Chapter 3

How to protect archaeological sites

INTRODUCTION

Alexandre Livingstone Smith[1]

This chapter explains the principles of site protection and excavation. It discusses various methods of site analysis (coring, test-pits, extensive excavation) and the different contexts in which excavations can take place. In short, this chapter deals with identification of site formation processes and the degrees of precision with which archaeological facts can be recorded, as well as the importance of stratigraphic interpretation.

As regards site formation processes, it is absolutely crucial to understand how the artefacts and ecofacts associated with a site came to be where they are found today. One has to be sure that the objects present in a layer were left there by people, as they sometimes can be moved and deposited by natural phenomena. Finding very different types of objects together in the same units (i.e. example Early Stone Age lithic material associated with potsherds or metallurgical slag) is an indication that something is wrong on a site, but disturbances may be more subtle. Concerning recording precision, one has to bear in mind that once an archaeological context is excavated, it is effectively destroyed. Thus, it is essential to know as accurately as possible where the artefacts and ecofacts were collected and what they were associated with. But there are various degrees of precision an archaeologist can work with. In some cases, like a pit structure, it may be enough to know which layer the objects are coming from. In other cases, such as a Stone Age knapping site or camp, it may be useful to number all artefacts and ecofacts and record their position in three dimensions. Finally, although one may sometimes feel at loss, with no coherent explanation, it is imperative before drawing the profile of a dig to have an understanding of how things came to be as they are. People do things - they discard objects, they dig holes, they build things, etc. - and these things fall, decay, and fill in, generally according to the laws of gravity. Once gravity has done its job, animals will feed on organic remains and dig through the layers of the site. It is important to be able to describe the stratigraphic sections of a site, even if the detailed geological processes are not understood. One should make sure that photographs, records and drawings show something that will be understood by other people. If parts of a profile are not understood, it is important to mark them as such on the drawings. It will be easier to make sense of things afterwards.

The various authors who contributed to this chapter highlight these various points, making sure that a variety of contexts are presented. As these contributions consist only in a basic introduction to the field, they generally offer some guidelines for further reading. Together they provide a series of guidelines for the excavation of various types of sites in various contexts.

Ralph Vogelsang tackles the very large topic of Stone Age excavations. He outlines the specific characteristics of this kind of archaeology, where there are no traces of built structures and archaeologists can only reconstruct the behaviour of early humans indirectly. This situation explains why the characteristics of the objects and their relationships, the context of the finds, are so crucial – indeed this is *the* most important concept in archaeology in general. Also, one should bear in mind that every type of site, such as open air or rock-shelters, may reflect specific aspects of human activities. To record this information and to be able to interpret a site, it is necessary to record all the finds in three dimensions. In this regard, the author explains a simple way to obtain effective data without the use of sophisticated equipment. Digging and recording techniques are considered next, with various options in the recording of artefact positions. Finally, advices are given on the way to backfill a site. This is important to preserve unexcavated parts of the sites and facilitate future excavations.

Hans-Peter Wotzka's contribution is focused on the excavation of villages. As it is difficult to dig a complete village and its surroundings, one will need to define the aims of the excavations carefully, based on the questions one wants to answer. The author offers a series of research questions, but points out, that at this stage, village archaeology in sub-Saharan Africa cannot be too selective! Clear research questions are always important, however, and affect the overall research design as well as excavation strategies. Concerning excavation strategies, a distinction is made between shallow and deep deposits. For both types of contexts, advice is given on how to open an appropriate window into the past. This contribution ends with general considerations of excavation methods and recording, as well as site protection.

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Alain Assoko Ndong examines the digging of pit structures step by step. Pit structures, their uses and their role in archaeological sites are explained. Recommendations are given about the lay out of the reference grid and the identification, cleaning and photography of pit structures. This includes the setting up of a cut axis, use of the Pythagorean triangle, and excavation proper. As regards the latter, he advocates use of artificial spits, within which distinct archaeological contexts can be separated. He also underlines the importance of a clear system for the labelling and bagging of material, the procedures for marking and numbering each individual find. Finally, he explains how the origin of the individual fragments, after refitting, can help in the interpretation of the history of a structure.

Jeffrey Fleisher outlines the complex process of urban excavations. He considers what can be learned from urban contexts, emphasising the variety of urbanisms and the renewal of their study - with a focus on the function of sites, rather than their typological characteristics. It is important to plan carefully the aims and the overall design plan of each excavation. He relies on established recording systems and a well-structured coordination of fieldwork, particularly as urban excavations generate very large amounts of data. Much of this data needs to be screened and processed in the field, a procedure that must be well crafted in advance. Finally, the author summarizes three essential aspects of this type of archaeology: site complexity, management of large datasets and safety.

Luc Laporte's contribution is dedicated to megaliths. He summarises the essence of archaeological excavation as a combination of planning and open-mindedness, before focusing on certain aspects of megalithic archaeology such as the variety of research questions, team work and the seasonal calendar of excavations. Fieldwork proper is considered step by step, with surveys, construction analysis, stratigraphic analysis and analysis of burial levels. Finally, he considers the importance of megalithic monuments as world heritage and the restoration of such monuments, as well as the conservation and publication of research results.

The contribution of **Caroline Robion-Brunner and Vincent Serneels** address the topic of metallurgical sites. They consider research strategies and field methodologies, starting with site inventory and site topography. They provide simple guidelines to site topography and technical characterisation, with a clear procedure for the excavation of a furnace and its surroundings, as well as a clear analytical grid for metallurgic waste, both slag and *tuyères*. Advice for the dating of metallurgical sites is also given, a very useful section considering the highly debated topic. Finally, procedures for the evaluation of production volumes and environmental impact are given. Figures and photographs provide visual support for each process.

For her part, **Isabelle Ribot** reviews the excavation of funerary sites, and associated tasks. Comparing the site to a crime scene, she starts with listing key tasks that the archaeologist has to bear in mind, although she stresses that the excavation of human remains is really a specialist's job. Some of these tasks are then discussed with a focus on locating the grave pit and uncovering the human remains. She provides a check list of the data to be recovered systematically, and finishes with advice on questions pertaining to exhuming and bagging the remains.

Benjamin Smith takes the reader one step further in the recording of rock art. His contribution is divided in two parts. First he considers the recording of rock art sites in general. He outlines the use of record sheets and the use of GPS to locate the site as accurately as possible, as well as various textual and graphic data that need to be recorded. This includes information ranging from the type of rock to the style of the art, and the mapping and recording of the site and its art by photography or tracing. A systematic approach is crucial for the study of any rock art project. Finally, he considers the input of specialists for, for example, image enhancement or pigment analyses.

Geoffroy Heimlich's contribution is dedicated to the specific case of the rock art sites of the Lovo Massif in DRC (Lower Congo Province). He advocates digital photography as a recording technique, coupled with digital enhancing (like Smith he recommends the use of DStretch), and gives an sample image treatment. He provides an appraisal of the use of GIS for the study of rock art, explaining how he built a simple database allowing for the 'aerological' study of rock art. He also considers problems related to graphic pigment analysis and dating. Finally, he considers the preservation of rock art in the province of Congo Centrale.

This last topic is central in the next paper, as **Benjamin Smith** makes a final contribution on the management and conservation of rock art sites. Here he considers three important aspects of the management and preservation of rock art sites: significance, training and conservation.

THE EXCAVATION OF STONE AGE SITES

Ralf Vogelsang[1]

INTRODUCTION

The African continent provides the most comprehensive record of the Stone Age period worldwide. Starting with the earliest evidence of tool-making dated to 2.5 Ma from Gona in Ethiopia (Semaw *et al*. 1997, or even 3.4 Ma ago, McPherron *et al*. 2010) and enduring in some regions until contemporary times (e.g. today's hide workers in the Konso region of Ethiopia that make and use stone scrapers (Brandt & Weedman 2002); it is by far the longest period of human history.

The Early Stone Age is also the only archaeological period with the coexistence of different kinds of hominids. However, the making of stone-tools is generally ascribed to a single genus – *Homo* – with several species, such as *Homo habilis* and *Homo ergaster*. The emergence of the genus *Homo* may coincide with the earliest archaeological evidence for stone-tool making but the correlation of cultural hominid evolution, represented by archaeological groups defined by stone tool types and technology, with anatomical hominid evolution, i.e. distinct human populations, is extremely problematic. Since 200 ka anatomically modern humans (*Homo sapiens sapiens*) seem to be the only surviving species in Africa.

The long duration of the Stone Age is however not reflected by an exceptionally large number of sites known from this period. On the one hand, population density was low during much of the Stone Age and on the other hand, sites were covered by such thick sediments that they are not accessible today or they were destroyed by natural or anthropogenic activities. The probability of post-depositional disturbance and destruction increases in time and impairs the number of Stone Age sites especially from the earliest periods.

I. THE SINGULARITY OF STONE AGE EXCAVATIONS

In contrast to the excavation of archaeological sites from later periods, most Stone Age sites are characterized by the absence of any preserved structures such as house floors, pits, graves or walls that we can analyze and interpret. At Stone Age sites, the presence of structures, activity areas (e.g. butchery sites) has to be recognised by the configuration and distribution of the lithic, bone, and organic tools (such as wood and leather) and their production debris. Further evidence can come from faunal/plant remains, ashes or stone arrangements that cannot be explained by natural phenomena such as rockfall, the deposition of volcanic ashes or bone accumulations by scavengers or birds of prey. However, quite often especially in the earlier periods, stone artefacts are the only preserved find category. The definition of relevant units of analysis and the interpretation of the patterning and distribution of finds for the identification of such 'latent structures' deserve a detailed as possible documentation of the original context (hence the extreme importance of the excavation grid system, the three-dimensional recording of the finds and the exact documentation of stratigraphic observations, described below). Idealized distribution patterns gained by experimental archaeology or by ethnographic analogy help to interpret archaeological patterns and to identify such 'latent structures' and activity areas (**fig. 1**).

The configuration and patterning of lithics can also tell about the choices made during stone tool manufacture (*chaîne opératoire*) and use. For example, large flakes occur mainly during the initial phases of tool production; high numbers of very small stone chips indicate the knapping of stone-tools on the spot. A low diversification of the tool spectrum indicates specialized inventories (e.g. hunting sites, raw-material procurement sites), whereas less specialized sites are characterized by a heterogeneous spectrum (e.g. long-term settlement sites). However, one should always keep in mind that the original composition and distribution of the assemblages might have been altered by later site formation processes (e.g. the loss of small chips by erosion).

II. OPEN-AIR SITES AND ROCK-SHELTERS: THE PROS AND CONS

Open-air sites and rock-shelters each record only a part of human behaviour and settlement patterns. To get the whole picture of a human population, both site categories have to be considered. Whereas rock-shelters were mainly occupied for protection from the forces of nature,

