21016

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Geoarchaeology and dark earths I

Tuesday 1st July: 08:30 - 10:30
2 hour session: 10-15 minute papers each followed by discussion

Yannick Devos (Universit, Libre de Bruxelles, Centre de Recherches Arch,ologiques)
Manuel Arroyo-Kalin (University of Cambridge)
Cristiano Nicosia (Geoarchaeological and Soil Micromorphological Consultant)

Abstract

Dark Earths embedding archaeological remains have been considered until recently as homogeneous, dark coloured, poorly stratified deposits of rather ephemeral interest for archaeological understandings.

In the last decades, however, geoarchaeological studies have begun to show the enormous potential of studying these soils in their own right. In this session our explicit aim is to assemble researchers of European and Amazonian Dark earths, at first glance completely different types of anthrosols, to share their research experiences. We hope that by comparing different research strategies, new insights will arise to tackle the study of these and other archaeological soils in the future.

We welcome contributions :

* dealing with methodological issues, * examining the role of dark earths in specific landscape histories, and * problematising their position in the soilscape as an integral aspect of archaeological understandings.

Keywords: dark earths, anthrosols, anthropogenic soils, geoarchaeology, palaeopedology, open-air sites

Papers

Terras Pretas and terras mulatas in the central Amazon region: a geoarchaeological perspective
[View Precirculated Paper]
Manuel Arroyo-Kalin

An interdisciplinary study on Brussels' Dark Earth (Belgium)
[View Precirculated Paper]
Yannick Devos, Luc Vrydaghs, Ann Degraeve, Sylvianne Modrie, Christine Laurent

From urban dark earths to land uses at the site of Tours/Saint-Julien (France)
[View Precirculated Paper]
Mélanie Fondrillon

Deep anthropogenic topsoils in Scotland: distribution, character and conservation under modern land cover
Jo McKenzie, Ian Simpson

Dark layers (camadas pretas) over sambaquís: an archaeosedimentary phenomenon of regional extent

Site formation processes at ...
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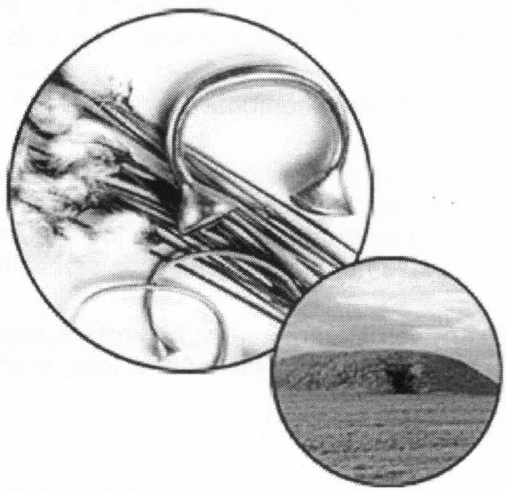
Ximena Villagran, Paulo DeBlasis
Site formation processes at Hatahara and their implications for understanding the archaeology of the central Amazon region
[View Precirculated Paper]
Lilian Rebellato, Eduardo Neves, Wenceslau Teixeira, William Woods
Origin of nutrients in Amazonian Dark Earths as assessed by molecular markers
[View Precirculated Paper]
Jago Birk, Wenceslau Teixeira, Eduardo Neves , Bruno Glaser
Dark earth and land use in Roman and Early Medieval contexts
Richard Macphail

Associated Posters

Dark Earth under the lights of micro-archaeology.
Dark earths in the central-Italian urban medieval context (Florence, Siena): their relation with the cultural and natural historical events.
Efeito da concentração de fragmentos cerâmicos na retenção de água no solo em sítios de Terra Preta de Índio na Amazônia Central
Multi-disciplinary and multi-scalar approach to the study of a medieval occupation deposit from Montegrotto Terme (Padova, northern Italy).
Terras Pretas and terras mulatas in the central Amazon region: A geoarchaeological perspective



