area is mainly located at the eastern domain along the Sincorá Range, the geomorphologic expression of the Pai Inacio anticline (modified from Pedreira, 1994; Alkmim and Martins-Neto, 2001). Abbreviations: WC – Western Chapada Diamantina; EC – Eastern Chapada Diamantina.