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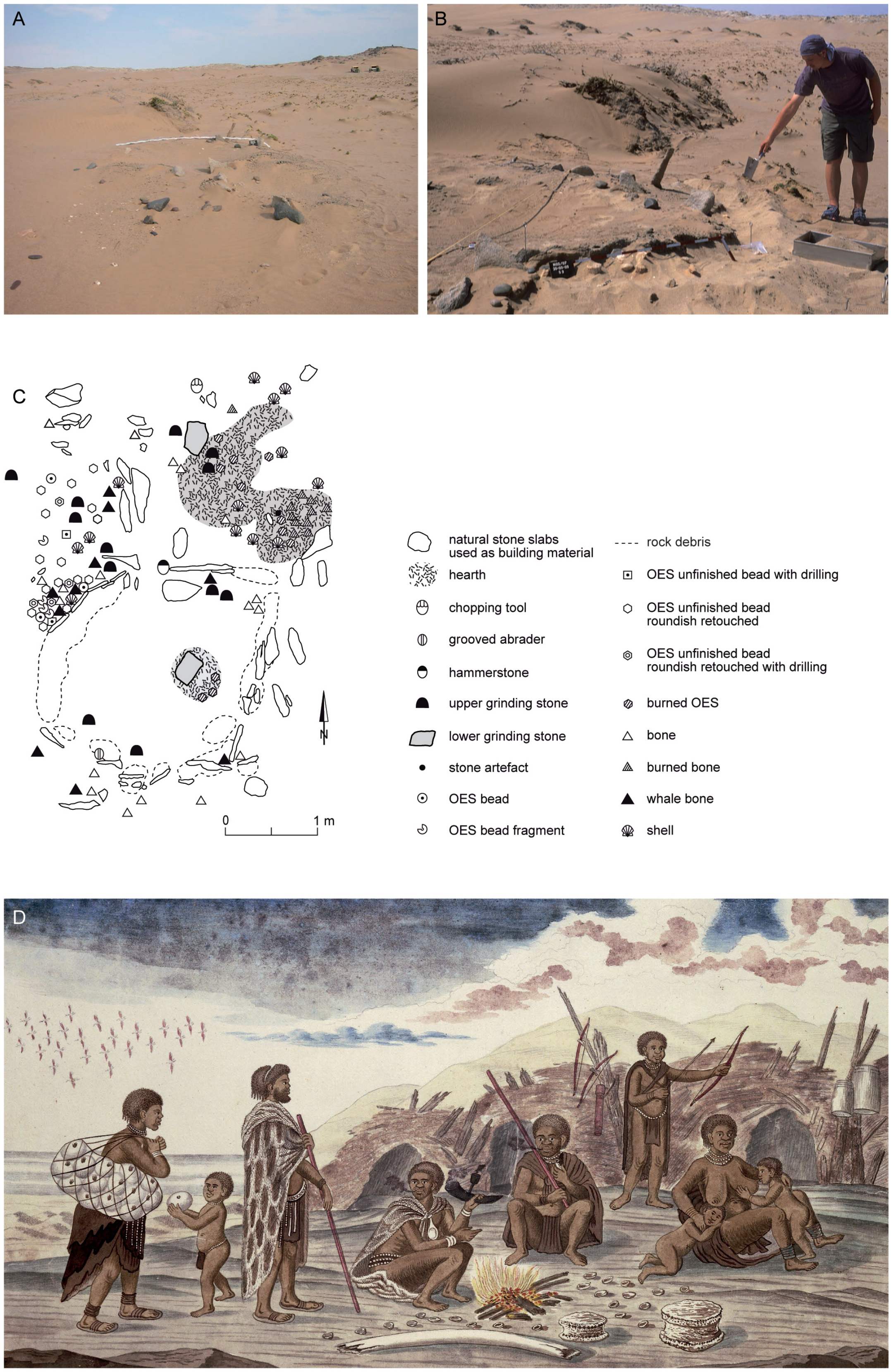


Fig. 1. Heavily eroded stone circle in the Skeleton Coast Park/Namibia (site N2002/7, circle 3) before (A) and during excavation (B). The distribution map (C) allows the reconstruction of the hut structure that is virtually lacking any finds in the inside. Two activity areas can be distinguished outside in the wind shadow of the former hut: an ostrich eggshell bead (OES) production area in the western part and a hearth with food remains (burned bones and mussel) in the eastern part. Remains of whalebones indicate their use as part of the hut construction. Four radiocarbon samples date the site around 850 calAD. A picture from 1779 (D), showing a Bushman family in front of their whalebone hut near the lower Orange River gives an idea of the assumed original state of such a settlement (Gordon 1779, source: Gordon atlas, Rijksmuseum Amsterdam). (Photos A and B © R. Vogelsang.)

open-air sites present a more diverse spectrum such as settlement, hunting, and raw-material procurement. Both have pros and cons regarding the preservation of archaeological remains. In arid regions, the number of open-air surface sites can be extremely high. In contrast to wetter regions, such as the central part of Africa, Stone Age sites were not covered by thick fluvial sediments and even artefacts from the earliest phases of the Stone Age can be found on the surface. However, such finds are not from a sealed context, so remains from different time periods might be mixed and the state of preservation (e.g. patina, weathering) can at best only be a relative chronological marker. A chronological differentiation is easier if artefacts are buried in sediments. If these sediments are undisturbed, there will be a succession from the surface (= young) to the basal layers (= old). However, not all assemblages found in sediments are *in situ*, i.e. in the place where they were originally located after their last use. In particular, fluvial (= river) activities might displace artefacts over long distances. For the identification of such post-depositional processes, the expertise of a specialist (geologist; geo-morphologist; geo-archaeologist) is highly recommended. If open-air sites are connected with favourable environmental conditions, such as a spring or a raw-material source, people and their ancestors might have returned again and again and a sequence of different archaeological layers, divided by natural sediments, might develop.

Rock-shelters are also favourable places for hominins and, in addition, they protect not only the human inhabitants but also their occupational remains and natural sediments. This is especially the case when large boulders at the opening formed a sediment-trap. For this reason, the potential of rock-shelters to preserve a stratigraphy with multi-sequenced settlement layers is relatively high. This is a great advantage and some rock-shelters are key-sites, offering a chronological and cultural frame for larger regions. The disadvantage of highly frequented sites is the danger of mixing of different occupational events. Especially in arid regions, the accumulation of natural sediments such as rock fall and other weathering products can be extremely low. In this case, archaeological horizons are not separated by sterile sediments, even if there is a hiatus of several thousands of years between the occupational events. This results in mixed assemblages, sometimes only identifiable by heterogeneous radiocarbon ages. Despite trampling and mixture the slow, gradual and long accumulation of sediments and archaeological material often offers sound cultural sequences that can be used as a starting point for relative and absolute chronology for single-phase occupation sites and even the classification of surface scatters.

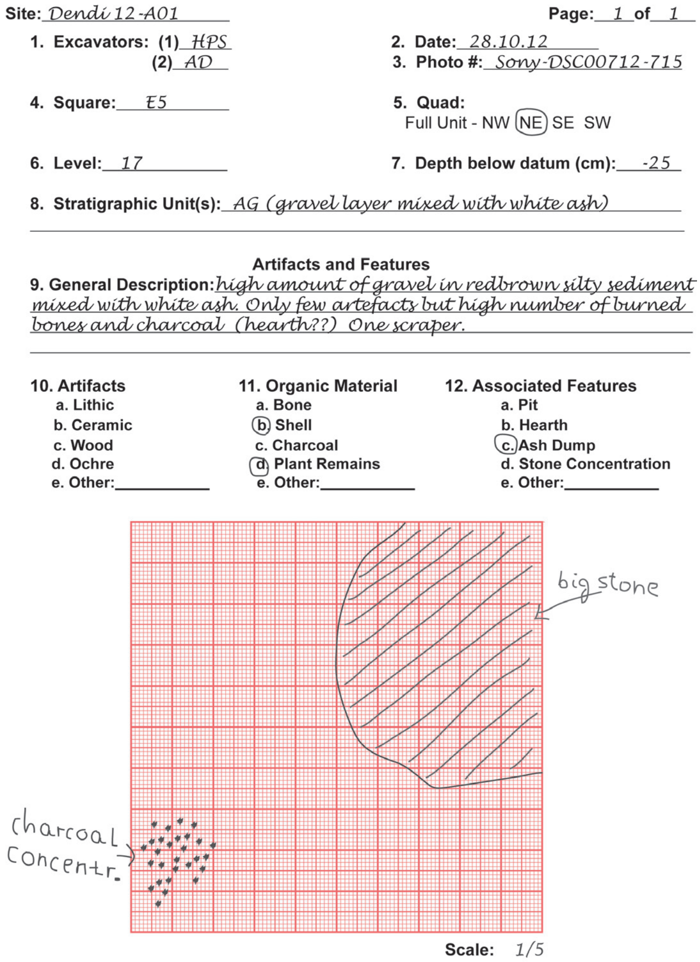
III. EXCAVATION METHODS

Information that has not been documented during the excavation is irretrievably lost for later analysis. Therefore, excavation methods and documentation should be as accurate as possible. The state-of-the-art field recording method for the subsequent spatial reconstruction of the distribution of finds (i.e. artefacts made of stone, bone, wood etc., but also faunal remains, charcoal, botanical remains) and features (e.g. ash-lenses, concentrations of rocks, pits, animal burrows) is the plotting of their x-y-z coordinates with a total station. The coordinates must be connected with a specimen number and provenience information. The coordinate data can then be processed with special Geographic Information System (GIS) software (such as ESRI ArcGIS or the freeware GrassGIS) to construct a three-dimensional model of the spatial distribution of finds and features (e.g. Marean *et al*. 2010: 239). However, this method requires expensive technical equipment, GIS expertise, and is time-consuming. Sometimes it is not possible to fulfil this sophisticated standard, especially during rescue excavations, when sites are endangered by construction work or by natural erosion. In this case, one has to act without delay but should follow some minimum requirements.

IV. PLANNING

Prior to the excavation, the current surface must be levelled, using a total station that records the x-y-z coordinates or using the grid system and a surveyor’s level. In connection with the mapping of the topographic features of the site (e.g. shelter wall, large rocks, drip-line) these data allow drawing of a relief map of the site. For this task and all further measurements, one has to define a datum point (= 0) that must be marked on a durable feature, such as a big rock or the shelter wall.

The next requirement is the surveying and mapping of a square-metre grid system that should be orientated to magnetic north (x-axis =north, y-axis = east). The 1 m squares must be named in a systematic and distinct way, for example by using capitals for the x-axis and numbers


Site: Dendi 12-A01 Page: 1 of 1

1. Excavators: (1) HPS (2) AD
2. Date: 28.10.12
3. Photo #: Sony-DSC00712-715
4. Square: E5
5. Quad: Full Unit - NW (NE) SE SW
6. Level: 17
7. Depth below datum (cm): -25
8. Stratigraphic Unit(s): AG (gravel layer mixed with white ash)

Artifacts and Features

9. General Description: high amount of gravel in redbrown silty sediment mixed with white ash. Only few artefacts but high number of burned bones and charcoal (hearth??) One scraper.

10. Artifacts
a. Lithic
b. Ceramic
c. Wood
d. Ochre
e. Other:

11. Organic Material
a. Bone
(b) Shell
c. Charcoal
(d) Plant Remains
e. Other:

12. Associated Features
a. Pit
b. Hearth
(c.) Ash Dump
d. Stone Concentration
e. Other:

Scale: 1/5

Fig. 2. Example of an excavation recording form, used by the author during his excavations in Ethiopia.

for the y-axis. Future extensions of the excavation trench should be considered when naming the first squares (do not start with square A1). The size of a trench depends on the main research question. For a first chronological classification of the settlement history, smaller but deep trenches (at best down to bedrock) are most appropriate, whereas spatial questions require the excavation of larger areas. Squares should be subdivided in 50 cm quadrants named after their bearing: NW, NE, SW and SE. The size of a quarter-square metre is in most cases small enough for the production of distribution maps.

V. DIGGING AND RECORDING

Excavations should be conducted in quadrants of 50x50 cm in regular artificial slices (spits), in general of 5 cm depth. The spits should be subdivided in case of visible sediment changes, which can be natural stratigraphic units or artificial features. These are documented in profile drawings ideally of the four walls and the ground levels of the trench or square at a scale of 1/10 and in photographs taken at regular intervals of both the profiles and the excavated surface. Often for Stone Age sites, drawings and pictures are made after every excavated spit and – as is standard archaeological practice – include an arrow indicating the North, identification of site, date, square, feature and a scale. All finds have at least an assignment to square, quadrant, sediment unit and depth within the 5 cm range of the spit. A quite simple way to control levels is by using a surveyor's optical level and a level rod. All information has to be recorded in a systematic way, at best using forms (**fig. 2**) that can easily be transferred in a form-based data-type system (e.g. Windows Excel). Sometimes, the excavation of 'natural' layers is regarded as a scientifically appropriate way. This might be the case at sites with clear sediment borders, but changes in the stratigraphy are, in many cases, fluid transitions and distinguishing a border would be arbitrary. However, even in the case of clear sediment layers, these do not have to correspond to archaeological layers but are quite often results of post-depositional processes. Treating these sediment units as equivalent to cultural units is incorrect and only pretends a greater scientific exactness. If an exact three-dimensional plotting of individual artefacts is not possible, the method of digging in artificial spits that are subdivided in case of sediment changes seems to be the second-best option.

Excavating in an optimal way is to plot all finds that were seen by the excavator in x-y-z coordinates by total station directly to a computer. Each find with precise 3D coordinates gets a specimen number and is separately bagged together with a label containing this number and other basic information (site, square, quadrant, level, excavator, date).

In the case of excavating in artificial spits, finds of one spit can be put together in a single plastic bag but should be separated according to find categories, such as lithics, pottery, bones and botanical macro-remains. Independent of the excavation method, the sediment of each unit (quadrant and level) should be sieved in several stages, using different mesh widths (e.g. 10, 5, 2.5 and 1 mm). As mentioned earlier, the size-distribution of stone artefacts can be a valuable factor to identify human activities (e.g. on-site knapping), but also of post-depositional disturbances (e.g. the loss of very small debitage by erosional processes). Therefore, even the smallest chips are important for our analysis.