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Site formation processes at Hatahara and their implications for understanding the archaeology of the central Amazon region

Lilian Rebellato (University of Kansas)
Eduardo Neves (Museu de Arqueologia e Etnologia, USP)
Wenceslau Teixeira (Embrapa Amazônia Ocidental)
William Woods (University of Kansas)

Abstract

To understand archaeological site formation it is necessary to take into account a wide spectrum of natural and human processes, including intentional and unintentional changes and post-depositional events. Through the Hatahara case study, an archaeological site located in the central Amazon near Manaus, Brazil, it was possible to determine numerous factors that had affected the site's depositional history. Through analysis of the distribution and characteristics of terra preta, terra mulata, ceramics and the topography of this site, it was possible to understand dark earth formation and differential use through time. As a result this investigation opened a new vision about village morphology in pre-European Amazonia. The present work was conducted under the sponsorship of CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brasil).

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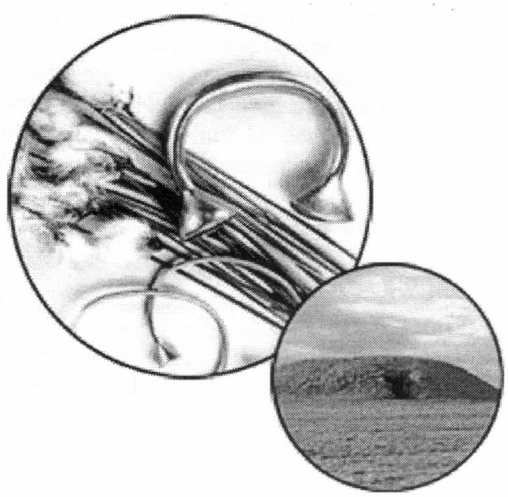

Site formation processes at Hatahara and their implications for understanding the archaeology of the central Amazon region

Rebellato, L.[1], E.G. Neves[2], W.G. Teixeira[3], and W.I. Woods[1]

[1] University of Kansas, Lawrence, KS 66045 (rebellat@ku.edu), USA

[2] Museu de Arqueologia e Etnologia, University of São Paulo, USP, São Paulo, 05508 900, Brazil

[3] Embrapa Amazonia Ocidental, Manaus, AM 69011 970, Brazil

Abstract

To understand archaeological site formation it is necessary to take into account a wide spectrum of natural and human processes, including intentional and unintentional changes and post-depositional events. Through the Hatahara site case study located in the central Amazon near Manaus, Brazil, it was possible to determine numerous factors that had affected the site's depositional history. Through analysis of the distribution and characteristics of terra preta, terra mulata, ceramics and the topography of this site, it was possible to understand dark earth formation and differential use through time. As a result this investigation opened a new vision about village morphology in pre-European Amazonia. The present work was conducted under the sponsorship of CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brazil).

I. Introduction

This paper presents evidence for continuity and change in settlement patterns during the pre European period at the Hatahara archaeological site in the Brazilian Central Amazon. The main goal is to demonstrate new interpretations about cultural changes and the consequences of these in the sequence of village morphologies at the site. Located on the top of a bluff parallel to the Solimões River, the site has natural protection against attack due its 40 m high location and steep scarp that surrounds ca. 60% of the site area. The secure location of the site was enhanced by access to a wide range of resources that allowed the population to survive by fishing, hunting, gathering, and farming. The Hatahara archaeological site is an example of the Denevan's Bluff Model (1996). This model suggests that major pre European settlements in Amazonia were preferentially located on bluffs adjacent to major floodplains, and, consequently, were not subject to the annual floods that cover the lowlands, but still had ready access to the fertile soils of the floodplain and riverine protein resources.

