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2018
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http://hdl.handle.net/10138/327072
Saunaluoma, S, Pärssinen, M & Schaan, D 2018, 'Diversity of Pre-colonial Earthworks in the Brazilian State of Acre, Southwestern Amazonia', Journal of Field Archaeology, vol. 43, no. 5, pp. 362-379. https://doi.org/10.1080/00934690.2018.1483686

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Journal of Field Archaeology

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--Manuscript Draft--

Manuscript Number:	JFA401
Full Title:	Diversity of Pre-colonial Earthworks in the Brazilian State of Acre, Southwestern Amazonia
Article Type:	Unsolicited Original Research Paper
Keywords:	Amazonia; Acre state; terra firme; earthworks; landscape archaeology
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Abstract:	Amazonian earthworks, which are an important testimony to ancient anthropogenic landscape modifications, have a significant variety of structures and sizes, and are found in different geographical and ecological locations that indicate separate time periods, distinct cultural affiliations, and diverse purposes. We introduce data from diverse archaeological earthwork sites, geoglyphs, mound sites, and walled enclosures, situated in the interfluves of the Purus River in the Brazilian state of Acre and propose a type definition for these sites. The profuse anthropogenic landscape features and their associated material culture indicate considerable human-induced environmental alterations and diverse earthworking traditions that are characteristic of the region of eastern Acre from at least ca. 2000 B.P. onwards.
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Funding Information:	Suomen Akatemia (253689)	Martti Pärssinen
	Alfred Kordelinin Säätiö	Dr. Sanna Saunaluoma

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Diversity of Pre-colonial Earthworks in the Brazilian State of Acre, Southwestern Amazonia

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Amazonian earthworks, which are an important testimony to ancient anthropogenic landscape modifications, have a significant variety of structures and sizes, and are found in different geographical and ecological locations that indicate separate time periods, distinct cultural affiliations, and diverse purposes. We introduce data from diverse archaeological earthwork sites, geoglyphs, mound sites, and walled enclosures, situated in the interfluves of the Purus River in the Brazilian state of Acre and propose a type definition for these sites. The profuse anthropogenic landscape features and their associated material culture indicate considerable human-induced environmental alterations and diverse earthworking traditions that are characteristic of the region of eastern Acre from at least ca. 2000 B.P. onwards.

KEYWORDS: Amazonia; Acre state; terra firme; earthworks; landscape archaeology

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Introduction

An important testimony to ancient anthropogenic landscape modifications includes earthworks, many of which are still clearly observable today, even centuries after their abandonment. In archaeological science, earthworks are understood to be artificial landforms composed of fine-grained soils dug up and/or piled on the ground surface. Earthworks can intrinsically be recognized as archaeological features, or they may contain separate features within and/or underneath their surfaces. The array of different types of archaeological earthworks typically comprises mounds, platforms, embankments, roads, causeways, ditches, canals, and raised fields.

Monumental earthwork constructions, such as ditched and walled enclosures and barrows of the Neolithic and Bronze Age Europe (Bradley and Fraser 2010; Midgley 1985; Valera et al. 2014; Varndell and Topping 2002), as well as ancient ceremonial mounds and enclosure complexes built in southeastern North America (Abrams 2009; Carr and Case 2005; Jones and Shields 2016), are well-known examples of earthwork-building traditions that resulted from long-standing community labor. These massive anthropogenic landscape modifications, which were meant to be places of gathering and feasting in connection with the sacred land, are an important demonstration not only of human impact on the environment, but also of past human behavior, which includes the inscribing of native knowledge in the landscape.

In Amazonia, earthwork engineering appears to have been a widespread cultural tradition from the Andean piedmont to the coast of the Guyanas and Marajó Island in the Amazon estuary, extending north to the Venezuelan Llanos and south to the Upper Xingu region and the Bolivian Llanos de Mojos. The scope and implications of the archaeological earthwork phenomenon have been the topics of many studies (e.g., Denevan 1966; Erickson 2006; Heckenberger et. al 1999; Lombardo and Prümers 2010; Moraes 2010; Plafker 1963; Prümers 2014; Pärssinen et al. 2003; Roosevelt 1991; Rostain 2010; Salazar 2008; Schaan 2012; Schmidt et al. 2014; Spencer and Redmond 1992; Walker 2011), which have demonstrated that Amazonian earthworks have a significant variety of

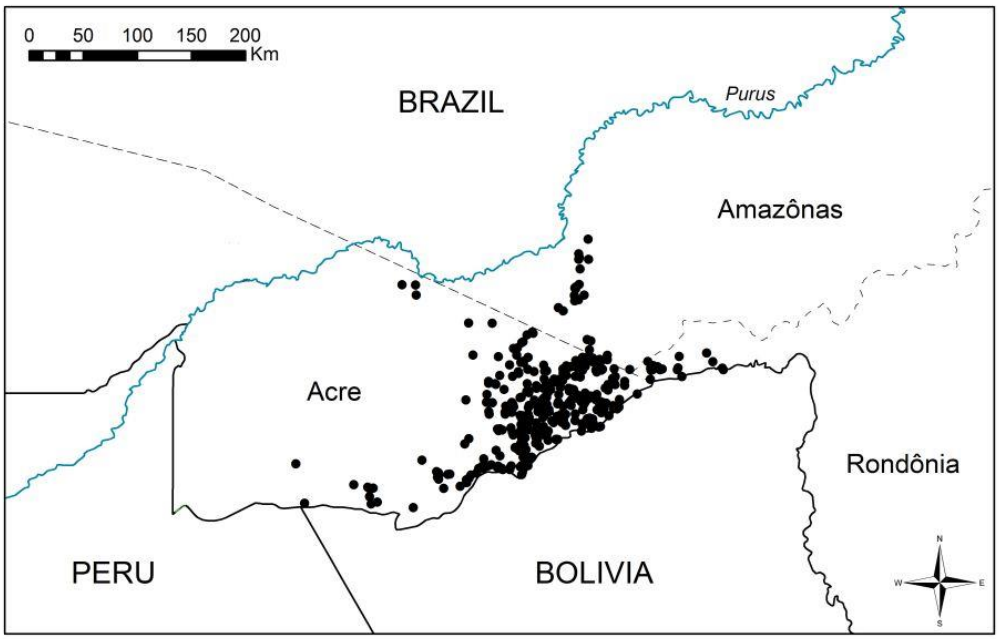
structures and sizes, and they are found in different geographical and ecological locations, that indicate separate time periods, distinct cultural affiliations, and diverse purposes. Additionally, in some cases, the significance of an earthwork may be much more complex than its being a mere representation of functional architectural compounds (Virtanen and Saunaluoma 2017).

In this article, we introduce data from six diverse archaeological earthwork sites situated in the interfluves of the Upper Purus River in the east of Brazilian state of Acre. This new information calls for a more precise categorization of the region´s earthworks: the aim here is to establish a type definition for Acrean earthwork sites, that will serve archaeological description and interpretation, and which is essential for communication between scholars. Because the ditched geometric earthworks, or Geoglyphs of Acre, have been included on the Brazilian State Party's Tentative List as a property considered to be a site of cultural heritage of outstanding universal value and suitable for inscription on the World Heritage List (UNESCO World Heritage Centre 2017), it is even more important to ensure that the region's archaeological sites and earthworks are identified in a coherent, consistent way. Our data from topographic surveys, 14C measurements, and excavations clearly demonstrate the temporal, structural, and functional differences between the sites and between different earthwork types.

Acrean Landscapes of Persistence and Change

During recent years in Acre state (FIG. 1) and, to a lesser degree, in the states of Amazonas and Rondônia, hundreds of ditched geometric earthwork complexes dispersed on the well-drained interfluvial plateaus of the Purus and Madeira river tributaries have been recorded (Dias and Carvalho 1988; Pärssinen et al. 2009; Saunaluoma 2012; Saunaluoma and Schaan 2012; Schaan et al. 2010, 2012). These sizable pre-colonial earthwork sites, which are labelled the Geoglyphs of Acre, are made up of continuous ditches of different geometric shapes (mostly circles and squares) and varying sizes, in association with exterior embankments enclosing areas which usually range between 1 and 15 hectares. The earthworks situated at the same site are frequently connected by ancient roads, which are delineated by low earthen banks and eventually link the earthworks to the nearby

streams. The Acrean geoglyphs are located at 135–280 masl, on elevated yet level terrain, with a good view of the surrounding landscape. Apparently, they were constructed not only as places to obtain complete visible control of the surroundings, but also as monuments to be seen and recognized from a considerable distance.



Today, approximately 50% of the lowland rainforest in eastern Acre is logged and most of the earthworks are found in the deforested areas used for cattle ranching or agriculture. The region´s vegetation structure is characterized by patches of bamboo-dominated (*Guadua* sp.) forest (Silveira et al. 2008) and an abundance of Brazil nut (*Bertholletia excelsa*) trees (Mori and Prance 1990). A recent paleoecological study (Watling et al. 2017) proposes, that already during the initial earthwork construction phase the region's forests were actively anthropized, but that only small-scale forest clearings were made to build the geoglyphs. A forest inventory carried out at a square-shaped geoglyph, today totally under forest cover, revealed that the sumptuous vine forest that currently grows atop the earthwork comprises a high density of palms and wild bananas,

which reflects past human influence in the area (Balée et al. 2012). Furthermore, McMichael and colleagues (2014) find an association with geoglyphs and bamboo forests, and they state that the geoglyphs were constructed near the edges of the *Guadua* forests, because after patchy, en masse bamboo die-off events forest clearing was much easier than in closed-canopy forests.

The period of intensive construction and use of the Acrean geoglyphs, which had been established predominantly for ceremonial purposes, spans a time-period of approximately 200 B.C.–A.D. 900, while the initial establishment of earthwork architecture in eastern Acre probably commenced some 1000 years earlier (Dias 2006; Nìcoli 2000; Saunaluoma and Schaan 2012; Schaan et al. 2012). The period of uninterrupted use of individual sites varied between 200 and 500 years. It seems, as was to be expected, that the more extensive and complex sites were used for longer periods than many of the smaller sites. The 14C measurements indicate gaps in the depositional record of certain sites (Saunaluoma and Schaan 2012), however, this may well only be the result of a bias created by insufficient sampling and they should be verified by more comprehensive chronological intra- and inter-site testing. The decline of the geoglyph tradition likely began during the eleventh century A.D. Nevertheless, the date cal. A.D. 1229–1386 (Pärssinen et al. 2003) suggests that the vast Fazenda Colorada site, which covers an area of approximately 10 hectares, continued to be used. However, it is uncertain whether the most recent occupation at the site was actually that of the original geometric earthwork tradition or that of another group that utilized the site for purposes (such as dwelling) other than those of the site's initial builders.

The interpretation of these geoglyph sites as being principally ceremonial in nature is based on the characteristics and distribution of cultural deposits at the sites, and on the monumental scale and the repetitive stylistic complexity of the earthworks. The sites are located in areas without evidence of ADE (Amazonian Dark Earth)[1], which is often considered to be one of the most convincing indications of long-term sedentism in tropical lowlands (e.g., Woods et al. 2009). The sparse archaeological material is mainly concentrated in the embankment and ditch structures, while the flat spaces enclosed by these formations are void of cultural residue. Clearly identifiable residential layers or burials have not been

encountered to date. Some of the discarded sherds found in the ditch slopes appear to be in secondary locations, most likely having ended up there as a result of periodic site maintenance. The most elaborate ceramic material was intentionally deposited in those parts of the ditch bases closest to the entrance of the enclosure, and in special features, such as a small artificial mound formation documented at the Fazenda Atlântica site (Saunaluoma 2012), which suggests a votive function of these contexts.

[1] The soils in eastern Acre are mainly acrisols, with some areas of latosols and luvisols (Ferreira do Amaral et al. 2013).

In the course of the field surveys conducted at the geoglyph sites, other types of archaeological sites were documented, including sites consisting of artificial earthen mounds arranged around a circular open space with several straight road structures radially entering the circle, as well as sites comprising simple circular embankments with walled entrance roads. At first, these structures were also classified as geoglyphs; however, through recent fieldwork in Acre, it has become clear, as will be discussed below, that they represent distinct types of archaeological sites, with dates, features, and material culture that differ from the geoglyphs, and imply more sedentary occupations. A small number of late pre-colonial urn burial sites within embankment structures has also been reported in Acre (e.g., Nícoli 2000). In addition to earthwork sites, some ceramic occurrence sites have been listed for Acre state in the Brazilian National Register of Archaeological Sites.