VI. CLOSING AN EXCAVATION

Before closing the excavation all sections have to be protected with plastic tarps. The best way to refill trenches is by using sandbags. This method facilitates the re-opening of trenches in case of a continuation of the field-work and protects the walls. Sandbags should be covered with a loose surface layer of sediment that hides the borders of the excavation trench. This keeps the particular feature from piquing the interest of casual visitors and prevents them from disturbing archaeological sites out of curiosity.

CONCLUSION

This chapter cannot be more than a very short and basic introduction to the excavation of Stone Age sites and some topics, such as operational safety, photography and drawing are described in other contributions to this book. Further studies of the literature are highly recommended (e.g. Burke & Smith 2004, Kipfer 2006; guides to specific topics can be downloaded under: http://www.bajr.org/BAJRread/BAJRGuides.asp). However, nothing can substitute the participation in fieldwork with professional guidance and personal experience.

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VILLAGE SITES

Hans-Peter Wotzka[1]

The most difficult thing about excavating an ancient village in sub-Saharan Africa is to know whether one is actually dealing with one. Due to the disconnectedness and generally inconspicuous nature of village remains, their incomplete survival, excavators' selectivity, dating, and other problems, there is frequently no certainty during excavation as to whether the features under investigation once belonged together or what type of site they may represent. Large settlement mounds as well as sites exhibiting contiguous (agglutinative) architecture may constitute obvious exceptions, but in most cases villages are not simply unearthed but need to be (re)constructed by careful analysis and adequate synthesis of field documentation after the shovel and trowel have done their job. One of the challenges during the dirt phase then is to do proper justice to all excavated features and finds to allow such synthesis, and this even under favourable circumstances where a (nearly) complete or otherwise unambiguous village layout is visible right from the outset, be it on the ground, on aerial or satellite images, or on plans resulting from geomagnetic, geoelectric, georadar or other types of pre-excavation survey.

I. WHAT IS A VILLAGE?

To keep things simple, let us apply the term to any relatively dense agglomeration of houses permanently inhabited by a small sedentary community of several households. This type of settlement was the presumed typical home base and centre of all cultural practice for most non-mobile populations in sub-Saharan Africa from the terminal Late Stone Age through the Iron Age. Villagers gained their livelihood from within and around their settlements, usually involving some sort of farming (gardening + agriculture and/or animal husbandry). It is therefore essential to obtain an idea of the range of activities carried out in and around ancient villages, yet the task is not straightforward. Usually at least a few hectares in size and occupied over a number of generations, such habitation clusters along with their associated structures and features do not normally lend themselves to total excavation.

II. HOW TO EXCAVATE

Instead, effective village-level archaeology[2] requires some proper probabilistic sampling strategy, guided by the specific research questions asked (**fig. 1**). Ideally, pre-excavation survey should yield an (approximate) plan or at least reasonable estimates of the settlement's limits and size; careful analogy with well-known village sites from the same culture may, if available, complement these estimates.[3] As a rule of thumb, given such previous knowledge, an adequately selected small sample of all extant village remains will suffice to obtain meaningful data on the majority of issues generally relevant to this line of research.

As in all scientific enquiries, the quality of village archaeology depends on a proper research design, to be developed before any other activity is taken up. The first step is the identification of the particular research problems to be approached by any given project (**fig. 2**). This choice will be governed as much by theoretical considerations and the regional state of the art as by the available time and financial and staff resources; other factors such as personal preference and expertise as well as exceptional field situations calling for opportunistic strategies may also intervene. For example, in the face of some Early Iron Age house remains exposed by

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2 Units of archaeological interest below village level include residential quarters, households, houses, activity areas, and features. Beyond the village, research may focus, for instance, on micro-, meso-, and macro-regions, and on interregional networks. Although many pits, layers, middens, graves, furnaces etc. will once have belonged to villages, they need not necessarily be investigated at village level. For example, excavation and analysis of individual Iron Age pottery deposits, refuse pits, settlement layers, and burials scattered over a 700 x 400 km area in the equatorial rainforests of former Zaïre (Eggert 1983; Wotzka 1995) primarily aimed at the first-time establishment of a basic regional pottery sequence and an outline reconstruction of human settlement history in this previously unexplored terrain. Village-level archaeology, for which such a chrono-stratigraphic framework is a prerequisite, follows basically different objectives (fig. 1) and procedures (fig. 2); it is most usefully practised as part of a research design with a regional scope, such as Settlement Archaeology (e.g., Edwards 1999) or Landscape Archaeology (Fleisher 2013; Zimmermann *et al*. 2009).

3 Foot survey to determine the spatial scatter and variability of surface finds is a basic step in pre-excavation exploration. Where this fails to yield at least approximate site limits, and geophysical survey techniques like those exemplarily mentioned in the first paragraph are impractical or produce inconclusive results, a systematic soil coring programme by means of an auger (multiple traverse and/or grid coverage) may be of help. This should also prove useful for detecting soil and erosional variability across the terrain and help in assessing site history, environmental impact, and local archaeological potential.

- Site chronology, relative and absolute
  - Overall duration of settlement
  - Abandonment phases
- Locational factors and choices
- Village size (by period/phase)
- Village history (in relation to environmental and regional culture history)
  - Foundation; phases of growth or decline; continuous vs. discontinuous use
- Range of activities carried out within and around village limits; i.a., residential; subsistence (e.g., gardening; agriculture; animal husbandry; fishing; hunting); craft; burial; ceremonial and religious
- Village structure (synchronic and diachronic, i.e. by phase)
  - Size (dimensions; area; acreage of farmed/managed gardens, agrarian land, pasture, forest etc.)
  - Layout
    - Areas covered by residential buildings
      - Residential quarters
      - Persistent, newly built, and abandoned structures
    - Parcelling (lots; small holdings; farmsteads)
    - Non-residential zones (e.g., gardens; middens; activity areas)
    - Paths/lanes
  - (Average) number of contemporaneous houses
  - Public buildings/installations/features (e.g., village enclosures; earthworks; palisades; communal granaries)
  - Spatial organisation at house, quarter, and village level
- Housing and non-residential structures
  - Architecture (i.a., building materials; wall and floor construction; post pattern; roofing)
  - Dimensions
  - (Average) use-life of buildings
- Types of household, e.g.
  - Single-house
  - House + associated features (household cluster)
  - Farmstead
- Demography (synchronic and diachronic)
  - (Average) number of inhabitants per house
  - Total village population
  - Average house and population density (i.e., houses and persons per ha)
- Ancient function(s) of
  - The entire village (e.g. as inhabited special-purpose site)
  - Structures
  - Features (e.g., refuse disposal; loam/clay quarrying; structural elements of houses, enclosures etc.)
- Village/household specialisation (e.g., in agricultural, craft, exchange, or ritual activities)
- Position and role of the village within regional settlement hierarchy (where applicable)
- Sites and features associated with the village
  - Examples: Middens; workshops; furnaces; smithies; slag heaps; within-settlement burials; cemeteries; shrines; sanctuaries; harbours; markets; outpost camps
  - Geographic (incl. distances) and functional relationships to the village site
- Travel and transport infrastructure
  - Route ways to/from the village
  - Accessibility
  - Relative connectedness/isolation
- Site catchment (synchronic and diachronic, cf. Historical Ecology)
  - Potential, extent and patterns of human landuse around the village
  - Ecological impacts of human landuse (e.g., vegetation change; enhancement/diminution of biodiversity; landscape transformation; soil improvement; erosion; salinisation)
  - Potential, extent and patterns of human resource acquisition around the village
- Exchange relationships
  - Position and role of the village in (interregional) exchange networks
  - Nature and quantities of exchanged materials and items
  - Non-local plant, animal, and mineral resources: Whence and from what distances must they have come (cf. Flannery 1976b)?
  - Modes of exchange (e.g., reciprocal vs. asymmetric; directional vs. down-the-line)
- Position and role of the village in (interregional) ceremonial networks
- History of local and regional human nutrition
- History of local and regional social organisation, including
  - Family and clan structure
  - Social division of labour
  - Status behaviour
  - Power relations

Fig. 1. Examples of research questions relevant to village excavation. Although the list is not exhaustive it will usually be impossible to pursue more than a selection of these goals within a given project.

- Identification of research questions
- Location of relevant region
- Appraisal of available resources (time; staff; equipment; funding)
- Budget for analyses by external specialists (e.g., radiocarbon/luminescence dating; zooarchaeology; archaeobotany; pollen analysis; phosphate analysis; micromorphology; sedimentology; geology; archaeogenetics; stable isotope analysis)
- Research design
- Assignment of staff responsibilities
- Acquisition of photography, survey, and excavation permits (national; regional; local)
- Involvement of local communities (i.a., chiefs; titleholders; elders; landowners)
- Procurement of most up-to-date (ordinance survey) maps, aerial photos and satellite images
- Pre-excavation exploration of study area
    - Previous regional and local research (literature, museums, and archives survey)
    - Ethnographic/ethnohistorical (local museums, collections, residents)
    - Historical (e.g., documents; maps; photos; aerial views)
    - Computer screen survey of satellite imagery (where applicable)
    - Ground reconnaissance
        - Foot survey (fieldwalking)
        - Surface find surveying, registration, and sampling
    - Inventory of sites and relevant off-site features, each with
        - Place name (where applicable)
        - GPS coordinates
        - General description (topography; visibility; dimensions; access etc.)
        - List of collected surface finds
        - Thickness of deposits
        - Assessment of local archaeological potential relating to research questions
    - Coring and/or geophysical prospection of most promising areas to locate enclosures, houses, features, workshops, graves etc.
- Selection of site(s) for excavation
    - Detailed description of selected site(s), including environmental (geology; soils; vegetation) + landscape setting; circumstances of discovery; type of site (e.g. nucleated vs. dispersed village)
- Pre-excavation photography of selected site(s) and prominent features, including aerial, kite or drone photography as appropriate
- Pre-excavation surveying of selected site(s)
    - Location of trig stations with known coordinates (where applicable)
    - Site datum line and points
    - Site grid layout
    - Insertion into fixed point grid (where applicable)
    - Generation of overall site map including contour lines, topographic features, paths, roads etc.
- Probabilistic sampling
    - Shallow deposits: Test square sampling
    - Deep deposits: Transect sampling
- Pegging out and surveying of sampling units
- Excavation and documentation of sampling units
- Enlargement/fusion of excavated sampling units and/or excavation of additional areas as appropriate with regard to research questions
- Amendment of site map to show location, designation, and size of all excavated areas
- Refilling of all excavated areas
- Site protection measures as appropriate
- Presentation and publication of data, analyses, and results

Fig. 2. Village site excavation and protection: Workflow. (Partly after Joukowsky 1980.)