Hatahara contains pottery from four different archaeological phases spanning at least 2,000 years of occupation, but I will concentrate only on the final two occupations: the Paredão phase (ca. AD 800 1200) and Guarita subtradition (ca.1000 1600), both defined by Hilbert (1968). The site presents a complex cultural stratigraphy with deep and extensive black and brown colored anthropogenic soil layers with high and low pottery concentrations, respectively. To understand the Hatahara archaeological site formation and its association with these human made soils termed Amazonia Dark Earths, it was necessary to conduct extensive fieldwork across the site. So far, three field seasons of excavations and other field activities have been conducted.

Research conducted in the Upper Xingu Basin and the Central Amazon has provided archaeological data that associates circular village shape and the presumed Arawak speakers in the pre colonial times. At Hatahara, the physical and chemical soil analyses have since confirmed this association and shown a circular concentration of organic material and black earths surrounding a plaza. Also, this work provided important information about the Guarita, the most recent phase, whose settlement distribution presented a linear shape. This investigation found a positive correlation between the Guarita phase and the Proto Tupian Tradition and was in agreement with

previous research conducted by Lathrap (1970) and Brochado (1984, 1989). In addition, it confirms descriptions made by the first European travelers, who observed a continuous and almost linear occupation along the Amazon riverside in 1542. Porro (1996) associated a linear pattern for this population with an economy basically associated with the water resources, which is completely understandable. Results presented in this paper also furnish one more reason for this shape, namely, better use of the previously formed dark earth soils for food production. Tupian speakers are generally associated with intensive agriculture and as will be shown, the Tupi expansion could also be related with the conquest of territories where these fertile soils were abundant.

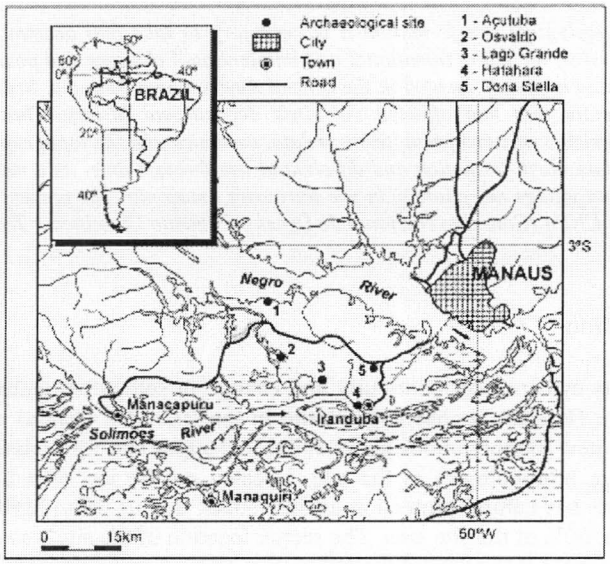

Fig.1. The Hatahara archaeological site is located in the area of confluence between Negro and Solimões rivers

A battery of soil chemical and physical analyses was conducted, this paper will concentrate on some of the soil characteristics identified at the site and correlate them with the pottery distribution. The soil physical analysis allowed the identification of aspects of site formation processes, an interpretation of the use of the dark earths, and the correlation of these soils with different social groups through time. The correlation between the variables topography, pottery, and soil signature allowed the identification of domestic areas, possible agricultural fields, public areas, places of refuse disposal, and other human altered zones through time. More widespread application of this methodology can contribute to the development of an overview of the diachronic, pre European settlement variability and differential environmental management by past societies.

Until now a dichotomous view provided two opposing models concerning the density, size, shape, and duration of Amazonian pre European settlements. One group of scientists believes that environmental conditions in the Amazonian region inhibit the social and cultural development of its populations and posit soil exhaustion and the low available protein as principal limiting factors. The second view presents the Amazon region as a cultural innovation center, especially the Central Amazon, where the oldest pottery was created and the first plant domestication occurred in South America.