Although the ceramic collections of the earthwork sites correspond to the general description of the Quinari tradition, which was established for the region by Ondemar Dias (2006), minor attributes of the pottery indicate considerable local variability (Nícoli 2000; Latini et al. 2001). Undecorated utility ware, which represents the majority of the ceramics recovered at the sites, is fragmented, and the potsherd surfaces are eroded. However, red and brown slips are perceptible on some sherds. Charcoal and *caraipé* (siliceous tree-bark ash) are the most common tempering materials, and hematite, grog, and sand tempers were often used as well. Many vessels were formed by coiling, and air bubbles and dark

cores were frequently found. The collected sherds suggest mostly globular and direct vessel body forms. The decorated pottery is of better quality, harder, and evenly colored. The body walls are generally thinner, and ceramic fragments reveal open forms. The decoration mainly consists of incisions in parallel horizontal lines, which are often executed on the rims. Curvilinear and stepped incisions and finger-nail incisions also occur, but to a lesser extent, as do painted sherds.

Most of the earthwork sites in Acre have been identified by aerial photography and high-resolution satellite imagery (see Ranzi et al. 2007; Schaan et al. 2010) within the deforested areas. New sites are constantly discovered as the satellite imagery coverage of the region improves and the size of the deforested areas increases; thus the numbers of known earthworks and the extent of their area of occurrence are constantly increasing and changing. Until now, approximately 450 geoglyphs and 15 mound sites have been recognized in eastern Acre. However, only the use of a LiDAR application will adequately resolve the question of the total number and attributes of the region´s archaeological earthworks. Even so, novel remote sensing techniques will not entirely substitute ground surveys for the conclusive identification and categorization of the sites.

Earthworks of Bolivian Amazonia and Upper Xingu

The southern neighboring region of Acre, in Bolivia, comprises the lowland rainforest area in the departments of Pando and Beni, where ancient earthwork sites have been documented on the terraces of the Orthon River and in the vicinity of the town of Riberalta (Arellano 2002; Arnold and Prettol 1988; Saunaluoma 2010). These earthworks typically consist of large, irregularly circular ditches enclosing habitation sites, and canal systems connecting different waterways, such as the main river with a minor watercourse. The earthwork tradition prevailed in the Riberalta region from approximately 200 B.C. until the period of European contact (Saunaluoma 2010). The Riberalta earthworks appear to have had diverse and practical functions, demarcating and at the same time protecting occupational areas, as is indicated by the evenly dispersed cultural deposits inside the enclosed areas. They are much simpler in outline than

those studied in eastern Acre, and certain structures, such as the distinctive external embankments along the ditches, and the roads connecting separate earthworks situated at the same site, are absent. Furthermore, the earthworks are not located on the interfluvial uplands, but on high river bluffs or just few kilometers from the main rivers. Nevertheless, the coverage of the still-preserved rainforest in the northern Pando department undoubtedly conceals abundant earthwork sites, of which at least the ones in the proximity of the Brazilian border likely encompass geoglyph types.

The vast seasonally flooded tropical savannas of Llanos de Mojos in northeastern Bolivia were actively domesticated, and gradually resulted in highly structured engineered cultural landscapes (Erickson 2006). Different types of raised fields, canals, causeways, and mounds in this region date to ca. 800 B.C.–A.D. 1600 (Walker 2008a). Archaeologists have divided Llanos de Mojos into different sub-regions, based on differences in the anthropogenic alterations of the landscape and earthwork engineering (Lombardo et al. 2015:Fig.1; Walker 2008b). In the northwest, extensive raised platform field systems, built to produce a variety of cultigens, as well as less formalized ring ditch sites, surrounded by extensive ditch systems enclosing the occupations, typify the earthwork landscape (Lombardo 2010; Prümers 2014: Walker 2008a). The earthworks in the northeast, in the region of Baures, comprise single ring ditches, as well as a variety of causeways and fish weirs (Erickson 2010). The south features monumental habitation mounds (some of which contain several burials and highly elaborate ceramics) which are integrated into earthwork compounds that include canals, causeways, and several types of raised and ditched fields (e.g., Nordenskiöld 1913; Dougherty and Calandra 1981–1982; Erickson 1995; Erickson and Balée 2006; Lombardo et al. 2015; Prümers 2009).

Although in some cases the earthworks of northern Llanos de Mojos bear the closest similarity to the Acrean geoglyphs, in terms of the construction techniques and the layout of the single ring ditches, they are likely a product of a different archaeological culture. These earthworks lack the geometric precision of the Acrean geoglyphs, and exact square shaped ditches, embankment structures, and straight roads to connect the adjacent ditched earthworks have not been

reported. The earthwork sites of the northwestern Bolivian lowlands resemble more the ditched sites documented in Riberalta and along the Orthon River. Just as in these regions, at the sites of Santa Ana de Yacuma and Baures cultural material is found dispersed inside of the spaces enclosed by the ditches, and the ceramic assemblages of the excavated ditch sites differ from the ceramic styles common to eastern Acre (Jaimes Betancourt 2016; Prümers 2014). Although the Baures earthworks may have served various functions, such as elite residences, cemeteries, ritual spaces, and special gardens, they are interpreted to have been constructed mainly for defensive purposes, as they enclose occupational areas (Erickson 2010).

Previously, archaeological circular, or ring villages have been considered to be typical of late pre-colonial central Brazil and the Upper Xingu region in southern Amazonia, and some have also been documented in central Amazon. However, certain regional differences are evident. The domestic areas of the central Brazilian ring villages, which are indicated by circular or oval patches of cultural debris with hearth features, form a circle, or two concentric circles, 100–560 m in diameter (Wüst and Barreto 1999). In the Xinguan villages, the residential unit areas were kept clean by depositing cultural debris behind the houses and along the roads connecting different activity areas, thus gradually creating elevated midden features, or middenscapes (Heckenberger et al. 1999; Schmidt et al. 2014). The mounds of the central Amazon sites were formed on top of the raised platforms for the construction of the housing units (Moraes 2010), or they were built by piling up layers of fragmented pottery and anthrosols (Machado 2005).

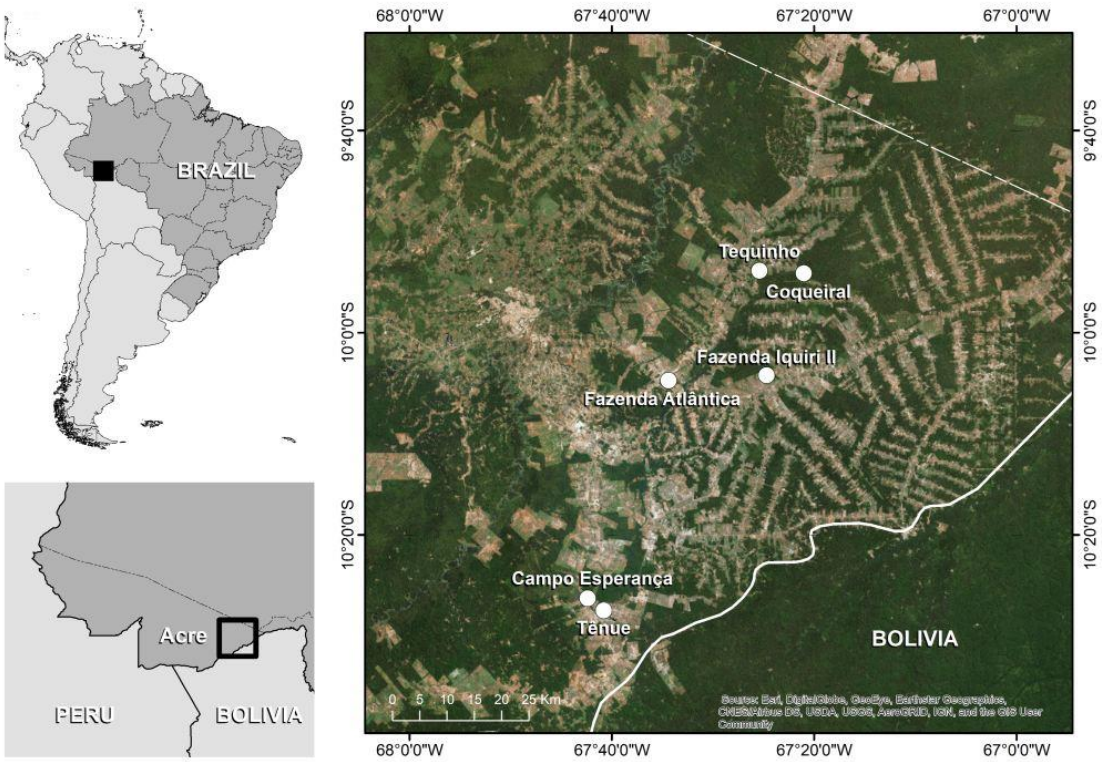
The Upper Xingu region´s archaeological circular plaza villages were interconnected by well-planned road networks that ran between clustered settlements and other activity areas (Heckenberger et al. 2008). Several types of roads have been identified in the region, which were formed by repeated movement along the trails and through an accumulation of refuse and underground vegetation along the road edges (Schmidt 2012). Defensive ditches surrounded the settlements, and linear mound curbs around plazas and along road edges defined the layout of the villages. The mound features were an outcome of construction and maintenance activities, and of refuse disposal in

middens in determined locations, which consequently demarcated the domestic and public spaces (Schmidt 2012).

In addition to the Acrean mound sites, the Bolivian El Círculo site provides evidence that circular villages also existed in southwestern Amazonia during the late pre-colonial period. El Círculo, which is situated in the Riberalta region on an ancient river bluff, features a circular embankment 350 m in diameter with an entrance facing the old channel of the Beni River (Saunaluoma 2010). Several mounds measuring 10–18 m in diameter and 1.5 m in height are attached to the inner side of the embankment. Cultural material is concentrated in the mounds and embankment structure, while the area enclosed by the earthworks is almost devoid of archaeological vestiges. The *caraipé* tempered, painted pottery of the El Círculo site differs from other ceramic assemblages of the Riberalta region. The obtained 14C dates indicate that the occupation of the site lasted from A.D. 1277 to A.D. 1446.

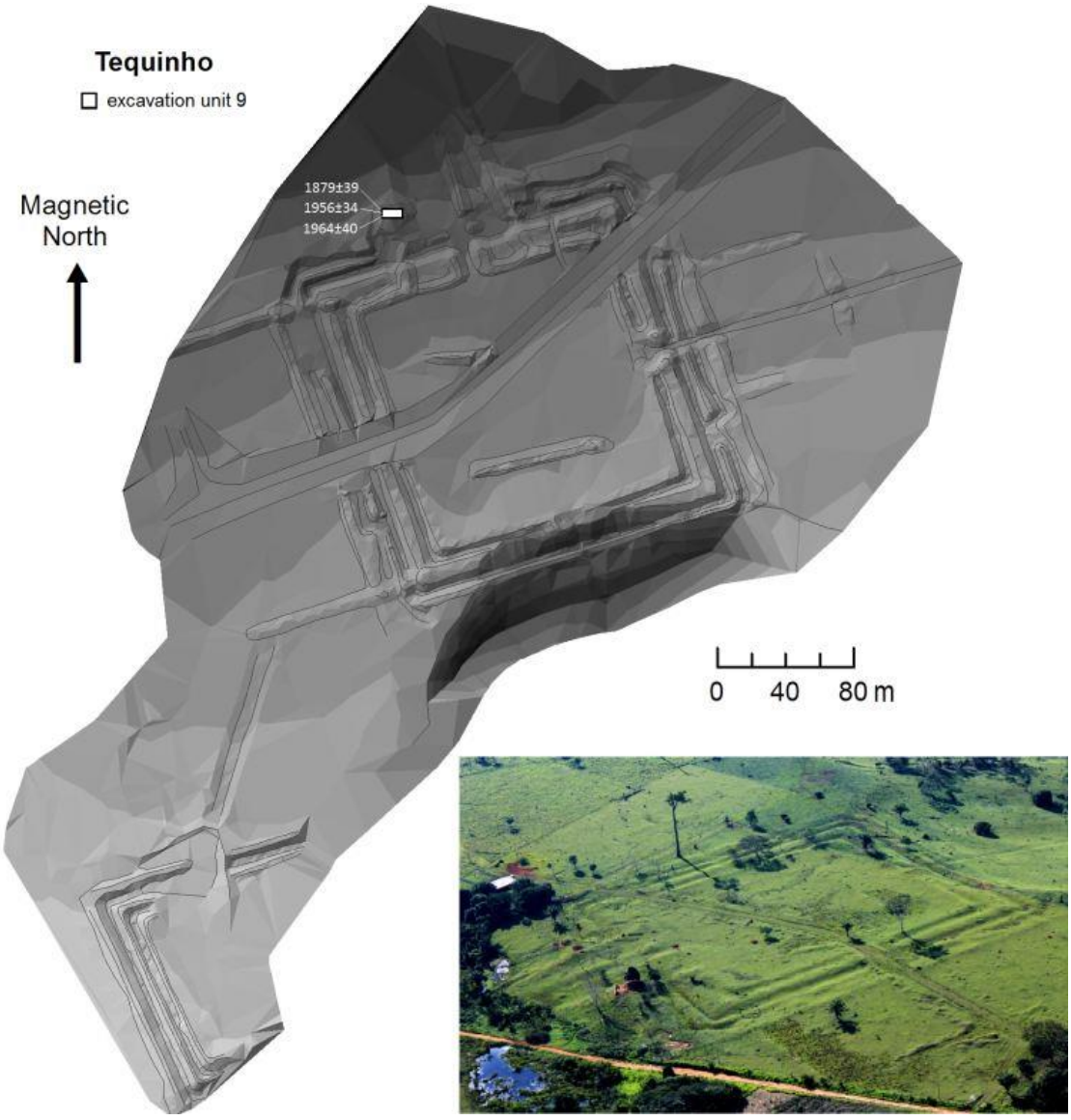
Archaeological Earthwork Surveys in Acre