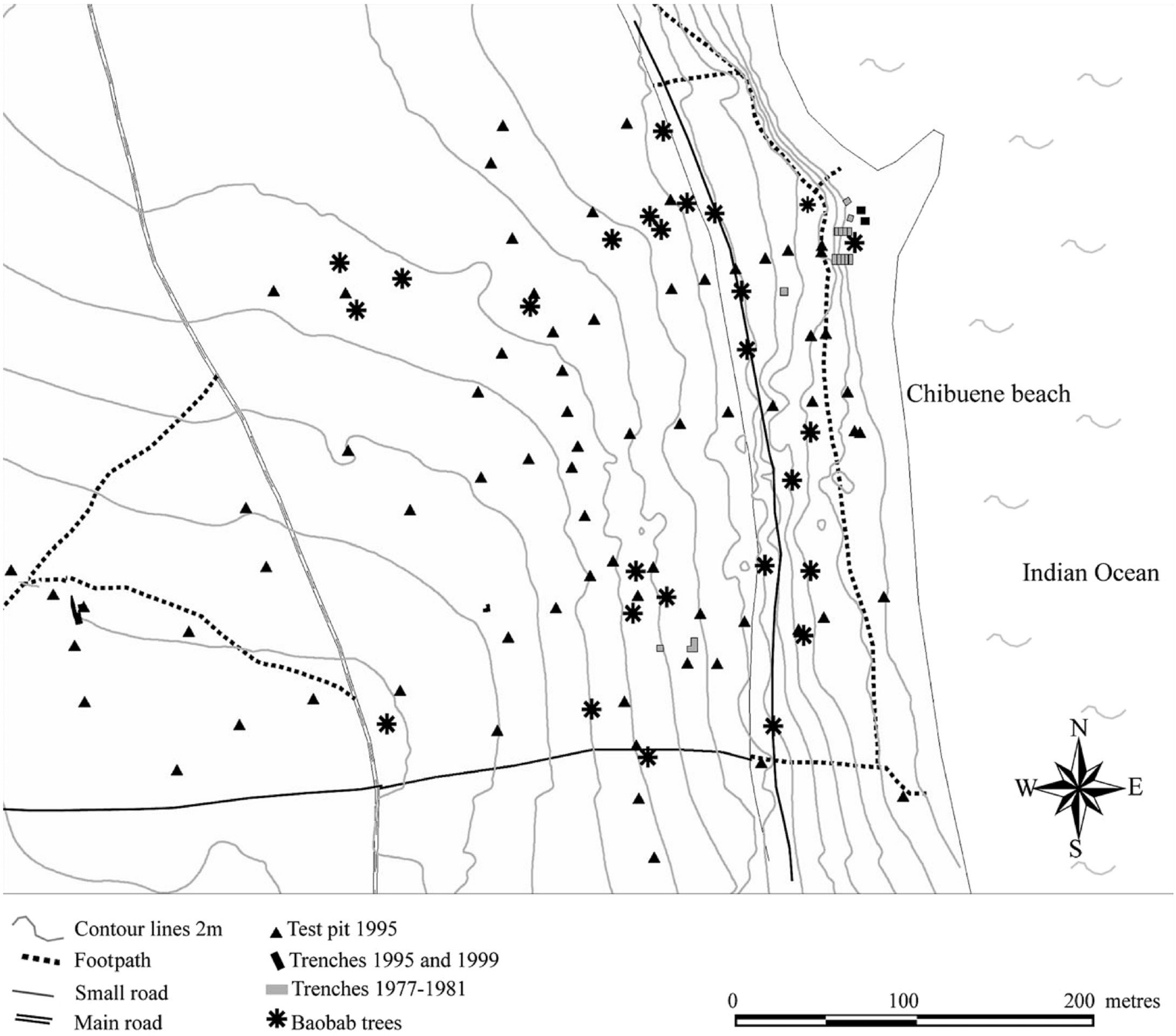

Fig. 3. Sampling units across a shallow Iron Age village site: The later first-millennium AD trade port of Chibuene on the Indian Ocean coast of Mozambique. (From Sinclair *et al*. 2012: 727 fig. 4.)

bulldozer activity it would clearly be unwise to engage first in a lengthy pre-excavation site survey, unless the variability of coeval houses from the same culture had already been sufficiently studied elsewhere in the region. Of course, more systematic approaches should be the rule, principally raising the question whether the specific state of previous knowledge might justify focussing new fieldwork on just one (or a very few) hitherto under-researched aspect(s) of ancient village life, such as house architecture, enclosures, middens, workshops or within-settlement burials, to the detriment of others. However, since village archaeology in most parts of sub-Saharan Africa has not yet reached a level allowing such selectivity, it will most of the time be important first to gain a representative sample of the entire range of relics present at the site of interest.

The sampling approach depends on the typical thickness of the sediments to be excavated. Estimates of this parameter may be gleaned from general site topography, previous work at the site, pre-existing natural or anthropogenic cuts, or from systematic pre-excavation coring.

A. Shallow deposits

Shallow deposits consisting of mostly disconnected sunken features less than about 2 m deep, such as (partially eroded) pits, postholes, ditches, or burials in virgin soil, may be investigated, for instance, by random sampling and complete excavation of an appropriate number of small 2x2 m squares (**fig. 3**); the same technique is adequate for once free-standing structures and features such as architectural remains, ovens, or middens covered by relatively shallow sediments. Smaller sampling units (e.g., 1x1 m) tend to hamper excavation, observation and documentation, and should be avoided if at all possible. Essential as such small test pits generally are for gaining an unbiased overview of shallow village sites, they will be insufficient when it comes to tackling more specific research problems. For instance, at some stage regional village archaeology will necessarily focus attention on the house as the basic structural module and central nucleus of family life at permanently inhabited sites. Questions relevant at this level, such as regularities and individual variability in dimensions, architecture, artefact categories, exchange objects, food remains, activity areas, and relationships to neighbouring houses (including distances, common orientations, shared installations etc.), obviously require considerably larger contiguous surface exposure optimally revealing complete house layouts.

Even more extensive windows into the past are needed in order to cover what has been called the household cluster in Mesoamerican archaeology, i.e. the house and all the surrounding storage pits, burials, middens, activity areas, ovens, and other contemporaneous features that can be reliably associated with that same structure (Winter 1976; Flannery 1976a). Depending on past cultural preferences of space use this may involve an area of 20 m diameter or more around any house. Therefore sampling units yielding house remains or other sufficiently preserved features of specific interest to regional village archaeology should by all means be systematically enlarged and/or joined as appropriate to be additionally excavated whenever this is compatible with the research strategy followed and the available resources.

Needless to say, if possible the maximum goal of any village project will be total excavation and generation of an overall settlement plan, unless regional village research had already reached a state making complete coverage dispensable. However, while total uncovering will remain an unrealistic objective in the majority of cases it may well be feasible little by little, for example during the course of several field campaigns in the framework of multi-season projects devoted to a single site. Even with such long-term strategies in mind it is advisable to start off by representative sampling and to join the initial sampling units successively later. In order to retain good stratigraphic control at all times excavation of adjoining squares should proceed in a chequerboard pattern. As with any sound archaeological field research design, this requires accurate insertion of sample and excavation squares into an appropriate overall site grid, preferentially by use of an electronic tachymeter, which optimally allows keeping surveying errors to within ±1 cm.

B. Deep deposits

Deep deposits resulting from accumulations of cultural debris as represented, for instance, by tell-like settlement mounds[4] require different treatment, mainly for two reasons: First, it would be unwieldy or even impossible to dig small squares down to several metres of depth, not to mention the difficulties this would entail with regard to documentation under poor lighting conditions and the observation of safety standards. Second, since such mounds are built up entirely of anthropogenic relics, such as debris from collapsed house walls, refuse, or the remains of craft activity, their whole sediment volume embedding individual features, artefacts and ecofacts is in principle relevant to village archaeology; it provides not only a matrix containing finds and potential sample materials for all sorts of scientific analysis, but also stratigraphic relationships and clues as to relative chronology, the nature and speed of site formation, building history, and phases of (partial) site abandonment, amongst other things. Ideally, and in contrast to most shallow contexts, a human-made deep village deposit can and should be analysed and understood as more than just the sum total of a number of spatially separate features and finds, namely as a coherent entity with more or less clear limits and a decipherable overall stratigraphy and formation history.

One approach suitable for exploiting the specific potential of deep village deposits is transect sampling in random directions. Optimally, this involves the complete excavation of several oblong trenches radially cutting through the entire site including its centre(s). Where this is impossible, one or two (partial) cuttings, if necessary only from one point at the outer limits to the centre, will

4 Not to be confused with shallow human habitation sites on natural elevations such as hillocks, rock outcrops, or dunes.

Fig. 4. Oursi hu-beero, northern Burkina Faso: Part of an excavated medieval village site composed of dispersed settlement mounds, dating to *c*. 1100 AD. For public display, a house complex in mudbrick architecture has been elaborately preserved and protected by means of a roofed structure admitting natural light. The site has its own museum, erected right next to it and opened in 2006 (Petit *et al.* 2011). (Photo © and courtesy of C. Pelzer, Bamako.)

have to suffice. Although this will frequently be inevitable, especially with large sites, it considerably decreases the likelihood of obtaining a representative sample.

For safety, cuttings through deep deposits must be wide enough at the top to allow for sufficient side battering or even stepping, depending on the stability and homogeneity of the deposit at hand. By way of example, cuttings into the Daima mound in northeastern Nigeria were up to *c*. three times wider at the top than at the bottom (Connah 1981: 104 fig. 6.3). The Daima transects were subdivided into parallel rows of 2x2 m squares and excavated in chequerboard pattern with individual documentation, a procedure generally recommended for exposing large surface areas. However, the long and deep sections resulting along the sides when transect excavation is complete are best photographed and drawn in a single pass after subdivision into one-metre squares by mason's string, although it is generally advisable to outline layers and features visible therein already right after exposition, i.e. before the sediment dries out and hardens. By virtue of their dimensions transects are usually superior to individual sample squares in offering more complete views of features, but they will eventually suffer from the same limitations and may therefore also be enlarged and/or supplemented later by further excavation according to research requirements and resources.

CONCLUSIONS

To conclude this cursory consideration of village excavation some more general suggestions seem appropriate. First, wherever feasible, excavation should follow natural or human-made layers and features instead of artificial horizontal spits, although a mixed technique will often be a reasonable and effective compromise; the many sections arising from archaeological work in small-area units as well as pre-existing cuts resulting, for instance, from erosion, mining, quarrying, or pit digging, may be used as convenient starting points for stratigraphically controlled exposure. Second, the investigation of village sites is likely to produce a wealth of varied observations on a multitude of features and structures. Keeping track of this complexity is greatly assisted by assigning unique feature numbers across the whole site, and using a documentation system involving separate data cards or sheets for each feature and fieldnotes that strictly follow a numbered activity log by feature and date. Third, unexcavated village remains are no different from other archaeological sites in that they are most effectively protected by leaving them untouched. Proper refilling of excavated areas is compulsory for various reasons, including site protection. The involvement of local communities in active site protection measures can be invaluable, but it may have adverse effects when it fails to prevent looting as a potential outcome of insufficient sensitisation (see David, this volume, pp. 49-52). A particularly felicitous example of the partial conservation and public presentation of excavated village structures administered by local residents can be found at the medieval site of Oursi hu-beero in northern Burkina Faso (**fig. 4**).

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THE PIT: ARCHAEOLOGICAL EXCAVATION AND ANALYSIS

Alain Assoko Ndong[1]

INTRODUCTION

The pit is an archaeological structure frequently found in Central Africa, especially at sites dated between the Neolithic and the end of the Early Iron Age, or from the 9th century B.C. to 1300 A.D. Moreover, a large majority of archaeological research focuses on sites characterized by the presence of pits, and, with practice, it is not difficult to detect a site of this nature by examining soil, road embankments, recently levelled areas, etc. (see this volume, Oslisly, pp. 42-44 and Eggert, pp. 60-64).

This type of structure appears in different forms, but its excavation is quite standardized. It is a question first of understanding the structure's historical stages, covering its creation, use (for example, as a mud pit), possible reuse (for example, as a rubbish pit) and, in the end, natural filling in. The excavation method varies according to available time and resources but always respects a few important archaeological principles.

I. THE PIT

The pit is a hollow structure. It often contains relics used, adapted or made by humans and environmental remains likely to tell us something about their lifestyle and the climate they lived in. The motivation for digging a pit could vary, such as meeting the need for:

- graves;
- latrines;
- wells, ores, ceramic, etc.;
- aquaculture;[2]
- silos;
- mud;
- rubbish dumps, etc.

But whatever the motivation, the abundance, variety and state of archaeological remains in a pit confirms that it is anthropogenic and that it ultimately served as a rubbish dump.

The pit appears as a spherical feature in the ground, of a darker colour than the surrounding earth (**fig. 1**). Its morphology can also be in relief (**fig. 2**), owing to water erosion. Runoff waters attack the backfill and the surrounding earth with differing intensity. Ablation of the soil around the pit occurs more rapidly than that of the backfill, which ferrallitization hardened. This is why some pits are mound-shaped (Assoko Ndong 2000). The diameter of the pit barely exceeds l.5 metres. In cross-section, its profile can be conical or concave and its depth around two metres.

Digging a pit could be a large investment in terms of time and effort. Consequently, it seems feasible that the pit became the historical property – on par with latrines – of a nuclear or extended family.

II. PIT EXCAVATION TECHNIQUE

Typically, pits are isolated from one another, although it is not extremely unusual to see two pits superimposed. But since young researchers are too inexperienced to undertake the paleoethnological excavation of a site containing more than one pit, these structures are usually approached individually.

