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A NEW ARCHAEOBOTANICAL PROTOCOL FOR COLLECTING CONCENTRATED WOOD CHARCOAL FROM ARCHAEOLOGICAL BONFIRE SITES

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ABSTRACT

Wood charcoal is the most commonly found bioarchaeological testimony at archaeological sites. In addition to dating sites, charcoal provides insights into the way of life of past populations and paleoenvironment reconstruction. Concentrated charcoal is usually recovered from archaeological bonfires. This paper proposes a new field protocol for standardized collection and registration of archaeological charcoal recovered from combustion structures, and which can be applied to different types of archaeological sites. The protocol was developed from field experiments involving excavation of archaeological sites in central Brazil. The systematization of information acquisition provided by this tool assures more effective sampling of concentrated charcoal and, therefore, the optimization of data for deeper paleoethnological interpretations.

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INTRODUCTION

Plant remains recovered from sedimentary matrices of archaeological sites fall into two categories: microremains, characterized by phytoliths, pollen grains, spores, starch grains, crystals and siliceous bodies (Pearsall, 2000); and macroremains, represented by fruits, seeds, fibers, leaves, wood *in natura* and charcoal (Ford, 1979). These remains constitute the botanical remnants that, after deposition, have passed or not through some type of taphonomic transformation and remained in archaeological sediment as important testimony for the interpretation of some aspects of the way of life of previous populations. Carbonized wood or charcoal is one of the main macroremains found in archaeological sites (Scheel-Ybert, 2004), given its advantages for preservation over other types of plant remains due its carbonization, to park the wood decomposition and to enable its preservation (Pearsall, 1988). Charcoal represents a faithful portrait of the flora that originally surrounded an archaeological site. It is deposited in the archaeological matrix in two distinct manners, which allow two different types of interpretations. Dispersed charcoal occurs randomly scattered throughout a site or part thereof. Concentrated charcoal occurs already assembled in combustion structures or bonfires. Dispersed charcoals lend themselves to inferences about the composition of past flora and allow paleoenvironmental reconstruction. Concentrated charcoal of bonfires, although representing a small portion of the diversity of the floristic paleoenvironment, offers direct evidence of the use of flora by previous populations and is more reliable for paleoethnological and paleoethnobotanical investigations and interpretations about resource exploitation, relationships between society and the environment, and livelihood systems (Pearsall, 1983, Thompson, 1994, Chabal *et al*., 1999, Figueiral, 2005, Mallol *et al*., 2007, Melo Júnior & Magalhães, 2015). Although archaeological charcoal is the target of almost all archaeological studies, mainly because it is used for dating and understanding the evolution of human occupation and abandonment of an archaeological site, and is innovatively recovered in the field by flotation (Chabal, 1988; Pearsall, 2000), there remains an absence of a complete standardized procedure specifically for the treatment of concentrated charcoal. Standardization of collecting bioarchaeological remains is focused essentially on the availability of archaeobotanical or zooarchaeological samples that can be compared among sites with regard to the paleoenvironment (Silva *et al*., 2013). Important works have made broader propositions for standardized recovery and sampling of bioarchaeological macroremains based on innumerable experiences of researchers of Brazilian archeology. These propositions evidence not only the need for systematization of field procedures in order to obtain comparable data in the fields of antracology, archaeobotany and zooarchaeology (Scheel-Ybert *et al*., 2005-2006), but also the need for the refinement of techniques for sample treatment at certain archaeological sites (Silva *et al*., 2013).

In these works, the protocols and techniques adopted are, for the most part, intended for dispersed charcoal. Concentrated charcoal, on the other hand, is approached in a rather detailed manner, which raises doubts as to the best set of field procedures to be followed to systematize studies that employ it as a source of archaeobotanical information. Based on experiments performed at Brazilian archaeological sites, the present study proposes a new protocol specifically designed for the recovery of concentrated charcoal from combustion structures at archaeological sites.