To exemplify in greater detail the scale of the diversity of the earthworks and their associated features, we present the results of the field research that was recently conducted at six archaeological sites (Tequinho, Fazenda Atlântica, Fazenda Iquiri II, Coqueiral, Campo Esperança, and Tênue) in eastern Acre (FIG. 2), and we discuss the modes of their ancient use and related cultural implications. Topographic mapping of the sites and measuring of the visible earthworks was conducted on-site using total station documentation. During the fieldwork periods from 2007 to 2014, ceramic, soil, and radiocarbon samples were collected from trial excavations, which were carried out in 1 m² units with 10 cm artificial levels. Tequinho and Fazenda Atlântica are examples of classic geoglyph complexes, the Fazenda Iquiri II site features circle of mounds and a simple geoglyph, and the rest of the sites comprise different types of mound and embankment structures.



Tequinho

The Tequinho site, which once covered an area of approximately 15 hectares, is located 2 km to the right margin of the Iquiri River in the geometric earthworks´ core area. The site consists of concentric square-shaped ditches with contiguous external embankments, the remains of rectangular walled enclosures, and linear roads (FIG. 3). The site's earthworks are partially affected by recent land-use and its southern side is damaged by a natural landslide. The main square has three concentric ditches, of which the outer trench measures 210 m x 210 m. Today, the depth of the ditches varies between 0.40 m and 1.10 m. In the center of the main square are found remnants of a rectangular embankment. Another square that is formed of two concentric ditches is located approximately 150 m south, half of which has been destroyed by a landslide. Originally, the outer ditch was 130 x 130 m in size and was connected to the main square by a 10-m wide road. Four additional roads lead from the largest square towards the cardinal points. The main entrance to the site, formed by a road that is 40 m wide and approximately 1.5 km in length, is located on the northern side of the main square.



The cultural material at the site is concentrated in elevated embankment structures that are situated in the center of the main geoglyph and surround the ditches. Ceramic sherds were also found in the ditch bases. A small mound structure, which forms part of the site's main entrance in the northwest, is the location for profuse dark brown cultural layers and ceramic accumulation, including fragments of exquisitely decorated pottery (FIG. 4A). The radiocarbon dates collected from the excavation unit 9 between 1–1.85 m demonstrate that the substantial mound structure accumulated fairly rapidly between cal. 46 B.C. and A.D. 321 (TABLE 1).

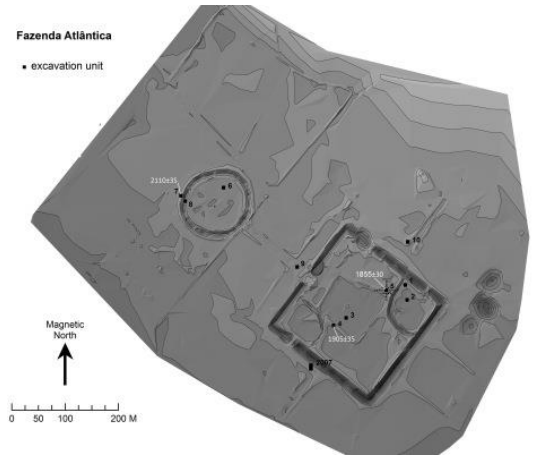

A
B

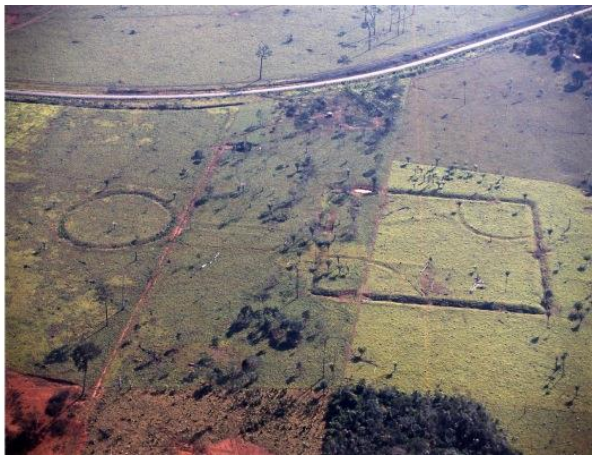
Site, provenience	Lab. number	$\delta^{13}C$‰PDB	^{14}C Age B.P.	Cal. Age (2 σ)
Tequinho, Unit 9 -100 cm, geoglyph (mound feature)	Ua-48323	-26,5	1879±39	A.D. 71-321
Tequinho, Unit 9 -160 cm, geoglyph (mound feature)	Ua-48329	-26,8	1956±34	39 B.C-A.D. 204
Tequinho, Unit 9 - 185 cm, geoglyph (mound feature)	Ua-48321	-28,0	1964±40	46 B.C-A.D. 204
Fazenda Atlântica, Unit 5 -110 cm, geoglyph (mound feature)	Ua-37252	-25,6	1855±30	A.D. 121-327
Fazenda Atlântica, Unit 4 -40 cm, geoglyph (inner embankment)	Ua-37251	-30,6	1905±35	A.D. 66-233
Fazenda Atlântica, Unit 7 -55 cm, geoglyph (exterior embankment)	Ua-37253	-27,2	2110±35	200 B.C-A.D. 20
Fazenda Iquiri II, Unit 3 -27 cm, mound	Ua-49943	-26,9	285±31	A.D. 1509-1799
Fazenda Iquiri II, Unit 7 -140 cm, mound	Ua-49944	-27,0	476±30	A.D. 1420-1606
Fazenda Iquiri II, Unit 13 -50 cm, geoglyph (exterior embankment)	Ua-49946	-27,6	706±31	A.D. 1281-1391
Fazenda Iquiri II, Unit 13 - 30 cm, geoglyph (exterior embankment)	Ua-49945	-26,5	1741±34	A.D. 249-411
Coqueiral, Unit 3 -60 cm, mound	Ua-48336	-27,8	404±39	A.D. 1452-1627
Coqueiral , Unit 4 -100 cm, mound	Ua-48335	-26,4	512±39	A.D. 1399-1479
Coqueiral, Unit 4 -135 cm, mound	Ua-48334	-27,6	534±40	A.D. 1392-1460
Campo Esperança, Unit 11, -80 cm, embankment	Ua-49941	-25,2	544±31	A.D. 1399-1449
Tênue, Unit 5 -90 cm, embankment	Ua-49942	-30,2	204±31	A.D. 1654-1891

Table 1. Radiocarbon dates from the earthwork sites treated in this study. The AMS dates were calibrated with the OxCal 4.2 program using ShCal13 curve for Southern Hemisphere. All dated samples were wood charcoal associated with ceramic-bearing contexts.

Fazenda Atlântica

Fazenda Atlântica is situated 2 km of the Iquiri River's right margin and 26 km northwest of Tequinho. The most prominent earthwork at the site is a 250 m x 250 m square-shaped ditch with shallow semi-circular ditches inscribed within the western and eastern corners (FIG. 5) (Saunaluoma 2012). The ditch construction backfill forms the external embankment of the square. Bulldozing has partially altered the northern segment of the earthwork; nevertheless, the preserved part of the ditch is still approximately 3 m deep and 20 m wide. An eroded, roughly quadrangular embankment is located in the middle of the square. Charcoal that was recovered from the embankment's cultural layer yielded the C14 date of cal. A.D. 66–233 (TABLE 1). The main entrance of the earthwork, which is defined by a 100 m wide road, is located on the southeast part of the square. Minor roads begin at the northeast and southwest sides of the square-shaped ditch and disappear into the terrain approximately 100 m from the square. On the northwest side, a 10 m wide road leads to a circular ditch situated 150 m to the northwest of the square. The circular ditch, which is surrounded by an external embankment, has a diameter of 125 m, its depth is approximately 1 m, and its width is 12 m. The 14C date, cal. 200 B.C.–A.D. 20 (TABLE 1), was obtained from the base of the cultural layer in the unit excavated on the external embankment of the circular ditch.



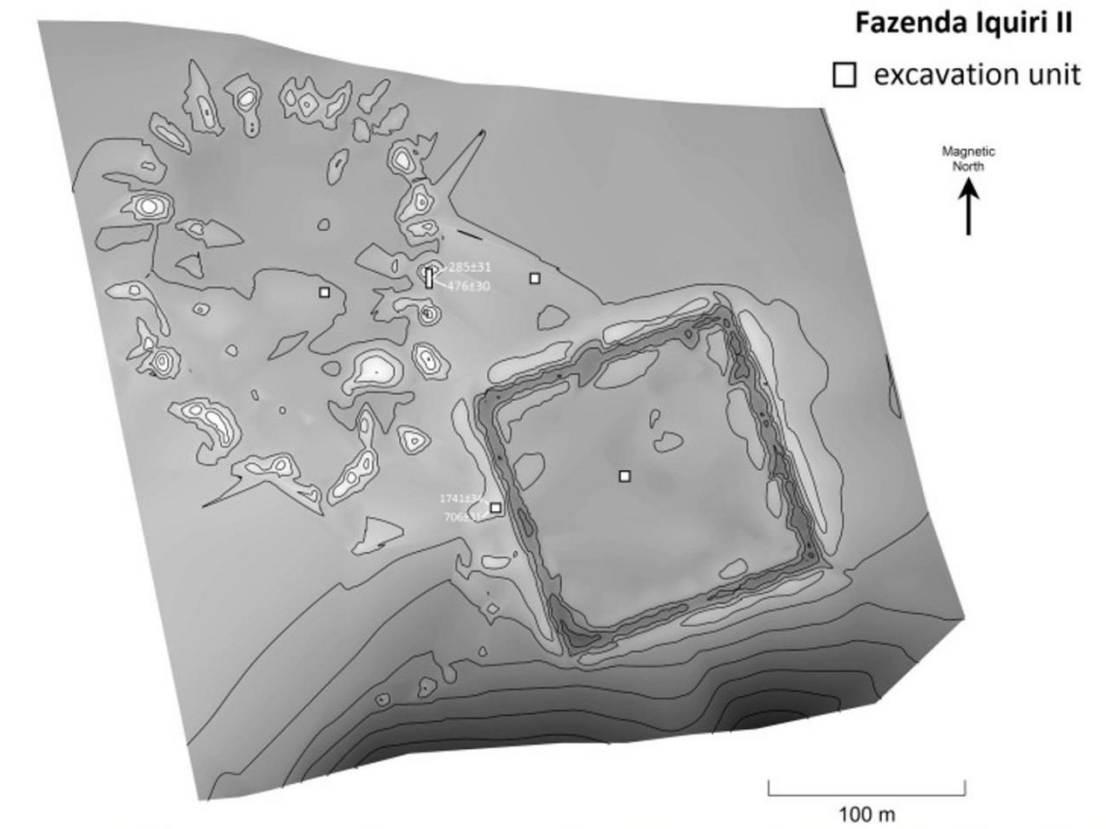


Furthermore, this site included an interesting archaeological context attached to the internal embankment structure: a small mound of dark brown anthropic soil

mixed with occasional charcoal fragments and a considerable quantity of decorated pottery. The 1.1–1.2 m level of the unit excavated on the mound contained a feature with a shattered carinated vessel (FIG. 4B), burned clay fragments, cemented calcium carbonate nodules, and a few unburned rodent bones (Saunaluoma 2012: Fig. 5). The feature is dated to cal. A.D. 121–327 (TABLE 1), which coincides with the dating of the Tequinho mound formation. In addition, certain ceramics, which are decorated with the same style, with incised linear, spiral, and meander designs executed on the vessel collar (FIG. 4), culturally affiliate these two structures, as well as the monumental geoglyph sites to which they belong.