A. Grid

Nevertheless, given that archaeological excavation is a destructive activity, surveys at different scales should be planned, because they allow us to remember what has been destroyed. The first survey consists of superimposing a grid on the surface of the site. This facilitates measurements and recordings as well as indications of where structures and remains were discovered. In practice, the grid – made of rope – divides the site into several square sections. Each section is an excavation unit one to five metres wide and assigned an alphanumeric code (example: square C4 or A7, etc.). The grid is marked by an immovable point – the site's reference point – located outside the excavation area. This is the starting point for all horizontal measurements. If vertical measurements must be taken, the site level (or the theodolite) is positioned on the reference point, and its height is measured. This is the site's altitude zero. It is used to determine the depth of remains. The grid thus allows surveys to be undertaken at scale for the entire site.

B. Identification, cleaning and photography

After identification, the pit and its surroundings are cleaned in preparation for the first small-scale surface surveys, namely photo shoots and drawings.

During shooting, the camera is set so that the photo-

1 Université Omar Bongo, Libreville, Gabon.

2 See Lanfranchi & Schwartz 1990: 495 and Mbida 1996: 217-219.

graphs will be up to standard in the event of publication. Among other things, a compass and a north arrow photo scale (**fig. 3**) are required. In photos, the north arrow photo scale will indicate magnetic north and allow for understanding the actual dimensions of the photographed structure.

A letter board (**fig. 4**) showing the site name, excavation date, structure number, etc., can enhance the photographic survey. Alternatively, a slate can be used.

Furthermore, a drawing board, graph paper, mechanical pencil and eraser are indispensable. The small-scale surface survey is complemented by drawing, which photography is not yet able to replace.

C. Determining the excavaton axis

To excavate such a structure, it can be cut into two or four parts. The following example describes a pit cut into two parts.

Using twine tied to embedded stakes, a right triangle is traced in the soil. The Pythagorean theorem, according to which ‘the square of the hypotenuse is equal to the sum of the squares of the other two sides’, is used to determine the length of the two sides that form the triangle’s right angle; the system is commonly called 3/4/5 (**fig. 5**).

The goal is to stake out a rectangle marking where to dig the trench in order to excavate the pit. This rectangle is obtained by repeating and inverting the right triangle (**fig. 6.1**) made using the 3/4/5 system. The length of this rectangle, passing over the pit, divides the latter into two equal parts (**fig. 6.2**); its perimeter is 14 m and its area is 12 m². The first small-scale (1/10) recording of the surface can be applied to the horizontal survey of the pit if its contours are reflected on the ground rather than in relief (**fig. 7**).

Without losing any information, the dimensions of the trench can be reduced: the perimeter to 12 m and the area to 8 m² (see hatched part of fig. 6.2). Note that the maximum diameter of the pit opening is typically less than or equal to 1.50 m. The first half of the pit to be emptied is within the hatched rectangle.

D. Excavation

Excavation can be performed by artificial stratigraphy of 5 to 10 cm, to below the base of its profile. The contours of this profile should appear clearly in the wall of the trench (**fig. 8**).

Within each artificial stratigraphic unit, different archaeological contexts can sometimes be distinguished. For example, the excavation unit from 10 to 20 cm can

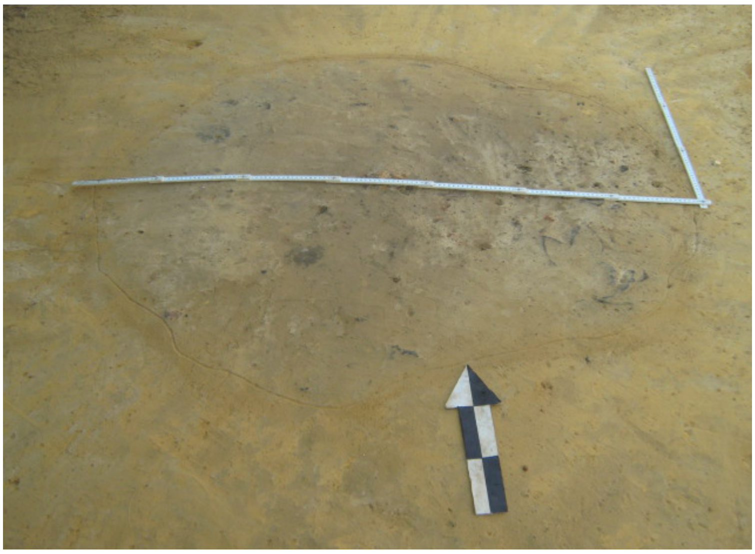


Fig. 1. Pit containing pottery shards and charcoal. (Photo © A. Assoko Ndong.)

Fig. 2. Pit in relief. (Photo © A. Assoko Ndong.)

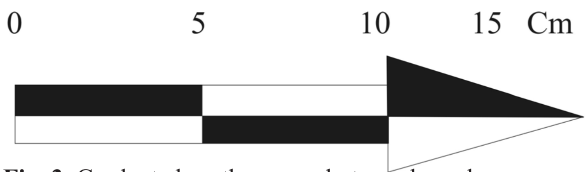


Fig. 3. Graduated north arrow photo scale scale.

Fig. 4. Letter board. (Photo © R. Oslisly.)

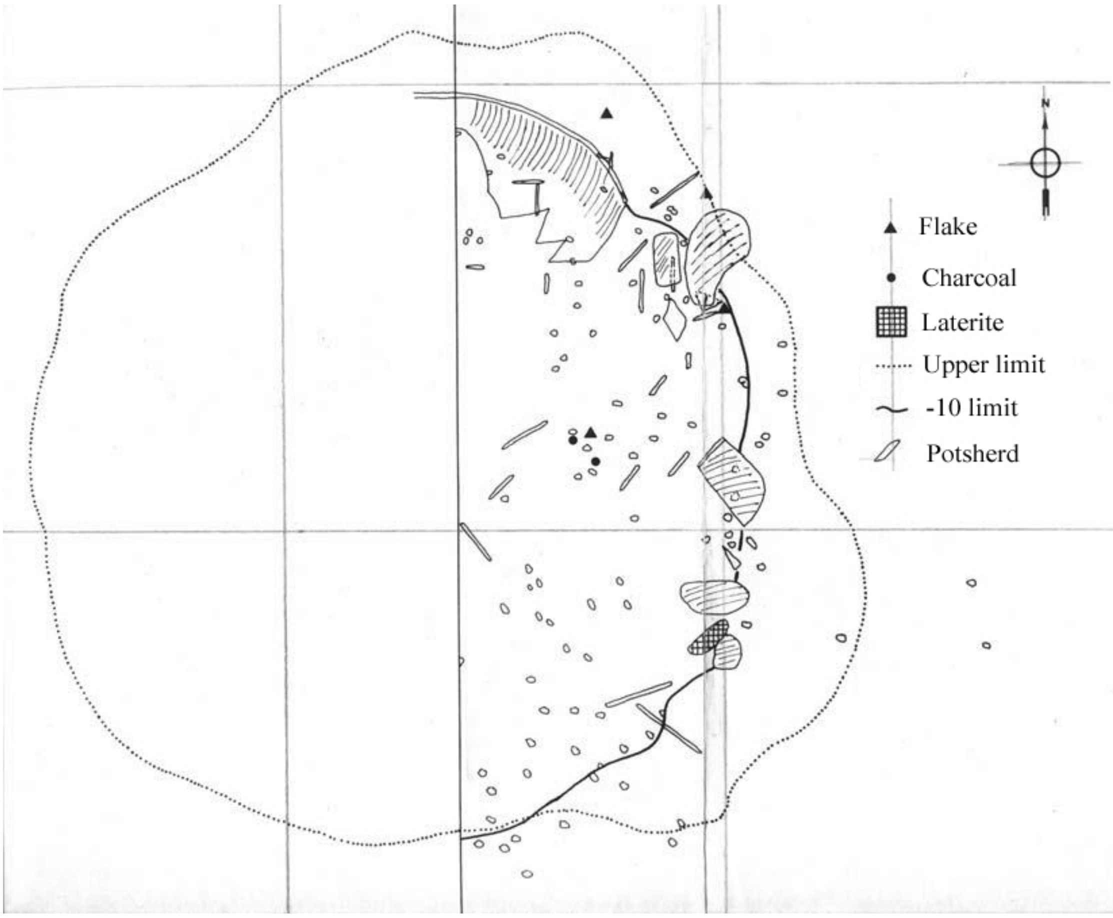


Fig. 7. Diagram of pit XXII of Okala (Clist 2005: 403). This site was excavated from 27/02/1989 to 10/03/1989, by Assoko Ndong and other students (PNUD/CICIBA training).

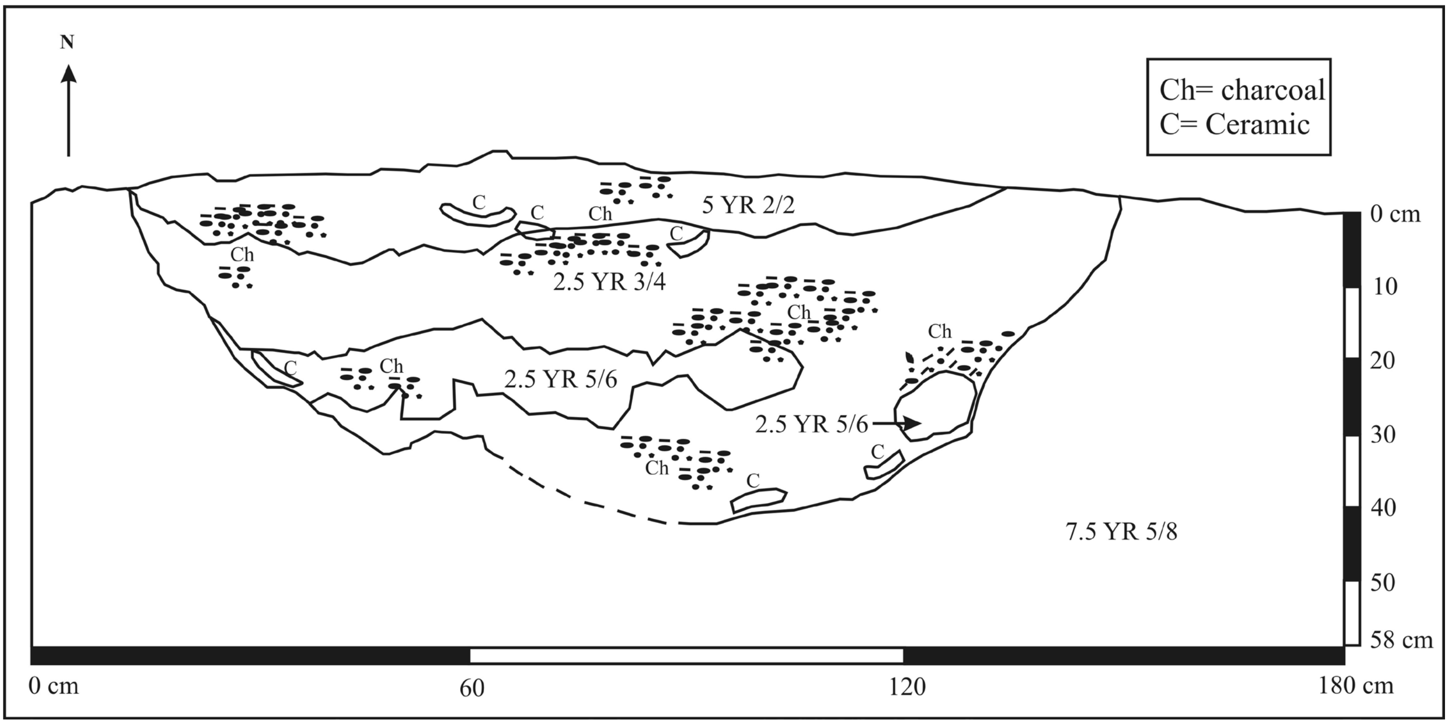


Fig. 10. Survey of a cross-section scaled 1/10.

include part of the surrounding soil, generally void of archaeological material, which will be called stratigraphic unit 1 (or SU1); a black sandy part rich in charcoal and archaeological material, which will be called stratigraphic unit 2 (or SU2); and a red clay part, with scant archaeological material, which will be called stratigraphic unit 3 (or SU3). These stratigraphic units must be distinguished during excavation, if a detailed description of the filling is needed. Another solution is to cut the structure into four pieces, like a cake. Two opposing quadrants are excavated in 10-cm increments, then after having surveyed the cross-sections (photography and drawing), the other quadrants are emptied by following the visible cross-sections.