Archaeological work carried out by Betty Meggers espoused cultural conservatism as the norm

with the aboriginal village structure and complexity, subsistence patterns, and low population densities of the present serving as a model for the past (Megger 1954, 1971, 1995). Donald Lathrap

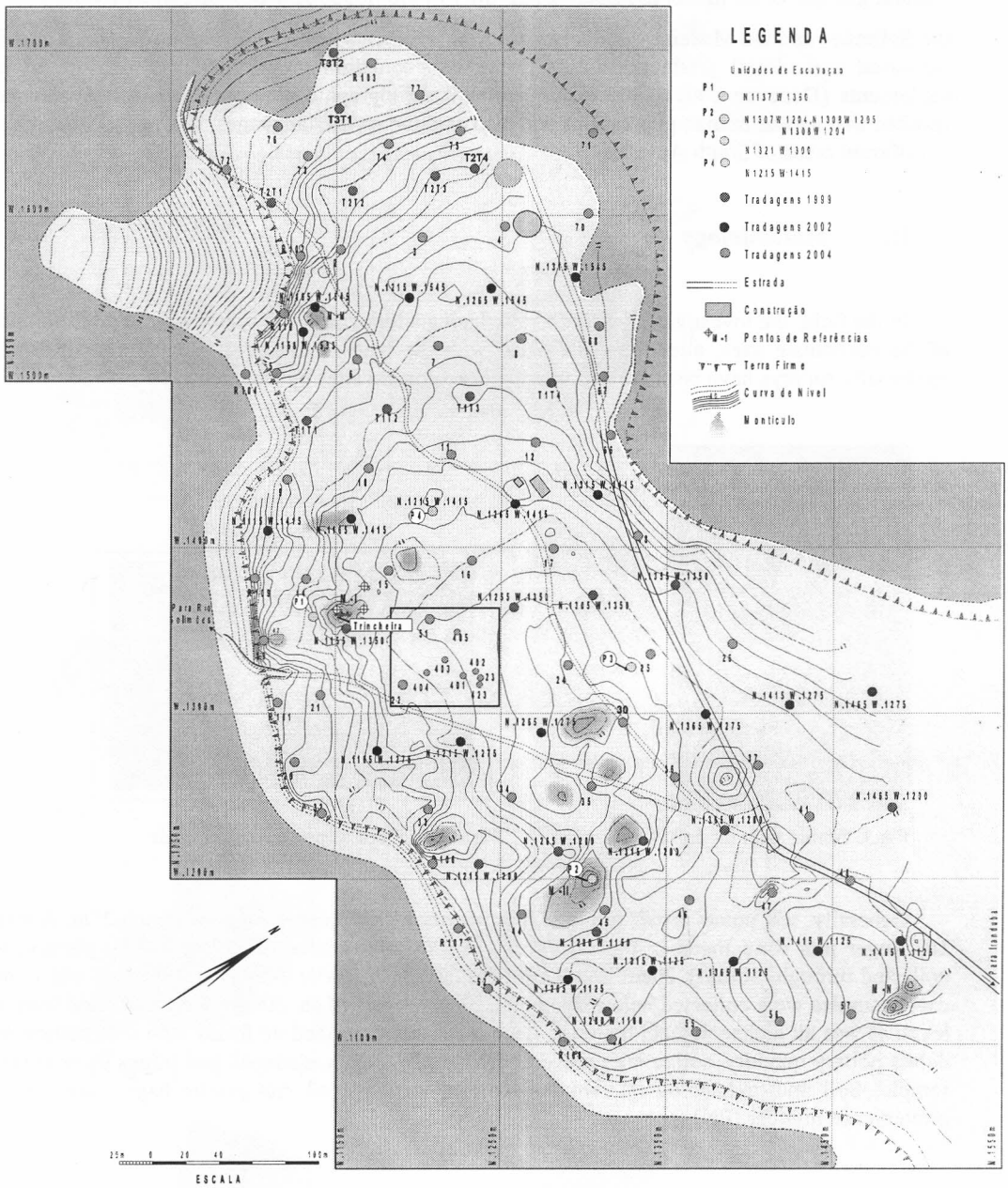

Fig.2. Fieldwork at the Hatahara site. The 103 auger pits are shown in red (recollected in 1999), blue (2002), and black (2004). The yellow indicates units excavated