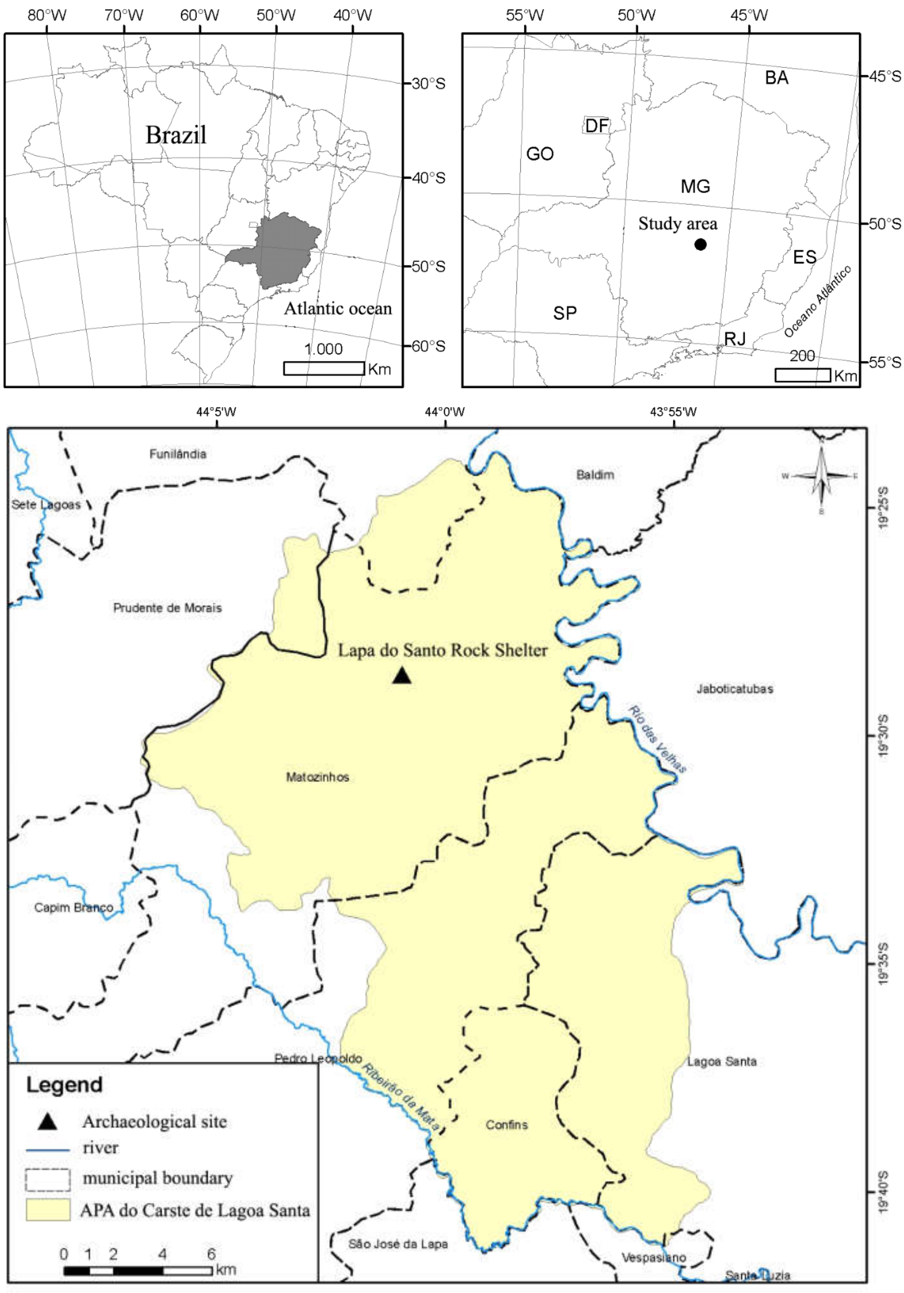


Figure 1. Location of *Lapa do Santo* archaeological site, *Carste Lagoa Santa*, municipality of Matozinhos, state of Minas Gerais, Brazil. Source: Melo Júnior & Magalhães (2015)

MATERIALS AND METHODS

The proposed protocol for concentrated charcoal was developed from field excavation experiences at the Lapa do Santo archaeological site headed by the bioanthropologist Walter Alves Neves of the Laboratory of Human Evolution of the University of São Paulo, Brazil. Lapa do Santo is a rock shelter located on Fazenda Cauaia in the Lagoa Santa enviromental protection area, municipality of Matozinhos, state of Minas Gerais, Brazil (S 19º28'39.6", W 44º00'55.9"; Figure 1). It is characterized as a cave of approximately 930m^2 in area with a wide sheltered area (1,300m^2) at its entrance. It possesses a relatively flat, dry floor in its southern portion near the entrance, and a steep slope in its northern portion, where it becomes flat again in the vicinity of a sink (Araújo *et al*., 2005).