Progressively, artefacts are collected in plastic bags labelled with the date of excavation and site, structure and layer references, etc. Charcoal and other environmental remains are preserved in separate referenced bags on which the depth of removal in particular is indicated (see Bosquet, this volume, pp. 152-156).

As soon as the entire profile of the pit can be discerned, the walls and bottom of the trench are levelled and cleaned. Artefacts embedded in the pit cross-section are left in place to be photographed and recorded in the profile-drawing (**fig. 9**).

The cross-section is reproduced on graph paper scaled 1/10, emphasizing, if possible, all visible natural and anthropogenic filling layers, which are also surveyed and referenced using soil colour coding (Munsell or Cailleux) (**fig. 10**).

Thereafter, the second half of the pit is excavated in the same way as the first. Removal of remains and samples will be performed according to the same principles of artificial stratigraphy.

In the laboratory, remains are cleaned, dried and numbered according to artificial stratigraphic layer. Each of the remains has a code (example: 7/-3-SU2): this code refers to the number of the structure (7) and that of the artificial stratigraphic layer from which the item was collected (-3, for the layer -20/-30 cm). SU2 refers, as the case may be, to the specific context identified during excavation.

The part of the code concerning the layer takes into account the pit's morphology. The digit referring to the layer is preceded by a + sign if there is relief (example: +3), by a - sign if there is none (example: -3).

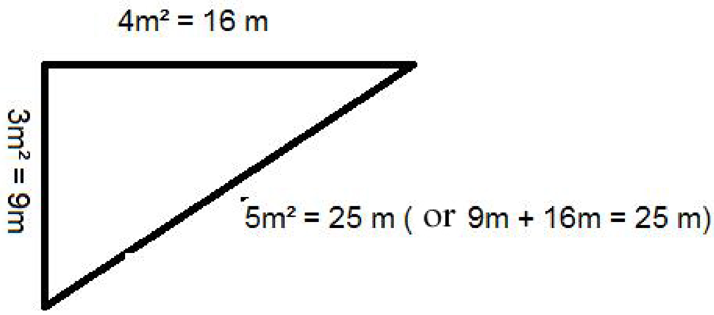
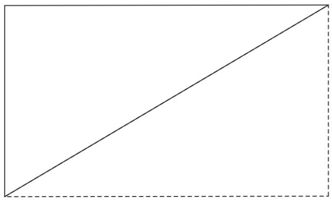


Fig. 5. Pythagorean theorem (3/4/5 system).



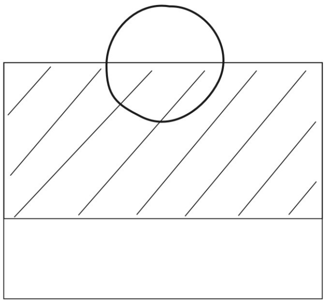


Fig. 6. 'Triangle rectangle' (6.1) and hatched trench excavation (6.2).

Fig. 8. Pit profile. (Photo © R. Oslisly.)

Fig. 9. Remains left in the trench wall. (Photo © R. Oslisly.)

Artificial stratigraphic layer – spits (cm)	Individual vessels (V)				
0 to -10	V1				
-10 to -20	V1				
-20 to -30	V1		V3		V5
-30 to -40		V2	V3		V5
-40 to -50		V2	V3		V5
-50 to -60		V2	V3		V5
-60 to 70		V2	V3		V5
-70 to -80			V3	V4	V5
-80 to -90			V3	V4	V5
-90 to -100				V4	V5

Fig. 11. Theoretical example of vertical distribution of shards.

III. WAYS OF INTERPRETING PIT BACKFILL

This part is founded on micro-stratigraphy and the vertical distribution of pottery shards. What fills the pit is simultaneously anthropogenic and natural. Anthropogenic backfill is comprised of domestic rubbish and archaeological remains. Natural backfill is comprised of sediment carried by runoff water.

Micro-stratigraphy is concerned with understanding the placement and deposit sequence of backfill layers and their number, dominant colour, thickness, texture, archaeological load, age, etc. It helps distinguish the surrounding earth from the pit's contours. When, for example, the pit remained open on a slope for a long time, runoff water erodes the walls, often resulting in an enlarged upper profile, indistinct pit contours and ambiguous layer colours.

Rigorous numbering of remains can help clarify how the pit filled up, mainly by interpreting the vertical distribution of pottery shards. This helps develop arguments on how long it took to fill a pit. Refitting potsherds (see Livingstone Smith and de Francquen, this volume, pp.173-179) leads to the identification of individual vessels and also helps determine any connections between layers (**fig. 11**).[3] Refittings spanning upper and lower layers indicate that all the backfill is almost contemporaneous and that the duration of filling had to be relatively brief – it is possible that use of the pit did not outlast a single generation. Conversely, lower and upper layers can yield containers that are in every way dissimilar. It is thus necessary to envisage distinct backfilling phases, and it could be interesting to date each layer.

CONCLUSION

One of the most widespread structures of the last 3,000 years, the pit is found very regularly in archaeological sites in Central Africa. As it was the property of a family, the pit is an archaeological structure that usually yields a rich and varied heritage that, when well analysed, can tell us about the lifestyles of prehistoric humans, their environments and the climates they lived in.

Such structures are excavated by cutting a trench that splits the pit in two, revealing within it the evolution of activities and industries.

Consequently, the archaeologist may try to discern layers of backfill and the distribution of remains therein, in order to interpret their placement and how long it took to refill the pit.

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3 The distribution of shards of containers 3 and 5, contemporaneous with the other containers, suggests relatively rapid filling of the pit.

EXCAVATING IN URBAN CONTEXTS

Jeffrey Fleisher[1]

INTRODUCTION

The archaeology of ancient urban contexts is an extremely rewarding but complicated process. Cities and towns are often the locus of socio-political, economic, and religious power, and they contain crucial centralized features that are essential to the understanding of regional polities. However, because they are often densely populated and long-inhabited, they generally present deeply-stratified and complicated archaeological settings. This chapter will provide an overview of how to approach urban sites archaeologically, and the challenges that archaeologists of the continent face in investigating them.

I. WHAT CAN WE LEARN FROM URBAN CONTEXTS?

The study of urban contexts provides crucial information about the nature of regional power; it is widely recognized that urban centres are important loci to examine how power is configured, whether through the control over religious practices, economic production and distribution, and the ideological means through which these are established and maintained. The archaeology of urban contexts has changed significantly over the last 50 years, shifting from a more normative approach that was based on Near Eastern and Western urban examples (e.g., Childe 1950) to approaches that better recognize the diversity and variety of urbanism across the world. This shift in thinking may be understood as moving from a definition of cities based on their traits to one which focuses on their functions (McIntosh and McIntosh 1984; LaViolette and Fleisher 2005). Accordingly, the types of contexts that archaeologists have traditionally investigated in urban settings have included those that help to reveal their function, such as specialized religious structures and production areas, elite and non-elite housing, community buildings or other public monuments, and cemeteries or other memorial zones.

II. EXCAVATIONS

The issue of where to place excavation trenches is addressed in a previous chapter (see Fleisher this volume). Because urban sites are often occupied for long periods of time, they can contain deeply stratified deposits. Therefore, before excavation begins, the archaeologist must decide the aim of any excavation unit – is the goal to excavate through the entire stratigraphy, providing a full chronological/developmental understanding of the site? Or is the goal to recover particular types of contexts, from particular periods, which may be found at certain depths below the ground surface? These considerations will determine whether an archaeologist will decide to use vertical or horizontal excavations.

A. Approaches to excavations

Deep, vertical soundings are best suited to excavations that hope to recover the full stratigraphic sequence of a settlement. These excavations will provide a more detailed understanding of an urban site than the test pits discussed previously. Larger, horizontal excavations are more appropriate for understanding the relationship between features and artefacts within particular periods of the site – this type of excavation is necessary if houses or other built features are to be excavated and interpreted.

In either case, there needs to be careful planning to determine how long it will take to excavate a particular trench; such plans will necessarily include an estimate of the team required to excavate a trench and, if the excavation process will occur over a number of seasons, how the trench will be protected. Because of the rainy seasons found in many parts of Africa, it is often not advisable to leave excavations open between seasons and so trenches may be temporarily backfilled between seasons.

B. Recording the excavation

Because of the complexity of urban archaeological deposits, the excavation process needs to be well-planned, and with an established recording procedure firmly in place before excavation begins. It is wise to adopt an established recording system, such as that offered by the Museum of London Archaeology Service (MoLaS),

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Fig. 1. Paleoethnobotanist Sarah Walshaw working with flotation at Songo Mnara, Tanzania. (Photo © J. Fleisher.)

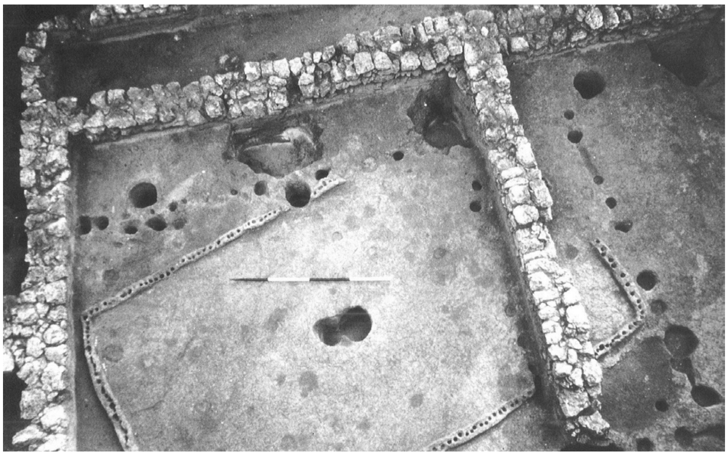

Fig. 3. Overlaying mosques at Shanga, Kenya (from Horton 1996).

which offers sample forms and a detailed description of all recording procedures. By adopting such a system, archaeologists guarantee that the recording of excavations will be consistent between trenches and different excavators. The use of forms ensures the uniform recording of data between layers and trenches; this includes complete recording of soils (texture, colour, compaction) and their inclusions, the thickness and extent of excavated contexts, the association of artefacts with particular contexts, and all additional data recording methods (maps, photographs, total station measurements). For all excavations, contexts should be recorded photographically (with a scale and north arrow) and scale plans and sections drawn. In addition to notes taken on forms, both trench supervisors as well as excavators should keep daily notebooks to record work completed, observations, and interpretation. There also needs to be a pre-established system of screening and sampling; in general, all soils are screened, at a mesh size appropriate to the soils and artefacts. Other sampling procedures – such as soils for flotation or geochemistry – should be established prior to the start of excavations, in consultation with project specialists (see Bosquet, this volume, pp. 152-156).

III. DATA PROCESSING IN THE FIELD

Because urban contexts often contain thousands of artefacts, a procedure to collect and process a full range of materials (e.g., lithics, ceramics, bone, glass, textiles, and metals) must be established. This procedure must cover the full path of artefacts, from the ground to long-term storage. This process includes the bagging and labelling of materials in the trench, washing in the field (if appropriate), preliminary sorting and analysis in a field laboratory, full cataloguing, analysis, and reporting. Many materials will require conservation prior to long-term storage, and this process should be considered before excavation begins.

In order to effectively and appropriately process the full range of archaeological materials from urban contexts, it is important to have a team of specialists to advise and oversee the field work, sorting and analysis. This will include ceramic, metals, lithic, and faunal specialists, as well as paleoethnobotanists and geoarchaeologists to assist with the soil sampling and processing (**fig. 1**). If it is not possible to have these specialists in the field, it is important to create excavation and conservation plans with them prior to excavations.

Increasingly, urban archaeologists are using integrated databases for their data collection and analysis, and a number of open source database systems are available, such as the Integrated Archaeological Database (http://www.iadb.org.uk/). Such a system allows for the different forms of information to be integrated into a relational database. Such a system allows for the correlation between strata and artefacts across an urban settlement, the basis of any interpretive work with large archaeological assemblages.