(1970, 1977) in disagreement, hypothesized that the Central Amazon region was a cultural innovation center. Based on differences between ecosystems found in Amazonia, Lathrap set up distinctions of natural resource availability which caused social and economic differences between cultural groups. In his model the enhanced fertility of the floodplains of white water rivers, such as the Solimões and the Madeira, results from glacial sediments originating in the Andes and provided increased agricultural productivity that promoted population growth and the creation of large settlements (Denevan 2001). Due to the resultant demographic pressure a centrifugal movement resulted that spread human populations and also ceramic styles, languages, and agricultural systems to different areas of South America.

II. Methodology

In the field, the investigation included emplacing a topographic network with intersection points of the coordinate axes, already consolidated with the help of total station surveying instrument. Systematic surveys have been done at many archaeological sites by the Central Amazon Project.

Fig.3. Picture with the soil sample

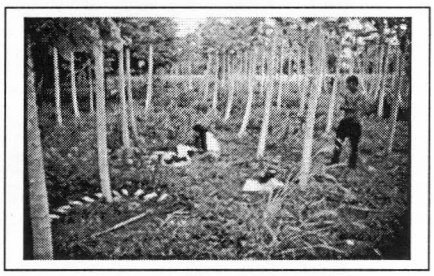

Fig.4. Recollection process and records

Generally, test points are determined in transects which receive auger pits each 25m. A total of 103 auger pits were made in the Hatahara site. Soil and artifact samples, mainly pottery, were collected through arbitrary 20cm levels until the culturally sterile subsoil was reached and in many cases samples were collected below this point. Soil samples of ca. 300gm were collected from each level, as was all archaeological material. Each level was described on forms with information about debris pottery quantity, soil texture and color (Munsell), bones, charcoal, and lithics presence in the sample. Soil and archaeological remains samples were placed into plastic bags, each one with provenience number (PN).