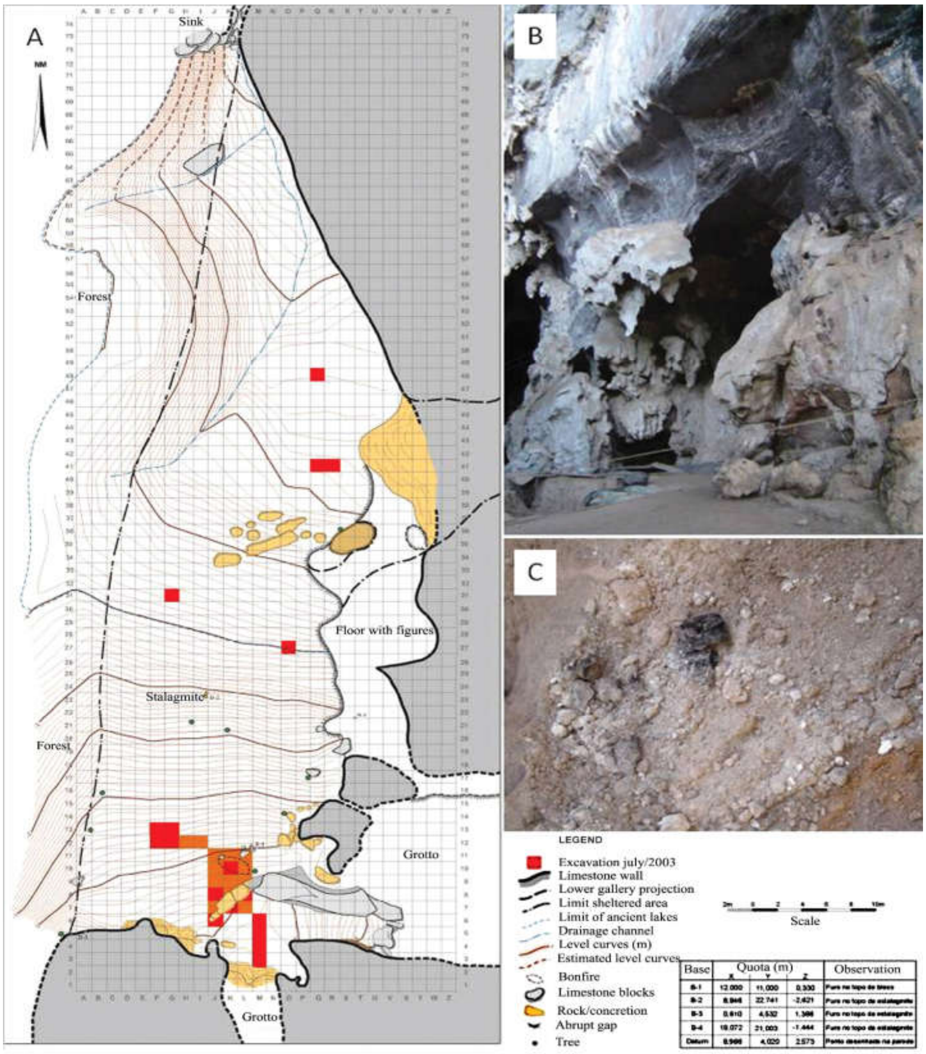


Figure 2 - Lapa do Santo archaeological site, *Carste Lagoa Santa*, municipality of Matozinhos, state of Minas Gerais, Brazil. Legend: A - sketch of excavation blocks. B - front view of the shelter. C - combustion structure. Source: Melo Júnior & Magalhães (2015).

The site has experienced successive stages of excavation, with the first being undertaken in 2001 involving a topographic survey and the opening of a block for probing. In 2002, new open blocks revealed an archaeological deposit of more than 3m-deep and evidence of human burials. Between 2003 and 2005, excavations were expanded, making a more comprehensive view of the stratigraphy of the area of greatest occupation of the site possible, with 2005 concentrating on the exhumation of human skeletons from, mostly secondary, burials. In 2006 and 2007, excavations were completed in the blocks considered to be the food preparation area of the site, and great efforts were made in the excavation of a second level of burials. In 2008, the excavation of burials was completed and the extent of the excavations closed, exposed profiles rectified and final recordings of site stratigraphy taken. In total, excavation encompassed 31 open blocks, revealing a homogeneous sedimentary matrix of a variegated gray-color interspersed by concrete levels containing archaeological material deposited uninterruptedly, including several combustion structures (Figure 2). Radiocarbon dating from approximately two meters depth was 8880 ± 50 years BP (Figure 3) (Neves *et al*., 2008).

