Journal of South American Earth Sciences 71 (2016) 161–171

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

journal homepage: www.elsevier.com/locate/jsames

Taphonomic and sedimentological aspects from PICOS II paleontological site, a quaternary pond deposit of Alagoas, Brazil

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ARTICLE INFO

Article history:
Received 3 May 2016
Received in revised form
6 July 2016
Accepted 9 July 2016
Available online 14 July 2016

Keywords:
Taphonomy
Pleistocene vertebrates
Megafauna
Pond deposit
Northeastern Brazil

ABSTRACT

The Picos II Paleontological Site (PIIPS), located in the city of Piranhas, in Alagoas State, is a fossil deposit with a pond-like geomorphological feature, a kind of peculiar deposit for the Quaternary of Northeast Brazil. A detailed taphonomic study is presented about the PIIPS assemblage, from material collection to the laboratory analysis. The conservation state of the collected fossils in PIIPS is different from that found in other tank deposits, showing a high degree of specimen preservation. Two taxa of pleistocenic mammals have been identified: *Eremotherium laurillardi* and *Notiomastodon platensis*, and fragments of an avian bone, whose taxonomic identification was not possible. The taphonomic analysis indicates that the deposited material experienced a short transportation in high-energy event, with a short period of subaerial exposure before the final burial, where at least the final disarticulation occurred *in situ*, which explains the high conservation level of the material. The sedimentological analysis made in each layer of the deposit corroborates the information related to the transport of the material, which were obtained in taphonomic analysis. Regarding these aspects, PIIPS reflects nearly non-biased biocenotic patterns. The well-preserved material found in PIIPS demonstrates the great potential of deposits with pond-like geomorphological features, with sidelines that are less steep than traditional tanks, providing smoother transport and accommodation for skeletal elements, which is a distinguishing factor in preserving fossils of vertebrates.

1. Introduction

The fossil record is rich in information related to the biology and ecology of species, but these data are often incomplete, the fossil is formed in a natural process of sampling biases (Behrensmeyer et al., 2000; Hart, 2012). Over the past 30 years, taphonomy has played a central role for better understanding these processes (Armstrong and Avery, 2014) in order to correctly evaluate fossil record data despite these tendencies (Behrensmeyer et al., 2000; Bissaro-Júnior, 2008).

In Brazil, during the late Pleistocene to early Holocene, the accumulation of vertebrate skeletal remains occurred (e.g. large mammals) in various kinds of fossiliferous deposits such as tanks; caves; ponds; riverbeds and ravines (Santos et al., 2002a; Bergqvist and Almeida, 2004; Porpino et al., 2004; Dantas et al., 2005; Viana et al., 2007; Ribeiro and Carvalho, 2009; Araújo-Júnior and Porpino, 2011). In the Northeast of Brazil, the occurrence of these deposits called tanks are very common. They are defined as natural depressions caused by erosion, and produced along the fractures of crystalline basement. (Ximenes, 2008; Rolim, 1981; Oliveira and Hackspacher, 1989; Santos, 2001). These tanks are a major source of information on paleobiodiversity and paleoecology of Quaternary of Brasil (Araújo-Júnior, 2016).

The taxonomic and paleoecological aspects are the most studied in Brazilian deposits of fossil vertebrates (Araújo-Júnior et al., 2013a). Although several studies have been published in the last decade focusing on taphonomic aspects (Silva, 2001, 2008; Santos et al., 2002a; Auler et al., 2006; Alves et al., 2007; Dantas and Tasso, 2007; Araújo-Júnior and Porpino, 2011; Araújo-Júnior et al., 2012, 2013b), tanks are still considered a very difficult and unique type of accumulation of fossil vertebrates in the Brazilian

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http://dx.doi.org/10.1016/j.jsames.2016.07.009
0895-9811/

Quaternary (Araújo-Júnior et al., 2013c). One of the standards recognized by most previous studies is the predominance of bone fragments with skeletal elements poorly conserved in accumulations of tank deposits (Araújo-Júnior et al., 2013b).

In Alagoas State, the presence of these types of deposits is very common. Twenty four cities report occurrences of fossil deposits and sixteen taxa of vertebrates have been identified (Nascimento, 2015; Silva et al., 2012; Silva, 2013b). Out of these, only a few studies deal with taphonomy in fossil deposits of Alagoas State (Silva, 2001; Oliveira, 2012; Lima, 2014).

This study aimed to analyze taphonomic and sedimentological aspects of the fossil deposit of Picos II Paleontological Site (PIIPS). Thus, the study aims to contribute to expand knowledge about biostratinomic processes, elucidating differences between taphonomic patterns found in different deposits of northeastern Brazil.