Fazenda Iquiri II

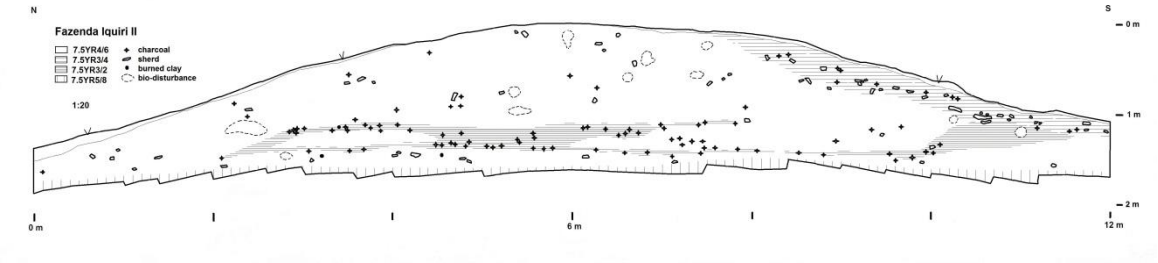
Fazenda Iquiri II is located 10 km east of the Iquiri River. The 25 oval shaped mounds of the site are arranged around an open area with a diameter of approximately 180 m in its major axis in the north - south direction (FIG. 6). Straight road structures, which are faintly observable today, enter the circle of mounds from different directions. The mounds of the site vary between 10–25 m in extension at their bases and from 1–2 m in height. Inside the circle of mounds remnants of smaller mounds in front of the more prominent ones were observed. In the south, outside of the main circle of mounds, it is also still possible to perceive the remains of another circular clustering of mounds. A shallow 140 m x 140 m quadrangular ditch, a geoglyph, is located 30 m southeast of the mounds. Today, the depth of the ditch is 0.5–1.5 m. Embankment structures were not observed inside of the flat area enclosed by the ditch, nor were any visible road structures coming into the square. The elevated parts of the enclosure´s external embankment mark the entrance of the geoglyph on the southwest side. The flat areas situated inside and around the enclosed spaces display sparse archaeological evidence.



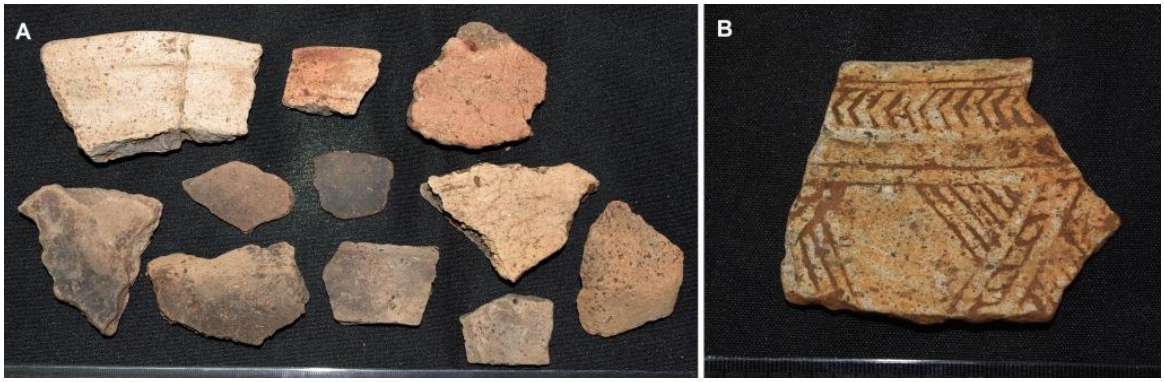


The trench excavation that transected one of the mounds on the site's eastern side revealed cultural soil that extended 1.5 m on top of the mound and 0.5 m below the ground surface on the mound's perimeter (FIG. 7). It appears that the mound was formed by continual accumulation of occupational debris. The

abundant ceramics recovered from the excavation are the remains of large undecorated containers for domestic use (FIG. 8A). Only a few finer painted sherds were obtained from the excavation. Fragments of grinding stones and stones axes were also present. The archaeological deposits at the base of the mound date to cal. A.D 1420–1606, and charcoal recovered inside of a semi-entire vessel at the depth of 0.27 m yielded the date of cal. A.D. 1509–1799 (TABLE 1).



The reddish-brown colored soil in the excavation unit placed on the exterior embankment of the geoglyph on its southwest side was clayey and extremely compacted. The somewhat disturbed cultural layers, present to 0.5 m depth, were mixed with shattered ceramics. At the levels 0.1-0.4 m the amount of ceramics was elevated, including thin sherds decorated with fine line incision and pertinent to the same vessel (FIG. 8B). This ceramic style is not typical for material collected from mound sites, nor for material recovered from the other geoglyphs surveyed in the region prior to this. The obtained C14 dates, cal. A.D. 249-411 from level 0.3 m, and cal. A.D. 1281-1391 from level 0.5 m (TABLE 1), show that the archaeological stratum is inverted, and that these two dates do not adequately solve the exact initial occupation of the geoglyph. Nevertheless, the deposits in the geoglyph embankment are older than those found in the mound structure, and they differ from the findings recovered from the excavation of the mound. Although the two earthen formations appear to be located in the same place and belong to the same set of earthworks, their temporal and functional differences are well-defined.

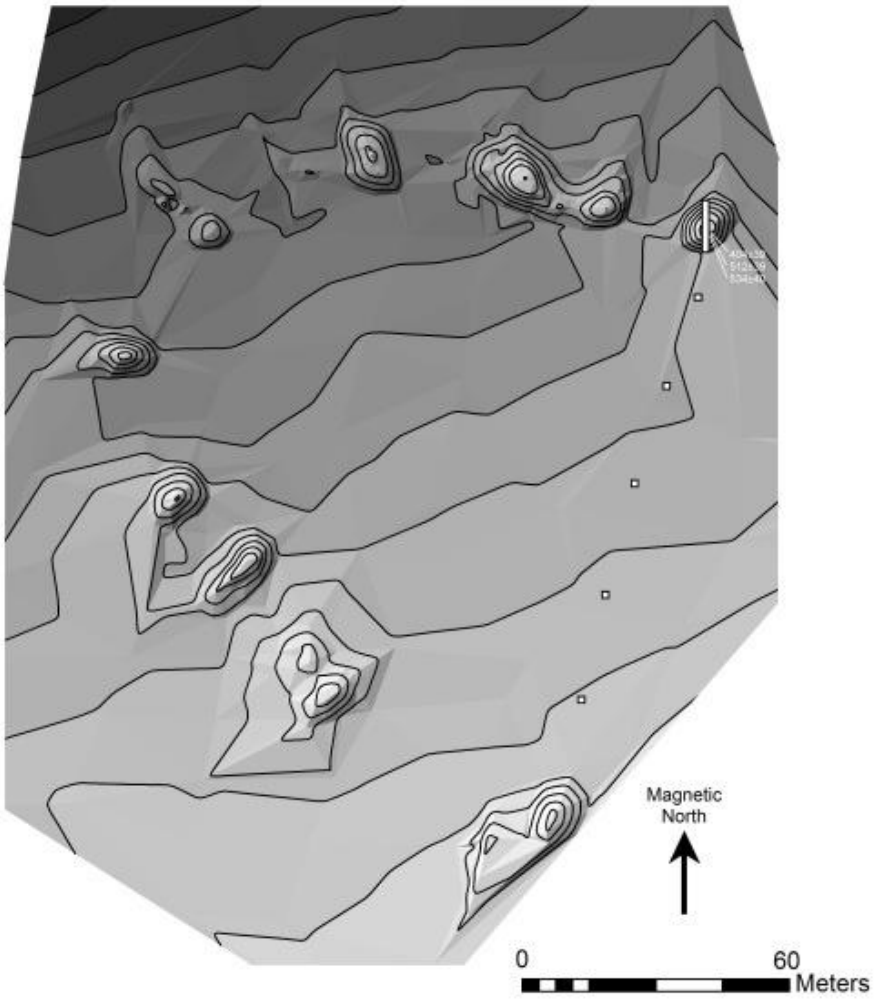


Coqueiral

Situated 1 km from the Iquiri River's left margin, Coqueiral is a type example of Acrean mound sites, even though radial road structures are currently visible only in the north of the site. The mounds of the site vary from 10–25 m in extension at their bases and from 0.5 to 1.5 m in height, and they are arranged around a roughly oval shaped area with a diameter of approximately 100 m (FIG. 9). Today, the mounds are eroded, and some are already destroyed by contemporary land use. The eastern side of the site is located on plantations, so access was not allowed in this sector of the site. It was possible to document only ten mounds, two of which are almost totally destroyed. Originally the site likely comprised some 6 to 8 more mounds. The flat open area surrounded by the mounds did not present any archaeological deposits, which was confirmed by five units excavated with 20 m intervals and crossing the enclosed space.