RESULTS AND DISCUSSION

The new protocol for the collection of concentrated charcoal (Figure 4) encountered among combustion structures during the excavation of archaeological sites (Figure 5) emphasizes the systematization of information that must be carefully recorded in the field so that more in-depth interpretations can arise from its analysis. The protocol requires the researcher to record information grouped into four categories as listed in the table below, which also provides detailed recommendations for completing the protocol and explanations of the nomenclature used. The architecture of combustion structures reveals the spatial distribution of rock fragments of varying sizes and lithic natures together with partially or totally intact wood charcoal, seeds, bones and other traces of animals, which are the targets of various archaeological studies of

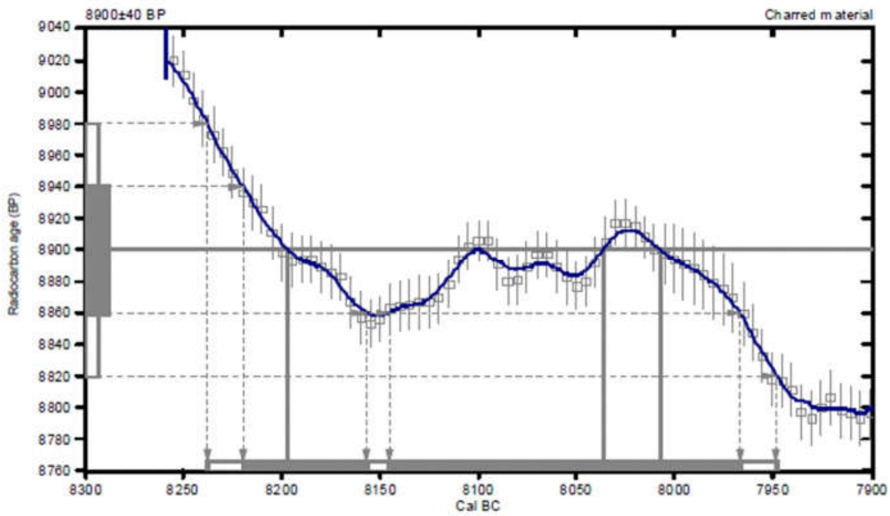
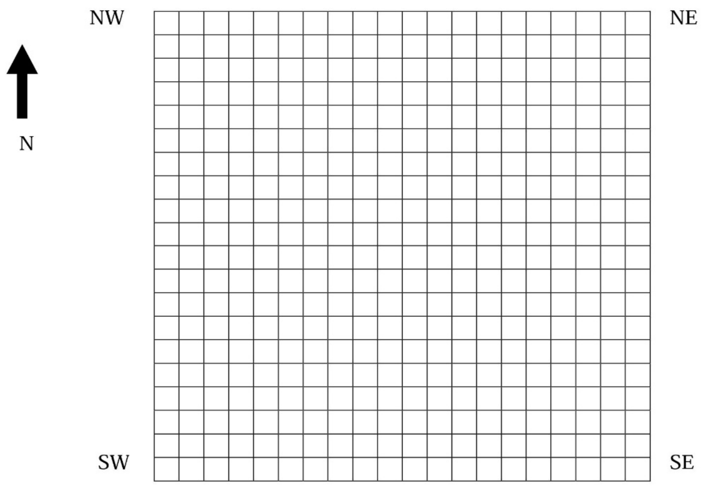


Figure 3. Calibrated radiocarbon age obtained for a combustion structure of the Lapa do Santo archaeological site, *Carste Lagoa Santa*, municipality of Matozinhos, state of Minas Gerais, Brazil