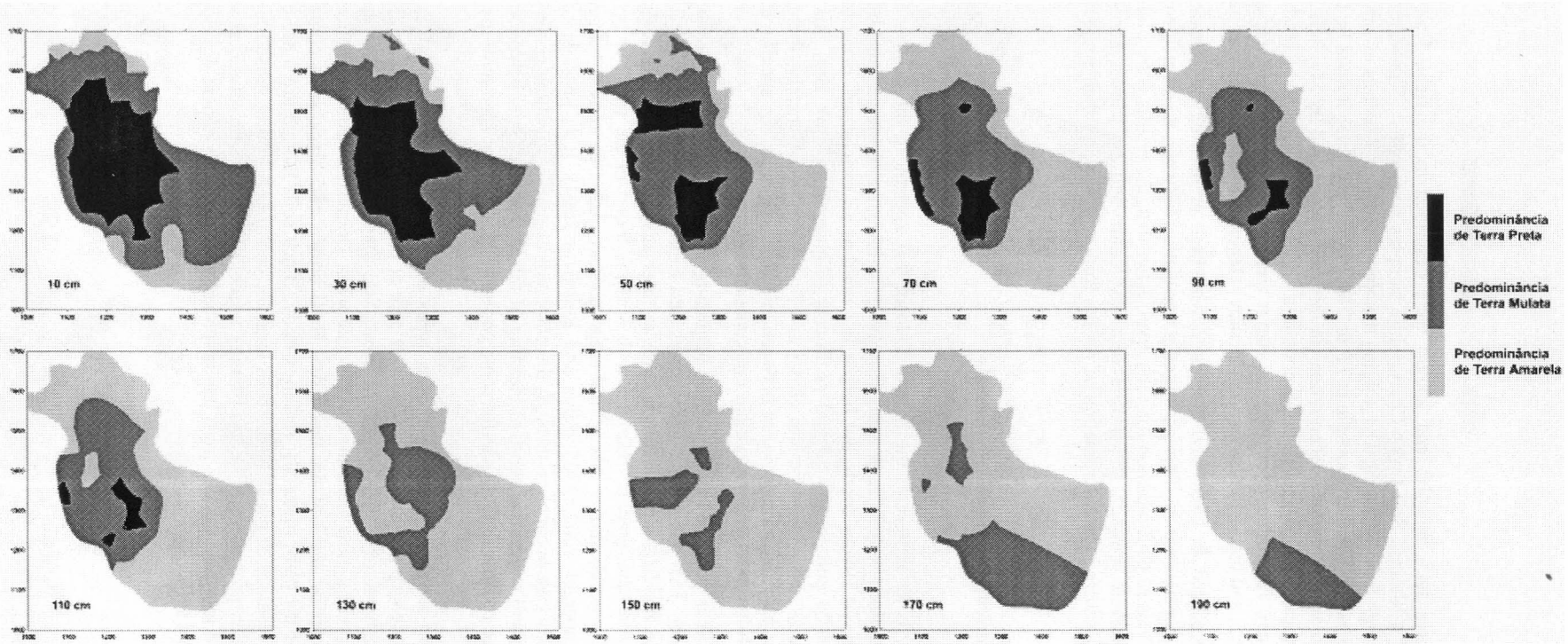

Fig.5. Hatahara site soil color distribution. Soil color behavior through the artificial levels.

Physical soil signatures such as color and texture were described in the field. Color was described with the aid of a Munsell Soil Color Chart, while samples were moist. The texture was estimated in the field through hand texturing and judging the approximate proportions of sand, silt, and clay. Nevertheless, to assign whether a sample is TP or TM, beyond its color, it must be further analysed for features such as phosphorus concentration (in this case determined by Mehlich 3) and the quantity of archaeological remains, that is, ADE contain a high levels of both and TM shows a lower concentration of them. To produce the soil color map it was necessary to merge chromas into three colors: yellow, brown, and black. In this way, each color category had specific characteristics.

Color results were recorded in Excel and compared with both archaeological remains and phosphorus and calcium concentrations. This permitted a correlation between these elements and the establishment of intervals of concentration for each level. After that, the results were plotted on a map, showing its behaviour through the profile (but just color will be shown here). The softwareused (Surfer 7.0) allowed the extrapolation of results from samples and their projection to nearby areas.

II.I. Soil and the chemical and physical analysis

In Figure 5 the yellow color represents the natural Latosol that appears in the deepest layers, where the anthropic interactions were little or none. However, the brown coloring can also be deep, as shown in the East Zone at 190cm depth; but here it is treated as an exceptional occurrence, a natural A horizon buried by subsequent cultural sediments (Figure 5, 190cm). But, this same argument can explain the brown soil in the site center at 170-150cm; unfortunately, there is no pottery in these levels that provides an association between this phenomenon and a specific cultural group. So, further research has to be done to explain this conclusively.

At the 130cm depth, it is possible to observe the beginning of a circular area of brown earth surrounding a yellow center. This phenomenon reaches its best expression at 110cm with its shape more clearly outlined and the first signs of black earth at three distinct points. This suggests a positive correlation between ethnographic examples with remains found in the site. For instance, some ethnoarchaelogical research shows that public areas such as plazas in current villages are constantly swept (Heckenberger 2002, 2005; Silva and Rebellato 2004). It is possible to infer similar behavior during this past occupation through the color soil results. The yellow center in the site surrounded by brown soil suggests a constant cleaning of this area. This social behavior slows down the soil color change process in the plaza for some period so that it is not seen until the 90cm depth.