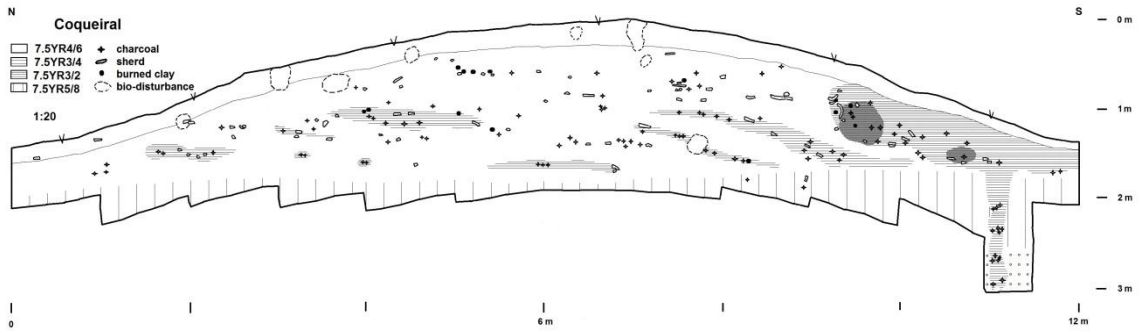
Coqueiral

☐ **excavation units**





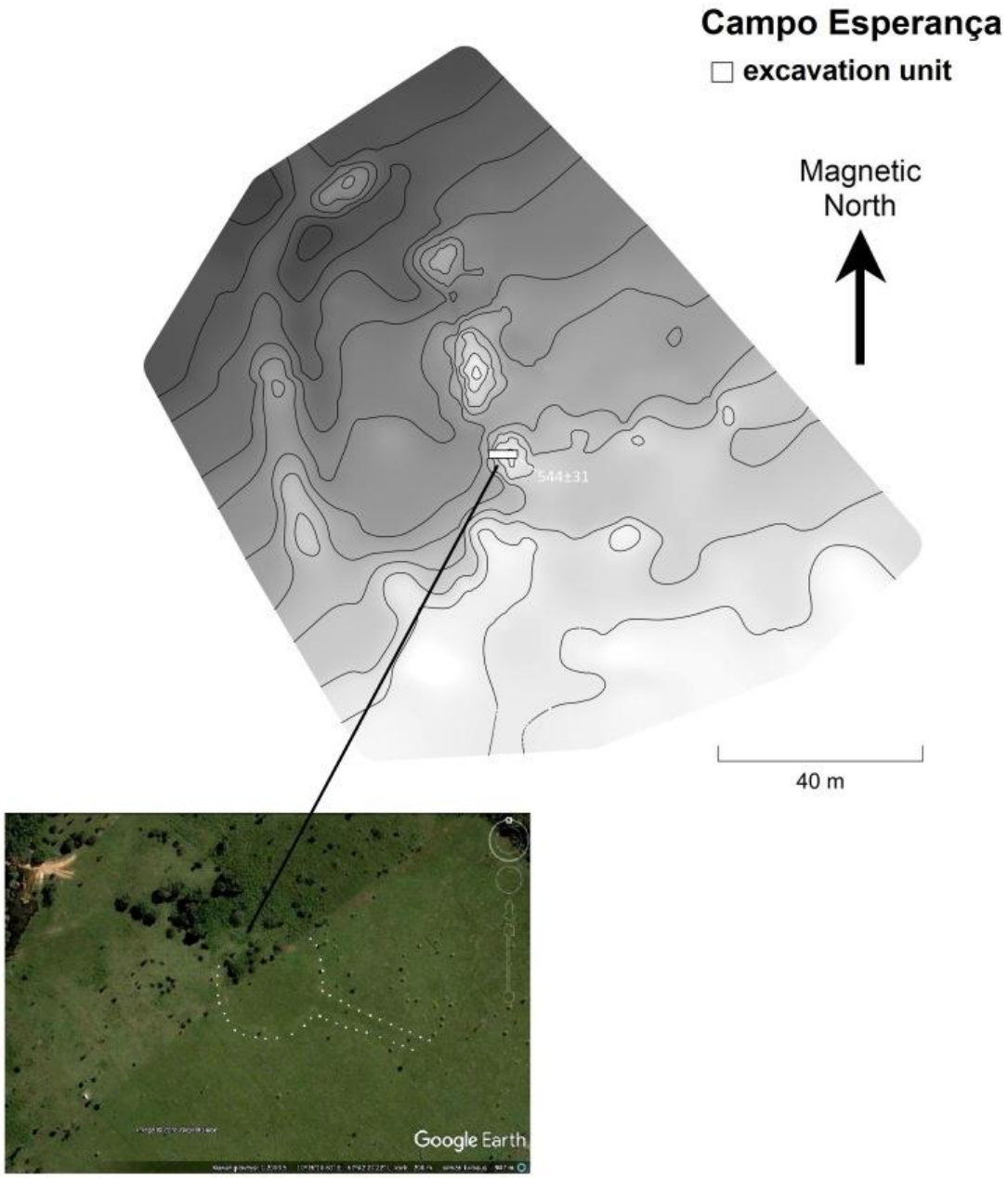
A trench excavation was opened in the north - south direction transecting a mound located on the north side of the site. The first layer of soil was sandy and dry, and it contained dispersed ceramic fragments. Below began the darker horizon with an abundant amount of cultural material. The thickness of this archaeological layer was 40 cm in the units located at both ends of the trench, and it reached 140 cm in the central part of the mound (FIG. 10). The southern part of the trench contained several cultural deposits: dark patches of loose, moist soil, filled with charcoal, pottery, and burned clay. A dense midden pocket reached up to 1.8 m in the southern end of the excavation. It appears that these features are associated with the domestic activities carried out on site. The C14 dates between cal. A.D. 1392–1627 (TABLE 1) place the occupation of Coqueiral contemporaneous with the Fazenda Iquiri II mound.



The ceramic density of the mound is high. A total of 62 kg of robust utilitarian pottery without decoration was collected from the excavation. Many sherds show traces of soot on the outer surface, which indicates that most are remnants of extensive cooking vessels. Fragments of grinding stones, which are associated with food preparation, were also found among the domestic ceramics. Not only the layout of the earthworks and their dating, but also the archaeological deposits and cultural material confirm a close cultural connection between Coqueiral and the mound sector of Fazenda Iquiri II. Both feature domestic areas (i.e., mounds) that were formed gradually through the continual accumulation of occupational debris.

Campo Esperança

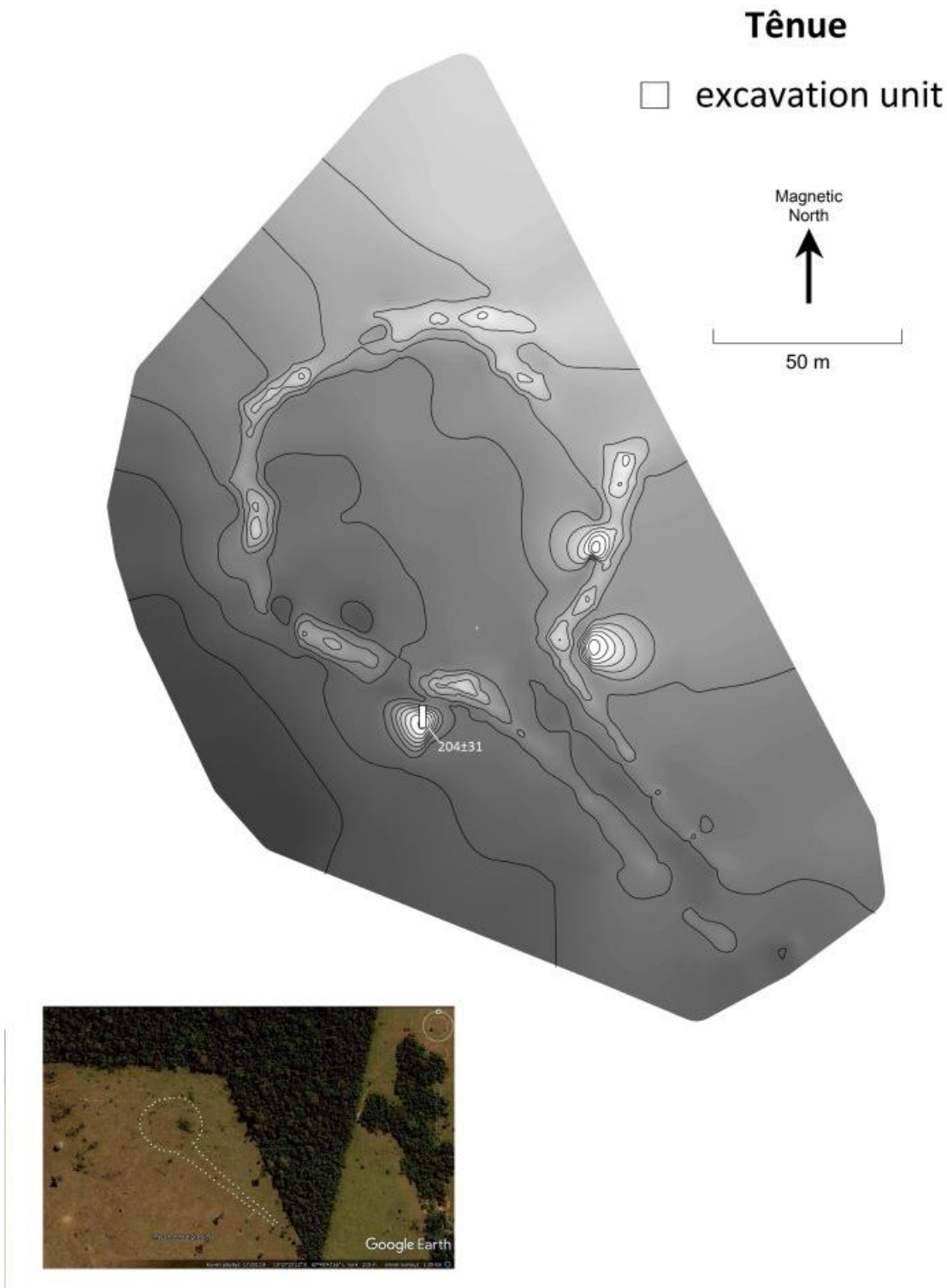
The Campo Esperança site, which is situated in the proximity of the source of the Iquiri, originally consisted of a circular earthwork 100 m in diameter with a linear entrance road heading to the southeast. The earthwork is still visible through Google Earth satellite imagery acquired in 2003 (FIG. 11). Today the site is severely damaged by the mechanical cultivation of sugarcane, and the majority of the archaeological features have already been destroyed (Schaan and Saunaluoma 2010). Still, some elevated structures have endured several years of pasture in the site's northwest sector. In 2014, a trench excavation, which was realized on top of the few remaining mound-like structures, revealed a 1 m deep cultural layer at the highest point and 0.3 m around its perimeter. Here, the soil was sandy and loose. Collected sooty undecorated utility pottery, grinding stone fragments, and lithic debitage (laterite flakes) indicate food preparation, as well as tool manufacture and/or maintenance at the location. A radiocarbon date from the charcoal that is associated with the 0.8 m ceramic residue context, suggests that the site was occupied approximately cal. A.D. 1399–1449 (TABLE 1). Despite the contemporaneity and similarity of the ceramic and lithic fragments collected here with material recovered from the Fazenda Iquiri II and Coqueiral mounds, the Campo Esperança earthwork is different, as it is formed by continuous embankment and not by separate mounds forming a circle.



Tênue

The Tênue site is located 3,6 km to the southeast of Campo Esperança, and it consists of a subtle circular embankment, approximately 100 m in diameter (FIG. 12). The height of the embankment varies between 0.5–1.2 m, and its average width is 10 m. The circle has an entrance to the southeast, defined by a linear road structure currently approximately 60 m in length.

Despite the formal similarity between Campo Esperança and Tênue, and the congruency of the position and measurements of the earthworks situated there, the latter is a site characterized by scant archaeological evidence besides its earthworks. From beginning to end, the excavation presented a loose sandy soil of a yellowish brown color with rare fragments of friable undecorated ceramics, many of which were sooty. In the unit excavated on top of the embankment, near the site entrance, a faint layer of soil mixed with charcoal without further cultural evidence was observed at the depth of 0.5–0.7 m. At the level below, few ceramic fragments were collected and the unit was closed at a depth of 1.1 m. The single 14C date cal. A.D. 1654–1891 obtained from the excavation (TABLE 1), shows that the site is quite recent, and occupied later than Campo Esperança. The occupation of the site appears short-term; however, exactly what type of activities were carried out at the site, and why it was rapidly abandoned or used only for a short time, remains unclear. Perhaps the devastating effects of Western colonization, such as the late nineteenth-century rubber boom (Vallvé 2010), were already operative, dislocating indigenous populations and weakening their cultural legacy.



Conclusions: Toward the Conceptualization of Acrean Earthworks

The abovementioned examples show a remarkable variety of archaeological earthwork features in Acre, constructed during an extended period of time on the southwestern Amazonian interfluvial plateaus, a terrain that is still surprisingly often considered to be culturally impoverished and monotonous, compared to the other regions of lowland South America. However, as we have shown, by exploring the profuse anthropogenic landscape features and their associated material culture, considerable human-induced environmental alterations we revealed to have occurred in eastern Acre at least ca. 2000 B.P. onwards. Furthermore, analysis of the phytoliths recovered from the Tequinho site indicates that the concomitant use of cultivated (maize and squash) and wild, or semi-cultivated, resources (particularly palms) was already common in the region during the period of the active usage of the geoglyphs (Watling et al. 2015).

We propose that the following attributes (TABLE 2) define the genuine *geoglyphs* (such as Tequinho and Fazenda Atlântica) of Acre: 1) the presence of geometric accuracy of the ditched enclosures, particularly of circular and square forms, occurring either singly, or forming composed earthwork complexes of 2–5 distinct earthworks interconnected by road structures; 2) the presence of external embankments contiguous to the ditches; 3) the monumentality of the sites covering areas between 1–15 ha with individual enclosures varying in diameter from dozens of meters to almost 400 m and in some cases still several meters deep ditches; 4) the low-density of the material culture, found unevenly accumulated in the ditches, in the embankments, and in special features (located at ditch bases near the enclosure entrances and in small mound formations) where the carefully elaborated ceramic material was deposited intentionally suggesting a probable ritual function of these contexts.

We may also conclude that the earthworks of the neighboring regions, Riberalta, Llanos de Mojos, and Upper Xingu, do not directly belong to the same cultural tradition as the Acrean geoglyphs due to the differences between the earthwork structures and cultural material associated with them.

Geoglyph	- precisely outlined ditch, usually circle or square, with external embankment - square-shaped embankment structures inside or adjoining the area enclosed by the ditch - occasional singular mound features being part of the embankment structures - 1 – 5 earthworks per site covering areas of 1 – 15 ha - roads connecting separate earthworks - dispersed deposits of material culture - special contexts for elaborate ceramics - predominantly ceremonial use
Mound	- mounds arranged around a circular space covering an area of 1 – 2 ha - 20 – 25 mounds per site - several straight roads radially entering the enclosed space - roads connecting separate sites - deposits of material culture concentrated in mounds - domestic use - more recent than the geoglyphs
Walled enclosure	- circular embankment enclosing an area of 1 – 2 ha - straight main road entering the enclosure - deposits of material culture concentrated in embankments - use uncertain - more recent than the geoglyphs

Table 2. Attributes for different earthwork site types.