ARCHAEOBOTANICAL PROTOCOL FOR COLLECTING CONCENTRATED WOOD CHARCOAL FROM ARCHAEOLOGICAL BONFIRE

01	**LOCATION OF BONFIRE**	
Archaeological site		
Block	Level	*Fácies*
Quota (center)		
Fácies characteristics	color	
texture	compaction	
02	**CHARACTERIZATION OF BONFIRE**	
Nº	Form ( ) circular ( ) elliptical ( ) irregular	
other form (specified)		
Volume (L)	Total charcoal mass (g)	
Light fraction ( ) mass (g)	Haevy fraction ( ) mass (g)	
03	**MATERIALS ASSOCIATED WITH BONFIRE**	
( ) shell	( ) fauna	( ) fruits and seeds
( ) lithic	( ) rock fragment	( ) bone instrument
04	**SAMPLES**	
Dating	Chemical analysis	
Charcoal reconstitution		Photos



Profile ilustration

	Stratigraphic level

Figure 4. Newly proposed protocol for the collection of concentrated charcoal from combustion structures and recording associated information at Brazilian archaeological sites

Table 1. Recommendations for completion of the newly proposed protocol for collecting charcoal concentrated in combustion structures of archaeological sites

A) Category 1 - Location of Bonfire			
A1	Site		Note the name of archaeological site, its typology and surrounding phytogeographic environment.
A2	Block		Record the block location of combustion structure(s) based on a sketch of the archaeological excavation.
A3	Level		Record the stratigraphic layer (natural or artificial) of the excavation block of the combustion structure(s).
A4	Fácies		The smallest litho-stratigraphic excavation unit (Stein & Rapp, 1985) in which a combustion structure is found.
A5	Fácies characteristics		Since fácies represents an event over time that resulted from the action of transport agents bringing material from similar sources and depositing them on the site, it possesses specific characteristics that must be recorded.
	A5.1	Color	Define the color of the natural sedimentary matrix following Munsell Table Color (Munsell Soil Color Chart, Munsell, 1994), and identify its hue, tonality and intensity.
	A5.2	Texture	Qualitatively determine the granulometry of the sedimentary matrix in which the combustion structure(s) is located.
	A5.3	Compaction	Qualitatively evaluate the presence and level of compaction of the sedimentary matrix in which the combustion structure(s) is located, the presence of concretions and the intensity of possible cementation of the same.
B) Category 2 - Characterization of Bonfire			
B1	Number		Record sequentially the number of excavated combustion structures with reference to the archaeological excavation block in which each is located.
B2	Form		Indicate the shape (circular, elliptical, irregular or other to be specified) occupied by combustion structure(s) in a two-dimensional perspective. Provide scale of the combustion structure(s) in the latter part of this form.
B3	Volume		Give the total volume of collected combustion structure(s), whose resulting material is stored entirety in litter buckets. Measure depth within the stratigraphic layer with a millimeter scale and illustrate the combustion structure(s) in the latter part this form (Figure 5).
B4	Total charcoal mass		Measure and record the mass of recovered charcoal by hand or by sieve (using 5mm mesh) using a precision analytical balance. Next, count the number of charcoal pieces recovered and separate about 100g of sediment from the combustion structure(s) if chemical analysis is desired. Add to the total mass the mass of charcoal obtained by flotation (light fraction + heavy fraction).
B5	Light fraction		Record the mass of concentrated charcoal that floated due to density difference during the flotation technique using a precision analytical balance, and then count the number of charcoal pieces recovered.
B6	Heavy fraction		Record the mass of concentrated charcoal that was decanted due to density difference during the flotation technique using a precision analytical balance, and then count the number of charcoal pieces recovered.
C) Category 3 - Materials Associated with Bonfire			
C1	Shell(s)		Record shell mass using a precision analytical balance and sort and count the number of shells according to species of shellfish present in the combustion structure(s).
C2	Fauna		Record the mass of bones of fauna with the aid of a precision analytical balance and count the number of bones according to species of fauna present in the combustion structure (s). Note the bone color and any traces of burning.
C3	Fruits and seeds		Triage and measure the mass of fruit and seed in natura or carbonized present in the combustion structure (s). Sort by morphological typology.
C4	Lithic		Record the number of arrowheads and other types of artifacts produced from rocks or minerals. Specific analyses of these materials should be made using appropriate of geoarchaeological techniques.
C5	Rock fragment(s)		Record the position, quantity and mass of rock fragment constituents of combustion structure(s). If present, lytic material should be represented in a sketch the combustion structure(s).
C6	Bone instrument(s)		Artifacts made of bone (Figure 5) should be recorded by type, nature and number and evaluated by using appropriate zooarchaeological techniques.
D) Category 4 – Samples			
D1	Dating		Select charcoal with a minimum surface of 1-2 cm for C14 or AMS dating of the combustion structure using. Each stratigraphic layer that the combustion structure penetrates or each new combustion structure found must be dated.
D2	Chemical analysis		Perform laboratory and specialized protocols for the detection of chemical traces to aid in the interpretation of the function of the combustion structure(s).
D3	Charcoal reconstitution		Perform when fragments of large dimensions are found (Figure 5) that allow estimation, with greater certainty, the size of firewood used in combustion structure(s). Charcoal of this category must be packed separately to avoid multiple fragmentation.
D4	Photos		Photography should be used as an inexhaustible method of recording the excavation of the combustion structure and all its components.