CONCLUSIONS

As described here, the archaeology of urban contexts must include multi-stage research that has been well-

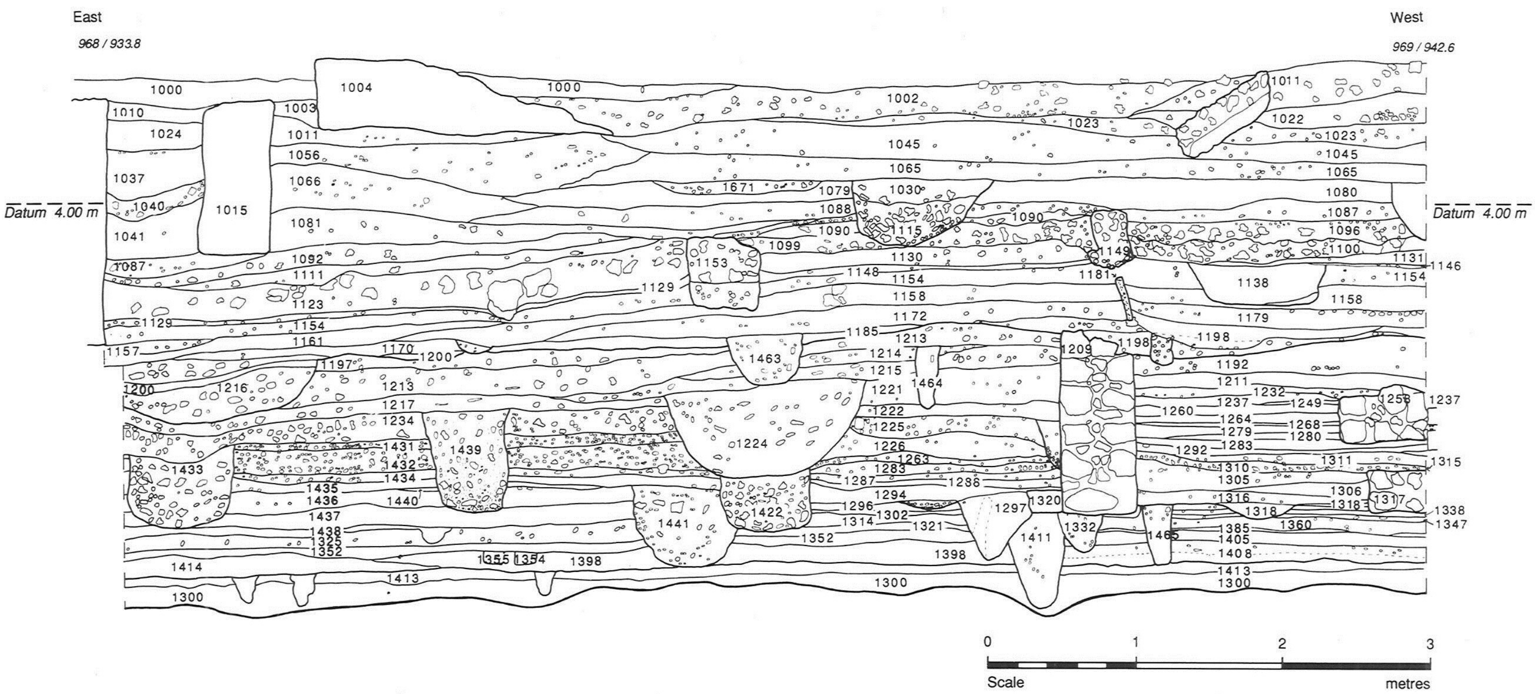

Fig. 2. Section drawing from the site of Shanga in the Lamu archipelago, Kenya (North section of Trench 1; from Horton 1996).

planned and crafted to address the research questions posed. As should be clear, the logistical challenges are great in carrying out research at urban contexts. Beyond these, urban contexts offer other challenges as well, including complicated stratigraphy and site formation processes, data quantity issues, and practical concerns such as onsite safety and site protection.

A. Dealing with complex sites

Because of the density and longevity of occupation, the stratigraphy of urban contexts is complex and challenging (**fig. 2**). This requires a firm understanding of how to disentangle the stratigraphic record, to learn what formation processes led to the creation of the archaeological record (**fig. 3**). Excavators must have good knowledge of the types of cultural and natural processes that likely contributed to the construction of the archaeological record: were strata deposited through active human deposition – such as trash disposal – or through the natural accumulation of soils – such as through windblown soils or erosion. Additionally, as the stratigraphy of urban sites build up through time, destructive processes (both human and natural) can remove evidence of previous occupations and activities, and urban archaeologists need to be able to assess and understand these processes.

B. Managing large quantities of data

Since urban contexts are often the location of dense human occupation, such sites often include tens or hundreds of thousands of artefacts. As already discussed, this requires established systems to excavate and track these artefacts. However, urban archaeologists also need to understand how and when to sample excavated contexts and artefact assemblages. Consistency and transparency in how and why assemblages were sampled is crucial; a well-analysed sample of material is much more useful than a large assemblage that remains unreported. For example, archaeologists often find thousands of fragments of locally-made pottery in urban excavations. If it is not possible to analyse all these fragments, an archaeologist might randomly sample a percentage of the assemblage – perhaps 10 or 25%. It is crucial that the archaeologists report fully the sampling procedure and how it was carried out. Sampling must aim toward ensuring that a representative sample is taken. In the case of ceramics, one must not, for example, take only decorated sherds – a sample should approximate the full range of materials in the assemblage.

C. Safety first

Finally, the health and well-being of both researchers and the site itself is of primary importance. Onsite safety includes an understanding of potential threats at the site (snakes, wild animals, weather systems, political disturbances). Onsite safety should include an emergency medical plan for hurt or sick team members, including medical evacuation protocols. Because urban contexts often involve the excavation of deep trenches, onsite safety also includes plans to keep excavators safe from wall collapse and other potentially dangerous situations.

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MEGALITHISM

Luc Laporte[1]

INTRODUCTION

The excavation of a megalithic site is not fundamentally different from that of any other archaeological site. The constraints are the same: as field work progresses, observations can never be exactly identical to ones previously made. On this matter, the practice of archaeology bears some similarities with that of astronomers and astrophysicists whose measures describe an object of study that probably no longer exists in quite the same state.

Moreover, the success of any archaeological excavation depends on the relevance of the questions as well as on the excavator's capacity to disregard them when facing unexpected observations. Making oneself receptive to what is special about each site, each place, each vestige is part of the exercise. Consequently adapting the implementation of excavation techniques, study methods or analytical frameworks often requires extensive knowledge of the subject under study but also extensive know-how and relevant field experience. And then, as with all archaeological excavation, it is a question of teamwork and thus also of a human enterprise.

In this chapter, we will focus on a few of the features unique to the excavation of a megalithic monument. By megalithic monument we mean any human contruction at least partly made of very large stones, usually displaced, erected or gathered together, and that retain, to our eyes at least, something of their natural outcrop appearance. By extension, we include any contemporary architecture showing similar characteristics, even if they were built with different materials (**fig. 1**). Megalithic monuments are sometimes found in very different forms and contexts.

On the African continent, the works of G. Camps (1961) in the Maghreb and R. Joussaume (1974) in the Horn of Africa are among the most remarkable. F. Paris (1996) revealed funeral monuments in Niger nearly as old as the better known ones of Atlantic Europe. Other forms of megalithism were identified in Mauritania (Vernet 1993) and Mali (Person, Dembele & Raimbault 1991), as well as in Senegal and Gambia (Todd & Wolbach 1911; Jouenne 1918). Still others exist in, for example, Guinea, Burkina Faso (Millogo & Kote 2000), Cameroon (Asombang 2004; Notué 2009), Chad, and Central African Republic (Zangato 1995). Contemporary forms of megalithism have long persisted in Madagascar, while such traditions are still active in the Konso area of Ethiopia (Joussaume 2013).

I. ESTABLISHING THE MISSION

The issues raised by the archaeological study of a megalithic monument can be as varied as the perception of space and architecture, funeral and ceremonial practices, or technical systems. But they often also concern the chronological and cultural setting, territories, the symbolic, and the organisation of societies. As monuments are made of stone, the questions of the geographical origin of the raw material or, where applicable, how they were extracted are crucial. Any answers to these questions will have to be compared with many other fields of study related to, for example, settlements, archaeological materials, or interactions between humans and their natural environment. Finally, such considerations will benefit from further observation of the practices of the people still living on the continent (Joussaume 2003; Gallay 2012).

A. Teamwork

Attempting to answer these questions can no longer be the work of one person. Equipping oneself with the necessary skills to address the relevant questions is just as important as the search for funding, which so often takes precedence. Transferring this knowledge, while providing training for one's staff in the field, is equally impor-

Fig. 1. Wood (Waka) and stone steles from Konso. (Coll. R. Joussaume)

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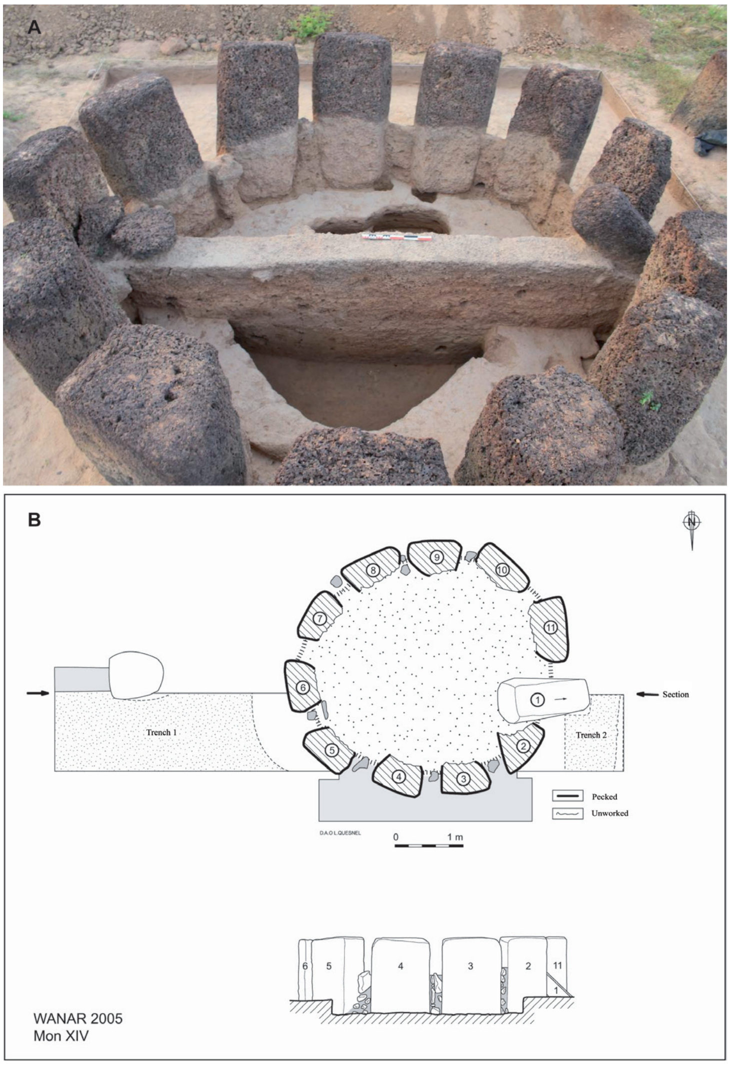

Fig. 2 Excavation and survey of Senegambian megalithic circles. (**a**) Monument XX of the Wanar necropolis (coll. L. Laporte); (**b**) Results of a first survey of monument XIV at Wanar.

tant. This of course includes students of different nationalities who might be involved in the project. But it also includes all technical staff. As an example, in the small village of Wanar, Senegal, some of the locals acquired skills on par with a qualified excavator from France's Institut national de Recherche en Archéologie préventive in just a few years . The quality of the results yielded by the excavation of the megalithic site of the same name owes much to them.

B. The choice of intervention period, and preliminary work

In a zone of contrasting seasons, the choice of when to intervene is crucial. We will see that it must match the goal in question. Material preparation for the field mission is an important phase in which on-site living conditions (particularly sanitation), accessibility, and personal security must be taken equally into account. To this point in sub-Saharan Africa, the implementation of large-scale, controlled mechanical stripping of soil around megalithic monuments do not appear to have been attempted, which may or may not be linked to questions of equipment availability or transport.

II. FIELD PRACTICE

The characteristic feature of a megalithic monument, compared to other archaeological ruins, is that it is often easier to notice in the field. Still today, it marks the landscape. Therefore, the research methods will be those the archaeologist applies to any type of architecture. Remember, however, that the bulk of information is initially invisible. This is firstly because the material elements we see today are quite often only the ruins of a now-vanished, more vast or elaborate structure. This applies to a single stone raised in isolation as well as to the many stones that constitute the framework of a dolmen. Secondly, most of this information is now buried, spared truncation by an erosion process that requires definition. A precise topographical survey of the exposed ruins is necessary before all further intervention.