The next level (70cm) shows an increase of both types of ADE; for instance, TM expands toward the central and periphery and the TP increases its area at the same three points until 50cm depth when there is a high increase of ADE in the west. Soil mapping shows another possible correlation with past and present, now associated with waste areas. Domestic waste production from a sedentary occupation can be the key for this issue. Both brown and black soils come from incomplete combustion of the plant materials, mainly woody. Black soils though are more closely associated with charcoal resulting from domestic fires used for cooking, repelling mosquitoes and animals, firing pottery, other processing, and also burning miscellaneous organic refuse, as well as depositions of organic and inorganic wastes from habitation activities and subsequent development of biota within the enriched soils.

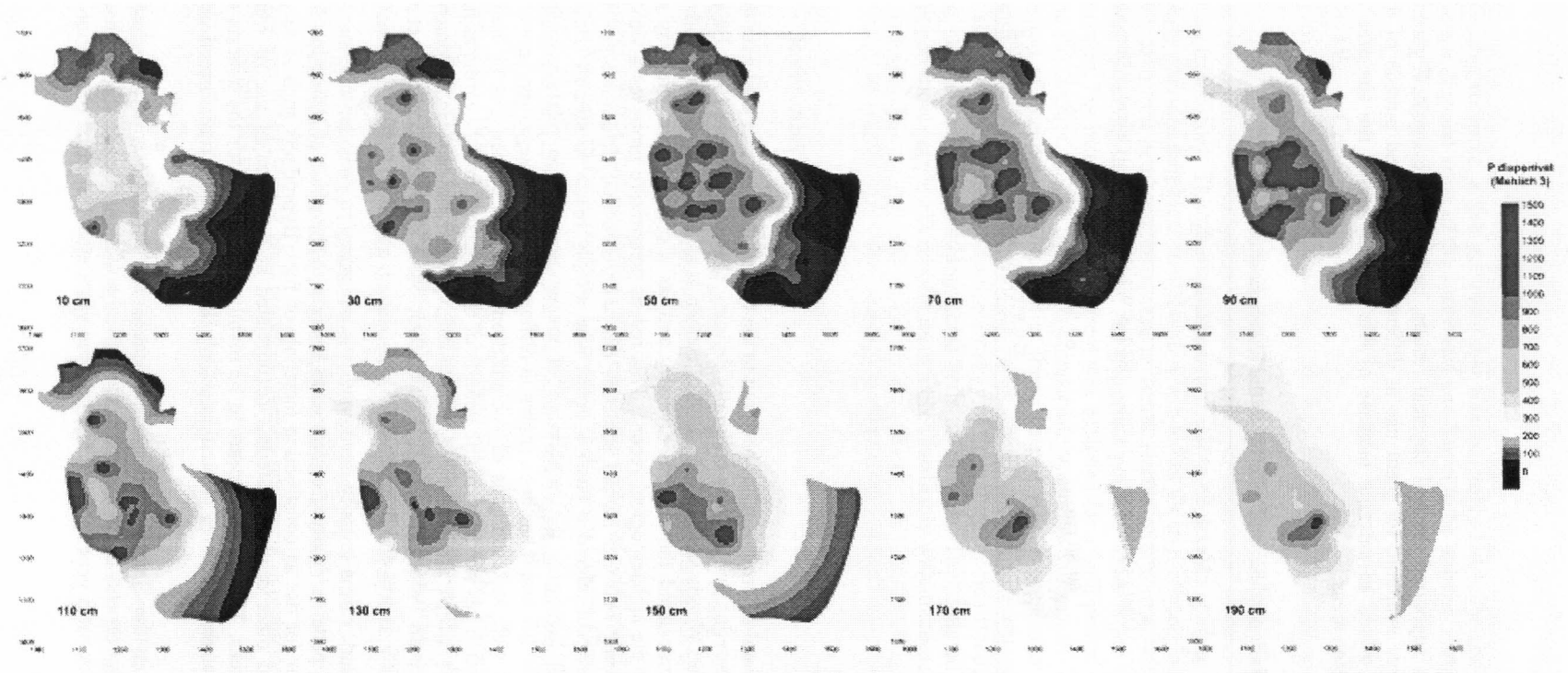

Fig.6. Available phosphorus concentrations. Observe the circular village shape and disposal areas in red, with high level P concentrations and a sudden change in this pattern in the last 10cm.