Initial surveys were conducted in eastern Acre at sites comprising various small earthen mounds arranged in a circular shape around a central open space. To distinguish these sites from the geoglyphs, we suggest labeling them *mound sites* because: 1) the density of the material culture is high and concentrated in the mound features, indicating a feasible domestic or residential human use; 2) the dates of these sites are later than those of the geoglyphs (i.e., the late pre-Colonial or early Colonial period); 3) the roads serve to connect the separate sites (not separate earthworks).

Interesting ethnographic analogy explains the formation of the Ceremonial Stomp Dance Ground of the Muscogee (Creek) Nation at Tukabatchee in Oklahoma: repeated cleaning of the square platform gradually led to the unintentional creation of a 1 m high embankment enclosing the ritual dance ground (Swanton 1928). Perhaps the Tênue earthwork is an outcome of similar short-term cleaning activities (not necessarily related to rituals) carried out at the local. Because the

site does not feature mounds, but only a circular embankment, we propose, that it should be categorized as a *circular walled enclosure.* Before it was almost totally demolished by sugarcane cultivation, Campo Esperança was also a circular walled enclosure. However, contrary to Tênue, the Campo Esperança site revealed considerable archaeological evidence concentrated in the earthworks. The findings, fragments of large ceramic containers, grinding stones, and recovered phytoliths (Watling et al. 2015) indicate domestic activities, the processing and storing of food, carried out at the site.

To conclude, the geoglyphs were systematically constructed as public spaces laden with visible and imperceptible socio-ceremonial meanings (Saunaluoma and Virtanen 2015), whereas the mound sites were local domestic units. Thus far, the evidence suggests that they were not contemporary. So where then, did the builders of the geoglyphs live, in small, archaeologically more obscure residential sites dispersed around the region of their public monumental centers, or in clustered communal settlements situated in the proximity of the earthworks that for some reason still remain undetectable? This issue, as well as the connection with the geoglyph-building communities and the mound site dwellers, needs to be studied further; the outstanding question is whether there was a close cultural affiliation between these two archaeological phenomena. The circular walled enclosure sites will also require more sampling to comfortably insert them into the regional cultural sequence and to define their primary utilization.

In any case, our current data suggest that the mound sites and circular walled enclosures are considerably younger than the geoglyphs, and that the extension and contents of the archaeological deposits, including ceramic material, of the mounds differs from the geoglyph sites. The imminent geographical proximity, or formal similarity of different earthworks, does not necessarily mean that they were initially constructed by the same, culturally (and ethnically) static population residing in the region for centuries. Southwestern Amazonia is not only indisputably impressive in terms of its biodiversity, but it is also incredibly variable culturally, as the research in-progress is demonstrating by gradually revealing more detailed sequences of local histories.

Increasing economic and political interests in the Amazonian rainforest are causing irreversible changes and even destruction, not solely in the natural environment but also in the social and cultural spheres. In the worst case, certain cultural phenomena may disappear completely in the not so-distant future. The most serious threats faced by the earthwork sites are related to logging, agriculture, cattle grazing, and the construction of infrastructure. These wide-ranging mechanized land-use activities not only directly destroy archaeological sites and features but they also often accelerate soil erosion, which in turn will hastily fill up and flatten the earthworks. Without protective surface vegetation, the earthworks may disappear in only a few decades, and it is uncertain whether we have sufficient time and resources to acquire comprehensive information about the earthworking cultures before this occurs.

Acknowledgments

Research described in this article was supported by the Academy of Finland and Alfred Kordelin Foundation, and was possible due to permits issued by CNPq — National Research Council and IPHAN — Institute of Historical and Artistic Patrimony, in Brazil. Wesa Perttola, Otso Manninen, and Guilherme Mongeló are thanked for helping with total station measurements.

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Figure captions

Figure 1 Locations of the registered earthwork sites in Brazilian states of Acre, Amazonas, and Rondônia.

Figure 2 Location map of Acrean earthwork sites mentioned in the text.

Figure 3 Contour map and aerial photograph of the Tequinho site.

Figure 4 Pottery decorated with linear, spiral, and meander motifs incised on the vessel collar and on the lip. (A) Sherd recovered from the excavation unit 9 of the mound structure at the Tequinho site. (B) Reconstructed carinated bowl with a down-slanting labial flange, measuring 18 cm in rim diameter, recovered from the 110–120 cm excavation level of the small mound at the Fazenda Atlântica site.

Figure 5 Contour map and aerial photograph of the Fazenda Atlântica site.

Figure 6 Contour map and aerial photograph of the Fazenda Iquiri II site.

Figure 7 N-S profile of the trench that transected one of the mounds at the Fazenda Iquiri II site.

Figure 8 Ceramic material recovered from Fazenda Iquiri II. (A) Coarse domestic pottery from the mound. (B) Rim sherd decorated with fine line incision associated with the geoglyph.

Figure 9 Contour map and aerial photograph of the Coqueiral site.

Figure 10 N-S profile of the trench that transected one of the Coqueiral mounds.

Figure 11 Contour map of the remaining earthwork strucutures at the Campo Esperança site in 2015 and satellite imagery acquired in 2003 (*Google Earth imagery © Google Inc., Europa Technologies; © 2016)*

Figure 12 Contour map and satellite imagery (*Google Earth imagery © Google Inc., Europa Technologies; © 2016)* of the Tênue site.