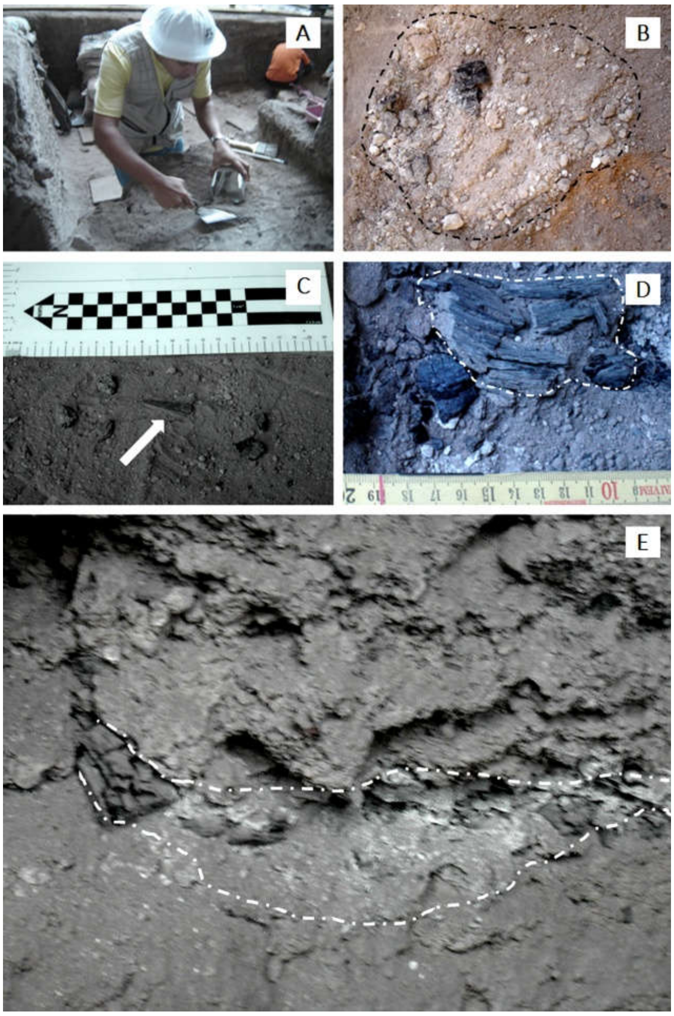


Figure 5. Lapa do Santo archaeological site, *Carste Lagoa* Santa, municipality of Matozinhos, state of Minas Gerais, Brazil. Legend: A – excavation of combustion structure. B - front view of combustion structure (dashed). C - bone tip (arrow) associated with combustion structure. D - large carbon fragment (dashed). E - combustion structure in profile view (dashed line)

ethnology given its immediate association with food preparation (Melo Júnior & Magalhães, 2015). In addition, studies conducted at prehistoric and historical archaeological sites in different parts of the world have found that food preparation is not dissociated from other activities, such as the practice of rituals or heat treatment of raw materials (Gonçalves, 2003; Beuclair *et al*. 2009; Cabral, 2014). On the other hand, although existing and published protocols in specialized literature for Brazilian archaeological sites are important tools for standardizing field methods for the reliable analysis and interpretation in an archaeological context (Scheel-Ybert *et al*., 2005-2006), they are very general and superficial regarding combustion structures and the concentrated charcoal therein. The proposal presented here contributes to the advancement of standardization of field protocols by focusing on charcoal concentrates in combustion structures, the knowledge of which contributes a wealth of information to understanding the food, diet and other practices associated with the way of life of previous populations.

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