The phosphorus analyses supported the soil physical results, as is possible see in Figure 6. Table 1 shows the phosphorus available for plant use at different points in and outside of the Hatahara site. It is possible to see an amazing increase of this element within the site area in comparison to the non habitation areas.

Table 1. Phosphorus concentration within and exterior to the Hatahara site.

Phosphorus Quantity (mg/kg ^{1})	Max.	Med.	Min.
Sampling location	N1155 W1350	N1315 W1415	Outside of the site
Level	60 80 cm	60 80 cm	60 80 cm
Concentration	1521 mg/kg ^{1}	356 mg/kg ^{1}	1,71 mg/kg ^{1}

Source: Rebellato 2007

III. A New Perspective

For some time environmental determinism has been put to the test by theories that deal with the environment as a social construction and not as a culturally defining element (Descola 1986; Balée 1989 Heckenberger et al. 1999; Woods and McCann 1999; Petersen et al. 2005). These two models represent distinct ways to understand the cultural diversity and, as a consequence, the way of interpreting the variability of the archaeological record. This recent perspective proposes a vision that goes beyond the dichotomy between human societies *and* environmental determinism - in which the human being is not considered a passive agent who simply reacts to stimuli (Balée 1989:2). Thus, this approach highlights the importance of the environment in relation to the structuring of indigenous social life and it has been shown in different forms of integration between society and environment, as well as techniques of socialization of nature carried out by these individuals. This new perspective has put forward the genesis of the Amazonian dark earths as the mark of the cultural changes which are associated with intensive environmental management, including agriculture e.g. Denevan 1966, 1976, 2001; Woods 1995; Balée 1989; Heckenberger et al. 1999; Woods and McCann 1999; Neves and Petersen 2005).

To understand how the dark earths initially developed it is necessary to consider subsistence practices and refuse disposal patterns. Many products were brought to the place of habitation for direct consumption as food or for use as construction materials or fuel. Byproducts such as feces and urine, charcoal, ash, and other organic materials accumulated at the locus of use or were disposed in specific waste areas. This refuse appears to be mainly responsible for the genesis of these distinctive anthrosols at the places of habitation. Only later were they transformed and utilized for food production.

The empirical results from the Hatahara site compare favourably with the widely accepted scenarios for dark earth formation and use. Physical and chemical soil signatures at the Hatahara site show a long period of dark earth genesis and a few hundred years after the initial occupation a

valuable resource, a rich anthrosol that was extremely fertile for agricultural use, developed in the former disposal areas of the settlement and began to be utilized. How is this demonstrated through the archaeological research?

IV. Conclusion

This paper has described distinct aspects of the Hatahara archaeological site. Through an interdisciplinary investigation it was possible to understand some of the occupational dynamics of the site's history. Though more research needs to be done to confirm some of the conclusions, this study provided empirical results with which to test theories concerning the settlement of the site and will lead to a better understanding of issues related with formation processes and use of the site area, including the dark earths. An important point to stress is the connection between divergent theories. For instance, the settlement was occupied for a long period during the Paredão phase and the structure of this occupation is comparable to current villages in Amazonia, except for the long period of occupation. The Guarita linear shaped village occupation is more consistent with the settlements present on the Amazon bluffs when the Europeans arrived. These agricultural societies maintained the earlier production strategy of exploiting the rich floodplain soils, but also developed an intense use of the anthropogenic soils on uplands. This coupled agricultural base could both support more people and support them more sustainably with decreased risk.

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