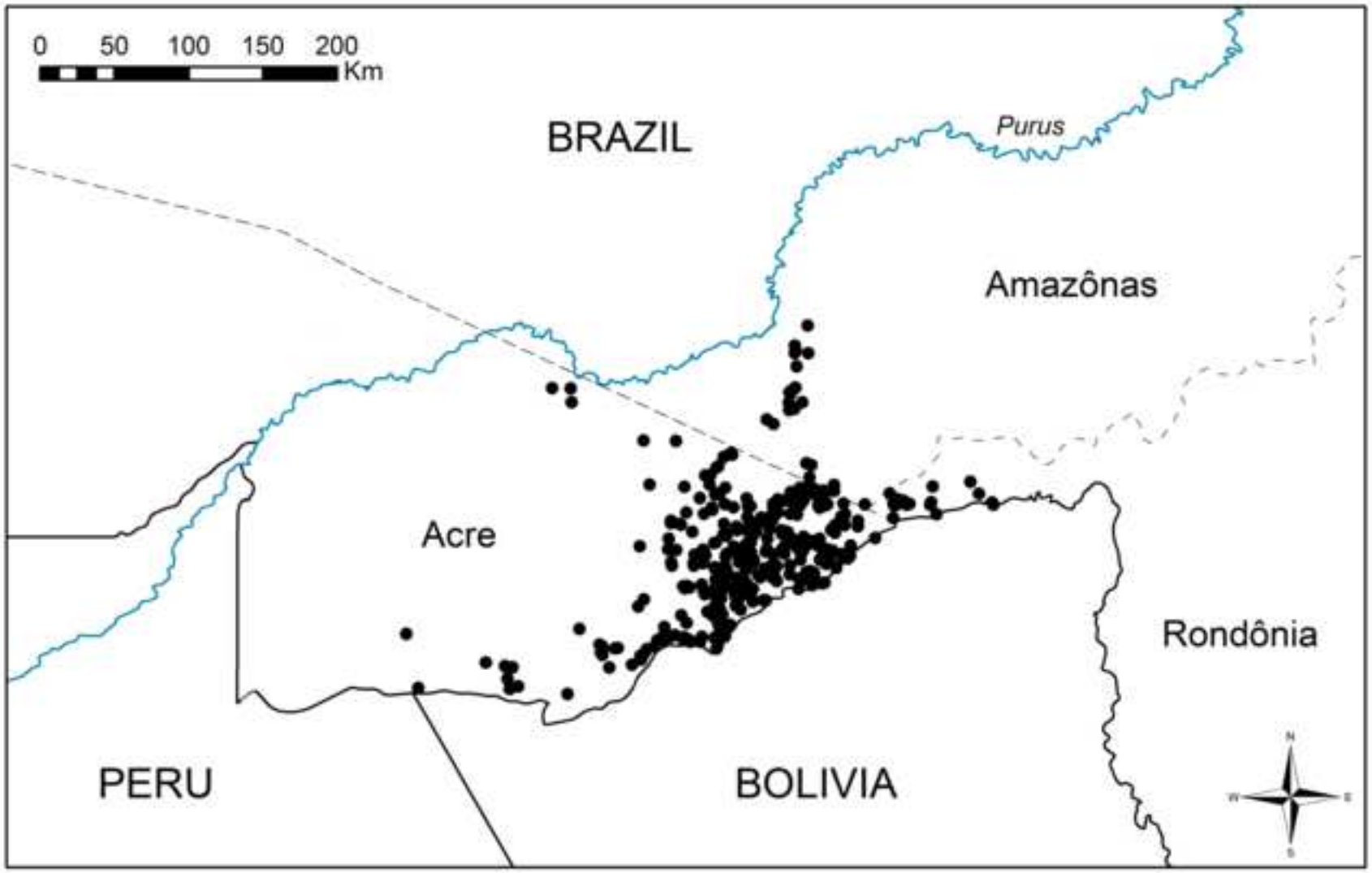
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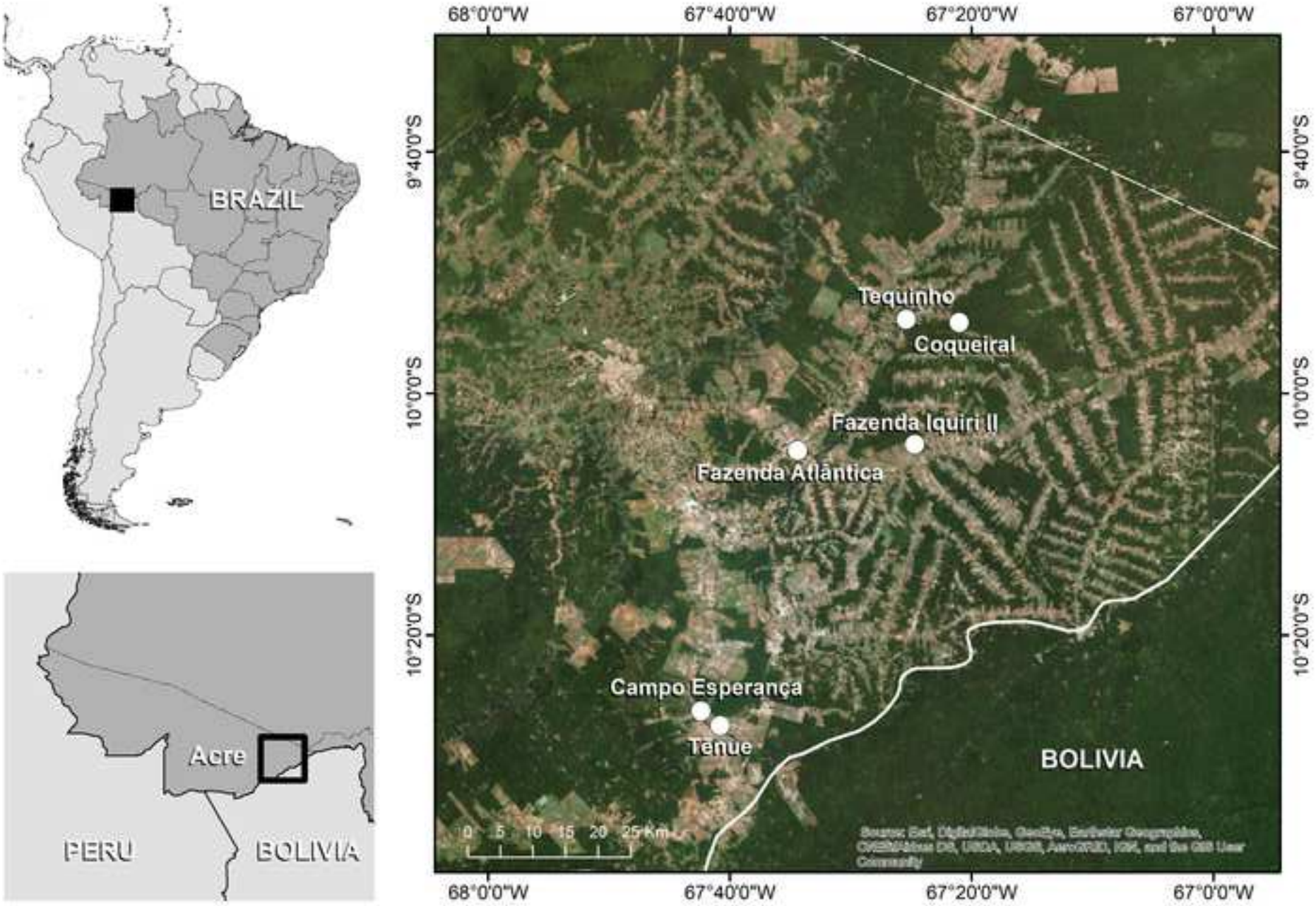
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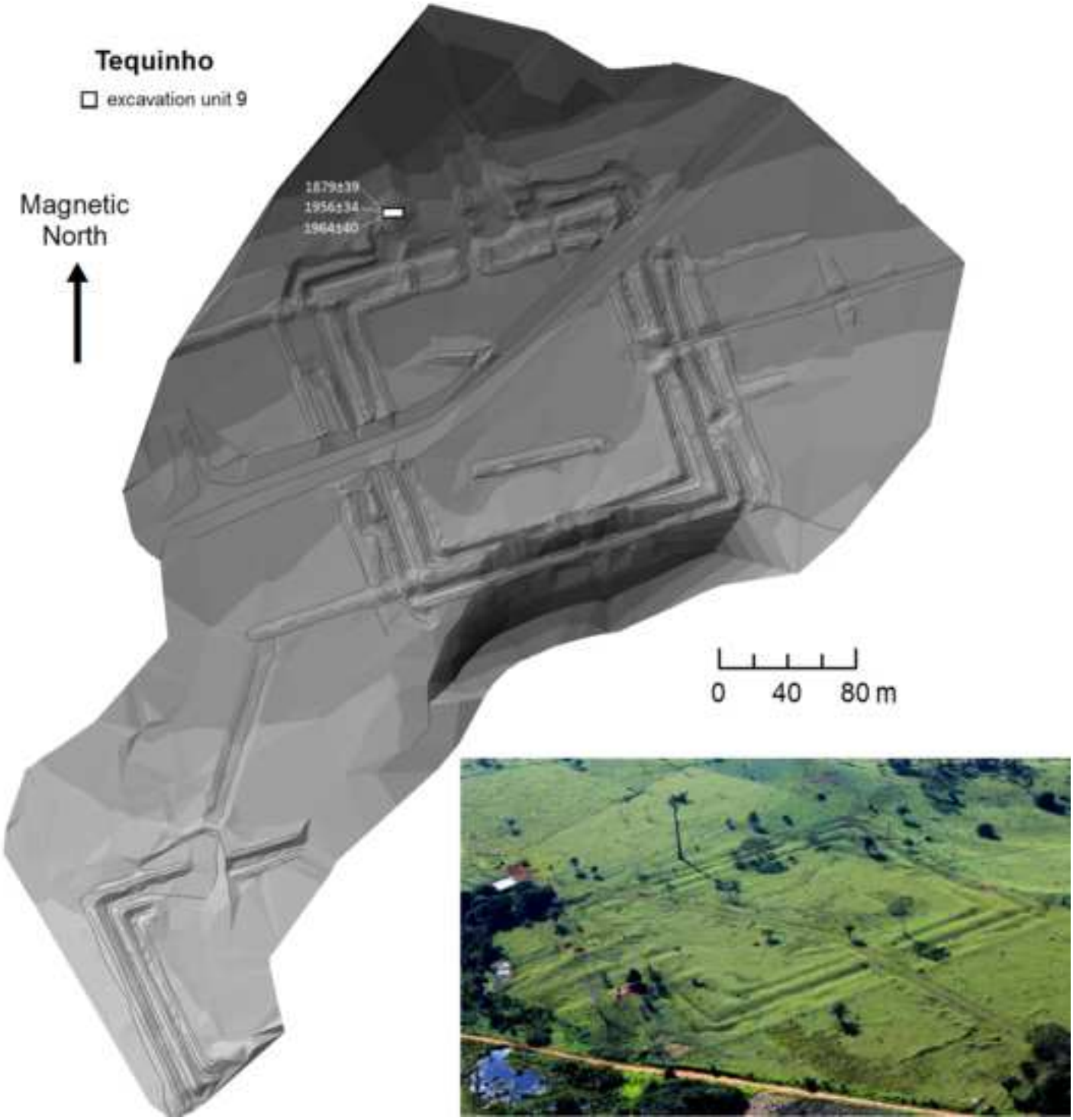
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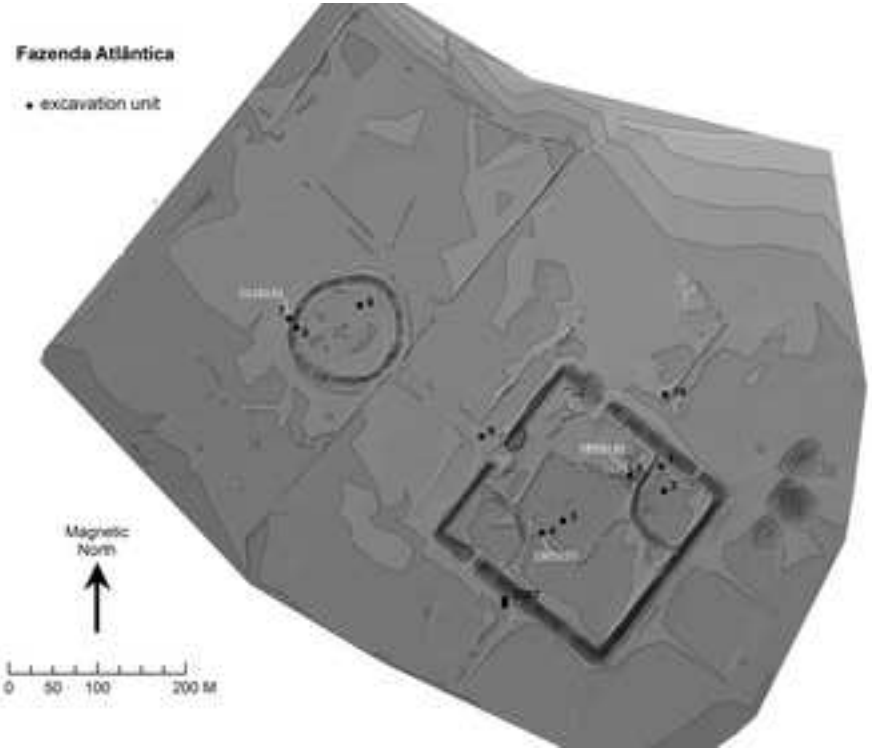
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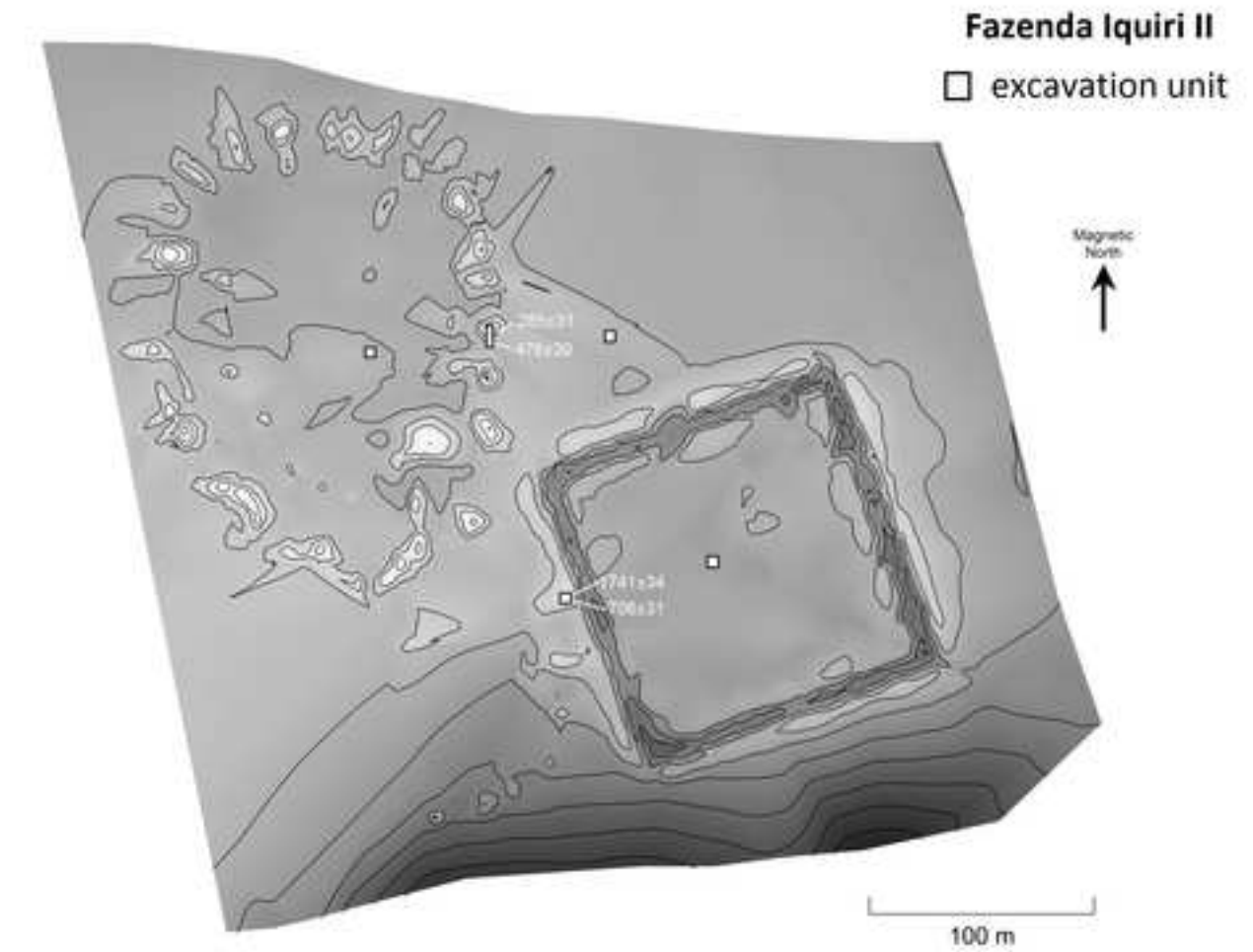
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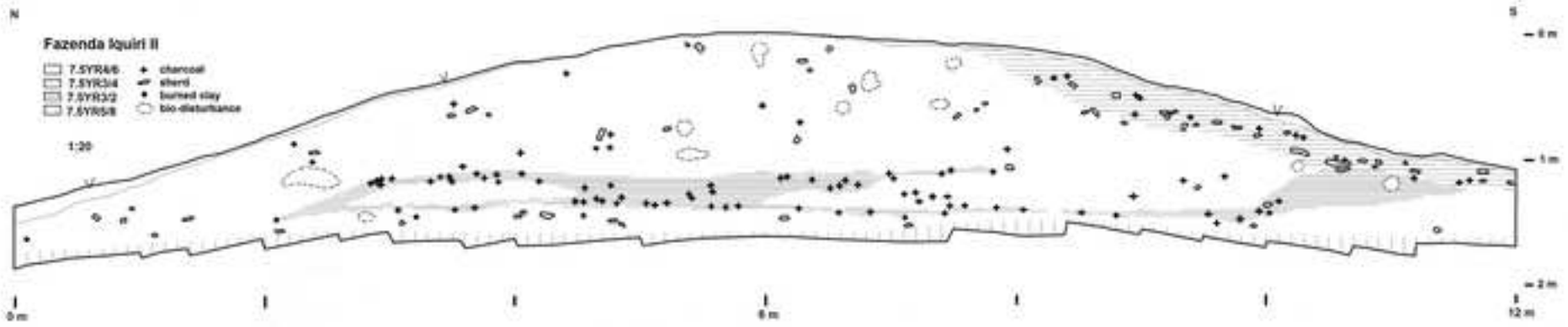
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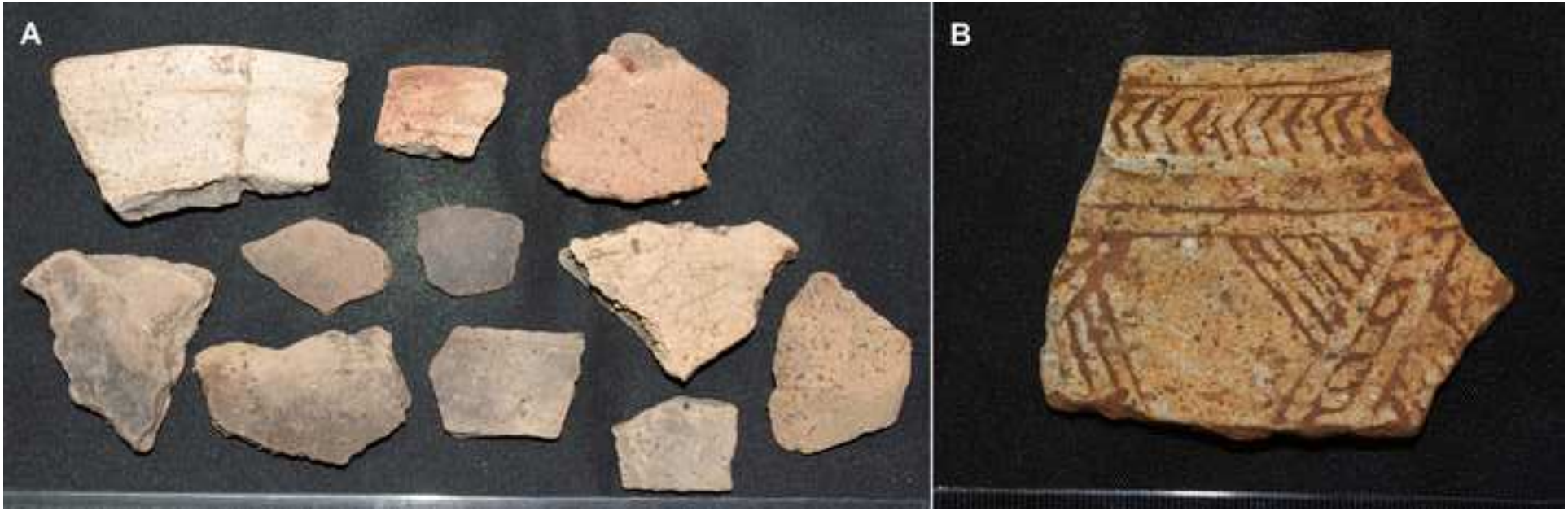
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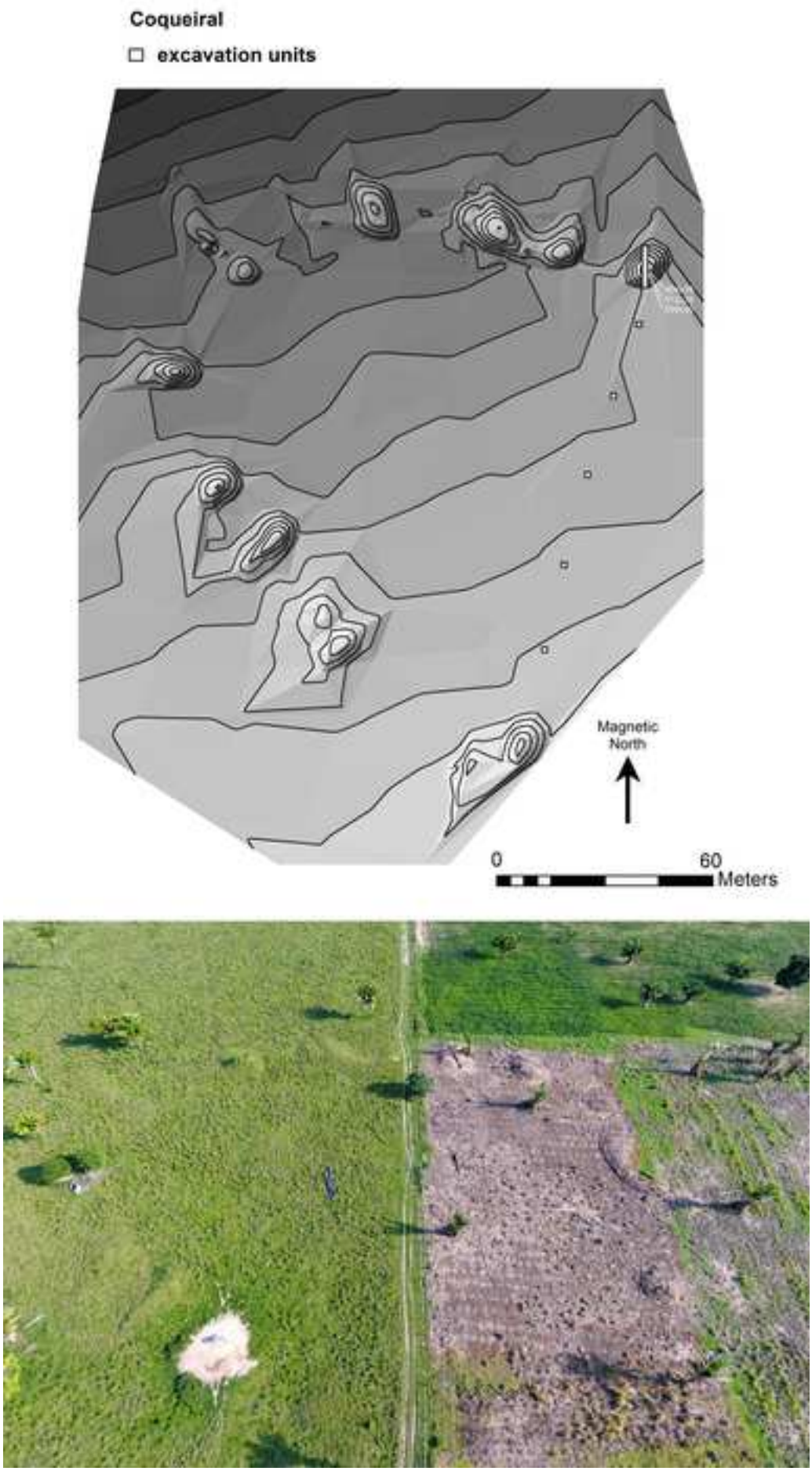