2. Location, geology and stratigraphy

The city of Piranhas is located in the backlands of Alagoas State, 270 km from Maceió, the state capital. It is predominantly in the geoenvironmental unit of *Depressão Sertaneja* (Depression of Backlands) (65%), which is the typical landscape of the northeastern semiarid region characterized by a monotonous pediplanation surface, predominantly soft-wavy relief, cut by narrow valleys, with dissected parts. Residual elevations, crests and/or hills punctuate the skyline. These isolated reliefs witness intense cycles of erosion that hit much of the northeastern backlands. The rest of the city area (35%) is inserted in the geoenvironmental unit of *Planalto da Borborema* (Borborema Plateau) (Mascarenhas et al., 2005). Geologically, it is in *Província Borborema* (Borborema Province), a tectonic entity of the Neoproterozoic age (Brazilian-Pan-African). In the region where the study deposit is located, the Salgueiro/Terra Nova Shoshonitic Intrusive Suite appears, consisting of biotite-amphibole quartz monzodiorite and granite (Mascarenhas et al., 2005).

The fossil deposit is located in Picos Farm, which is 26 km away from the seat of Piranhas (0636428/8951370 UTM). The paleontology site has a pond-like geomorphological feature, located next to a small hill, which has about 20 m high (Fig. 1). The outcrops of granitic rocks of the Neoproterozoic, which are the crystalline basement in the studied area, are spread throughout the property where the fossils were found. Over the years, the natural depression generated by the movement of surface water has been gradually enlarged by residents who dug into the tank to collect rain water for dry periods. The area excavated by the residents was near the base of the hill, about 10 m from the studied area.

In Picos Farm there is still another paleontological site called Picos I (PIPS), a spring that was dug by people who live there, leaving as testimony only three small fragments of fossilized bones.

The classic definition of tank implies that these deposits are natural depressions, caused by erosion produced along the fractures by physical and chemical action (Oliveira and Hackspacher, 1989). However, it was observed that these deposits may present considerable morphological differences (Araújo-Júnior et al., 2013b) that influence their taphonomic stories.

Deposits with pond morphology found in Alagoas State have the same characteristics and origin of the tanks, except the sidelines are not as steep, with an average 25° slope between the edge and the bottom, it is even less deep than classic tanks. It will be shown how these deposits provide better preservation of organic waste, primarily due to their smooth entry and accommodation in the depression bottom.

These tanks were filled by lithoclasts deposited by flow detritus and/or mud via alluvial fans or floods carrying large number of bioclasts (Silva, 2001). Among the latter, we can mention some mammals and other groups of vertebrates that lived in late Pleistocene to early Holocene (Oliveira and Hackspacher, 1989; Oliveira et al., 1989).

3. Methodology

Specimens were collected during January 2011 to January 2012 with the staff of Setor de Paleontologia of Museu de História Natural at Universidade Federal de Alagoas (SP/MHN/UFAL), requiring three field works. During this period, an emergency treatment was performed on the most fragile specimens; which means that some parts were glued with white glue and its stability was reinforced with white glue diluted in ethanol. Also, very fragile pieces were wrapped in plaster bandages.

As proposed by Badgley et al. (1995), to maximize the sample size and the targeted granulometric range, there were three types of collections: surface collection, digging and sifting. Thus, it was possible to cover a larger number of skeletal elements of the fossiliferous concentration. The collected fossils were accommodated properly in transport with foam and plaster to prevent shock and breakage. Taphonomic data, as biostratinomy paleontological feature, fossil orientation and position were observed during the field work and recorded for later analysis.

Subsequently, a stratigraphic section was made to identify the layers that form the tank, collecting each layer for subsequent granulometric analysis in laboratory. The sediment was taken to Laboratório de Geologia Costeira e Ambiental at Universidade Federal de Alagoas (LGCA/UFAL), where the granulometric analysis was performed by wet and dry sieving. Sedimentological results were obtained using percentage values of textural classes (gravel, sand and mud) in the triangular diagram of clastic sediment classification – Shepard Diagram. Morphoscopic analysis of sand grains, held in SP/MHN/UFAL, was used as complementary data in this study. A binocular loupe was used to evaluate the composition, selection degree and roundness of sand fraction in each sample.

The collected specimens were taken to the laboratory, where they were prepared and placed as a patrimony in Paleovertebrates Collection at SP/MNH/UFAL. Of all evaluated material, only species whose degree of conservation provided a specific, osteological and conclusive diagnosis were used in this study.

All specimens were submitted for macroscopic taphonomic analysis proposed by Shipman (1981), Behrensmeyer (1991), Rogers (1994), Holz and Simões (2002) and Simões et al. (2010). Thus, the following macroscopic aspects were considered: taxonomic composition and ontogenetic stage; degree of articulation and fragmentation; rounding; dissection marks; marks of roots and teeth and bioerosion. For the analysis of fractures, abrasion and weathering, classifications of Shipman (1981) and Behrensmeyer (1978) were used.

4. Taxonomic composition

Picos II Paleontological Site is a macrofossil dominant, low diversity, multitaxic and monodominant assemblage (Eberth et al., 2007).

One hundred and thirty specimens were found and were set as patrimony under government protection, including teeth, cranial and postcranial bones. Of all specimens, 102 were considered anatomically and taxonomically identifiable. The other specimens are fragments that were not identified (Table 1). Taxonomic classification used in this study was based on studies of Hoffstetter (1958), Paula-Couto (1979), Cartelle (1992), Ferretti (2010) e Mothé et al. (2012).

Two individuals of ground sloths *Eremotherium laurillardi* Lund, 1842 (*Xenarthra*, *Megatheriidae*) were identified, belonging to