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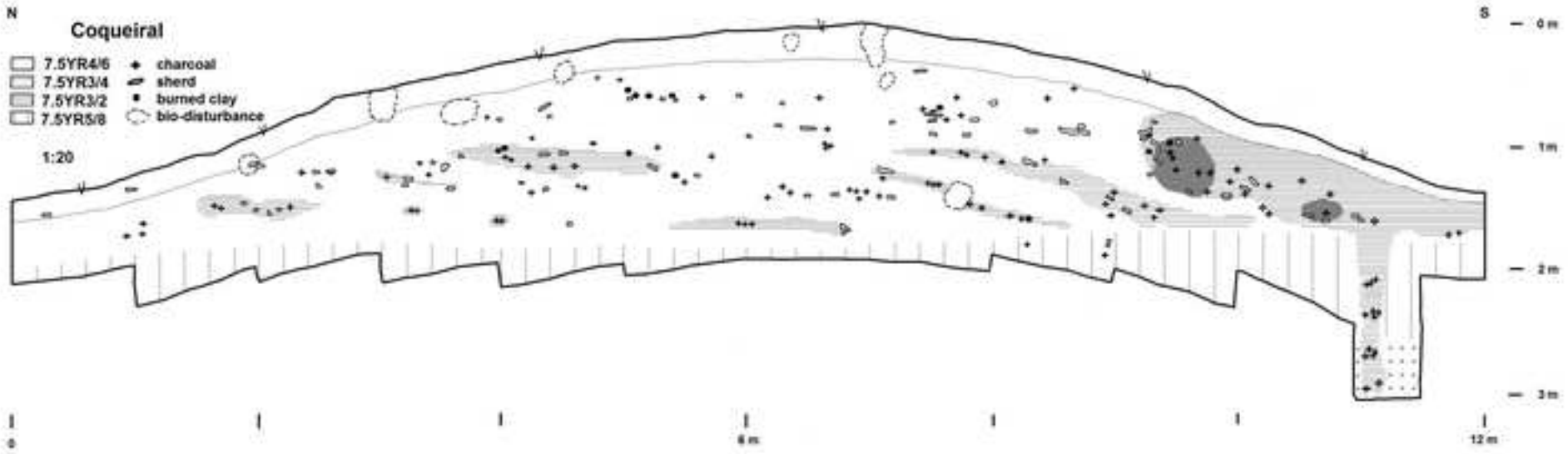


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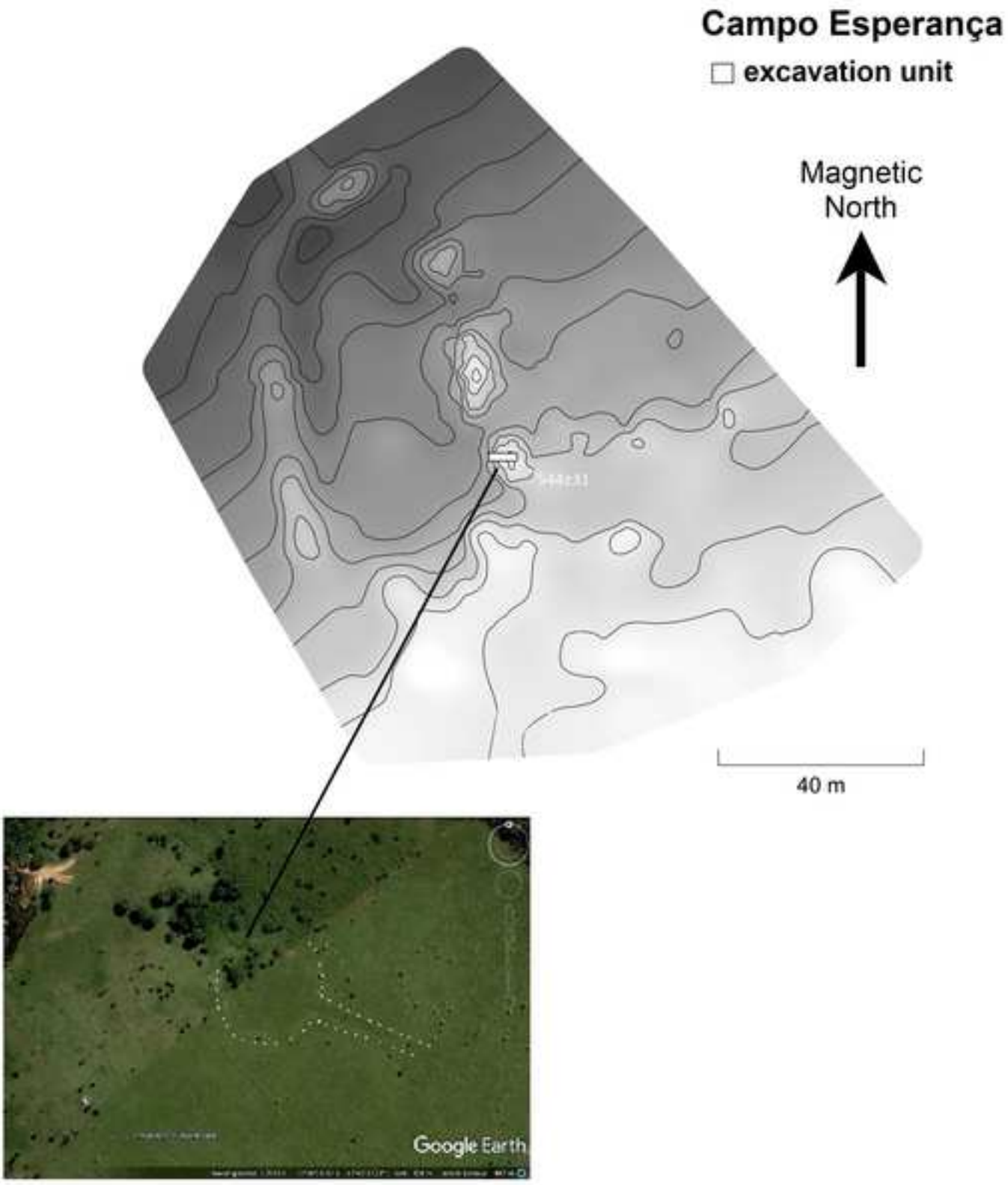
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