A. Surveys

The best time to pedestrian survey is, of course, the dry season, when vegetation is low. In densely populated farming areas, planting season can also be favourable. An oral survey of villagers can prove very productive. To locate identified ruins, in the absence of sufficiently precise or current maps, satellite photos are now very easily accessible. Access to aerial photos can sometimes prove more complicated. Moreover, those taken during the colonial period are not always locally available. At the site scale, beyond the topographical surveys that require the use of suitable equipment, geophysical surveys help to identify many of the peripheral structures. Radar seems a particularly efficient method for sand burial mounds, especially to locate the burial chamber.

B. Construction analysis

The study of any architecture that is still standing requires specific records (maps, cross-sections, construction, axonometric or three-dimensional diagrams, etc.). On initial examination, manual drawings entry is often preferable as it sharpens our observation skills (**fig. 2**). Certain software programmes can now generate three-dimensional scatter diagrams from a sufficient number of digital images. This is the principle of photogrammetry.

Fig. 3. Extensive digging at the Wanar site. (Coll. L. Laporte.)

Scanner technology is continuously improving. Nevertheless, owing to the costs involved, it is necessary to first establish very stringent and precise specifications. Studying the building site is a supplementary component that, in addition to the nature of techniques implemented *in situ*, mainly includes the origin of raw materials, how they were transported, and the quarries from which they came – an economy of megalithism, in a way, which cannot be entirely dissociated from its social and environmental context (Laporte *et al.,* 2014).

C. Stratigraphic analysis

Owing to deflation or very active pedogenesis, many soils containing archaeological remains in sub-Saharan Africa are known for not revealing much stratigraphy. Our own experience tends to put this point into perspective, first showing that different stages marking the ruin of a monument often leave layered remains in the surrounding soil. They can thus be evaluated in relationship to the horizontal deposits (stone layers, gravel/cobble, etc.) buried in the immediate vicinity of the megaliths. Revealing such remains entails a very detailed and extensive excavation, somewhat like the famous excavations of the prehistoric site at Pincevent (Leroi-Gourhan & Brézillon 1966). Second, our experience shows that the moistening of sediments during the rainy season makes these stratigraphic elements a bit easier to read than they are during the dry season. In our case, an intervention at the end of the rainy season, or shortly afterwards, as soon as the site was accessible, helped us to identify pits (trenches, silos, post holes, etc.) at each soil level, and even to reveal what was once above-ground construction (earth walls). The use of micromorphology is sometimes necessary (**fig. 3**).

D. Analysis of burial levels

Not all megaliths are associated with graves. When the latter are present, they can be studied using methods developed by H. Duday (2005). Inspired mainly by concepts of forensic medicine, such analysis differs from other physical anthropology studies as it requires the on-site presence of a specialist. Failing this, the information gathered on burial methods and the decomposition of bodies risks being lost forever. More generally, accounting for the taphonomy of the burial levels also includes all deposited goods or features made of perishable materials. In addition, too few palaeogenetic tests have been performed to date; the reputation that fossil DNA preserves poorly in tropical climates warrants wider, case-by-case, confirmation.

III. RESTORATION AND USE OF RESULTS

The heritage aspect of archaeological research of megalithic monuments in Africa cannot be neglected. When well-managed, it is a field in which the production of new knowledge contributes to national wealth. Two sets of megalithic sites have been classified as UNESCO World Heritage: the megalithic steles at Tiya and in the Konso Cultural Landscape in Ethiopia; the stone circles of Sine Ngayène and Wanar in Senegal and Wassu and Kerbach in Gambia.

Maintaining excavation archives, as with archaeological material, is the prerogative of each state. But scientific publication of results – particularly in international journals – is also an important guarantor of data acquired during different field seasons. The publication of monographs is essential (Joussaume 2007). Particular attention has to be paid to increasingly abundant digital archives whose long-term conservation can sometimes encounter problems.

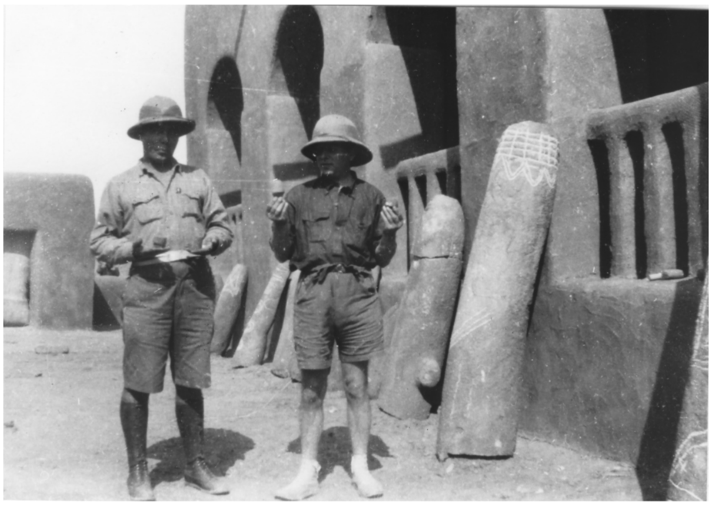

Fig. 4. Toundidarou megaliths. (IFAN archives, Dakar.)

Local authorities often request restoration of the site. On this topic, it must be understood that every restoration is also a reconstruction. To be understood by the general public, this reconstruction also assumes choices that are rarely compatible with the presentation of a single state, or even with the mythical first state whose restoration is often sought to ensure authenticity. On a megalithic site, the temptation is great to just pull a few stones upright again, move or gather together a few others, sometimes even without any preliminary investigation, all while forgetting to indicate, using physical markers, the nature of the physical transformation. This, unfortunately, is what occurred at the megalithic site at Toundidarou, Mali (**fig. 4**).

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Other resources

http://wanar-excavations.jimdo.com/

METALLURGIC SITES

Caroline Robion-Brunner[1] & Vincent Serneels[2]

INTRODUCTION TO THE ARCHAEOLOGY OF IRON

The origin in terms of both time and place of iron metallurgy is a matter of lively debate. Iron is clearly evidenced during the second half of the first millennium before the Christian era in the Sahelian zone and the Great Lakes area. On the other hand, the archaeological data are insufficient to demonstrate any greater age or to retrace the stages of its spread through history. Those who work with iron often occupy a particular place in traditional society. Very little information exists to help us write the history of this social differentiation.

The priority is therefore to develop the study of metallurgic sites to accumulate more (and more precise) data. On this renewed basis, it will be possible to re-examine the major questions that remain unanswered.

I. RESEARCH STRATEGIES AND FIELD METHODOLOGY

A. Locating and mapping sites

As many authors have already noted in this document, inventory and site mapping are essential tools. Interviews with local populations are the best way to identify sites. This phase also helps understand the relationship between the current inhabitants and the remains. The information harvested can only be validated through site visits, taking GPS readings, describing the site, and establishing photographic documentation.

Inventory and site mapping are important not only for primary production sites, but also for mines, charcoal production sites, and forges. These data are related to the occupation of the land (homes, cemeteries, etc.).

B. A description of the techniques

Topographic surveys aim to reveal the spatial organisation of the site and to calculate the volume of the waste. Made to a precise scale (1/100 or 1/200), they show furnaces, related facilities (crushing areas, storage, etc.), discharge areas (scattered waste, slagheaps), and important topographical elements (roads, rivers, etc.). Surface morphology is studied to establish a relative chronology for large slagheaps.

This general approach covers a large area, several hundred or even thousands of square metres. It can be undertaken using simple surveying methods or with the help of tools. A topography created using a theodolite will be more precise, but this precision is not really required, because the boundaries of a slagheap are always unclear. Generally, we establish a survey axis that passes down the middle of the site, made visible using a series of nails or stakes. The orientation is taken by compass. A measuring tape is set in place. Then, we note the perpendicular distances to either side. If the distances are less than 10 metres, there is less chance of error. Some GPS data points are recorded.

Altimetric measurements can help determine the thickness of the slagheaps. A simple builder's level is all that is needed. It is also possible to revert to simpler methods using tape measures and a spirit level fixed to a pole. This method is very effective if the gradients are very high (more than 5 or 6 m).

To study furnaces (morphology, dimensions, construction materials, means of ventilation), it is essential to move on to an archaeological excavation. It is never enough to study visible structures. It is imperative that the lower parts of the furnace, which are covered in sedimentation that post-dates the abandonment of the site, be observed. The excavation centres on a well-preserved and representative furnace. The structure and the immediate perimeter are excavated in half, in order to obtain a stratigraphic section of the fill. It is important to bring to light the circulation around the furnace. At the end of the excavation, detailed diagrams (1/20 or 1/10) of the structures are made. As furnaces are not simple forms, it is important to establish a map and at least two sections, one along the axis of the opening, the other perpendicular to this. The various construction materials are described. A detailed report of a stratigraphic section through the furnace fill must be made, in particular to note the location of charcoal that will be used for dating. Furnaces are not the only facilities. There can be all sorts of annexes. Extensive excavations will be needed to bring these to light.

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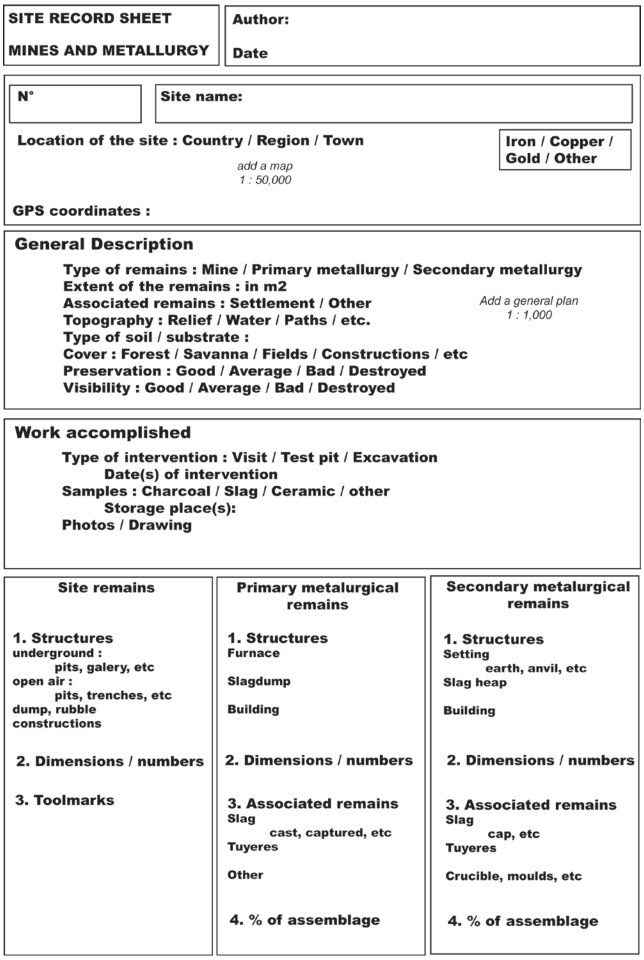

SITE RECORD SHEET
MINES AND METALLURGY

Author:
Date

N°
Site name:

Location of the site : Country / Region / Town
add a map 1 : 50,000
Iron / Copper / Gold / Other
GPS coordinates :

General Description
Type of remains : Mine / Primary metallurgy / Secondary metallurgy
Extent of the remains : in m2
Associated remains : Settlement / Other
Topography : Relief / Water / Paths / etc.
Type of soil / substrate :
Cover : Forest / Savanna / Fields / Constructions / etc
Preservation : Good / Average / Bad / Destroyed
Visibility : Good / Average / Bad / Destroyed
Add a general plan 1 : 1,000

Work accomplished
Type of intervention : Visit / Test pit / Excavation
Date(s) of intervention
Samples : Charcoal / Slag / Ceramic / other
Storage place(s):
Photos / Drawing

Site remains	Primary metalurgical remains	Secondary metallurgical remains
1. Structures underground : pits, galery, etc open air : pits, trenches, etc dump, rubble constructions	1. Structures Furnace Slagdump Building	1. Structures Setting earth, anvil, etc Slag heap Building
2. Dimensions / numbers	2. Dimensions / numbers	2. Dimensions / numbers
3. Toolmarks	3. Associated remains Slag cast, captured, etc Tuyeres Other	3. Associated remains Slag cap, etc Tuyeres Crucible, moulds, etc
	4. % of assemblage	4. % of assemblage

Fig. 1. Example of a specific survey sheet designed for ironworks.

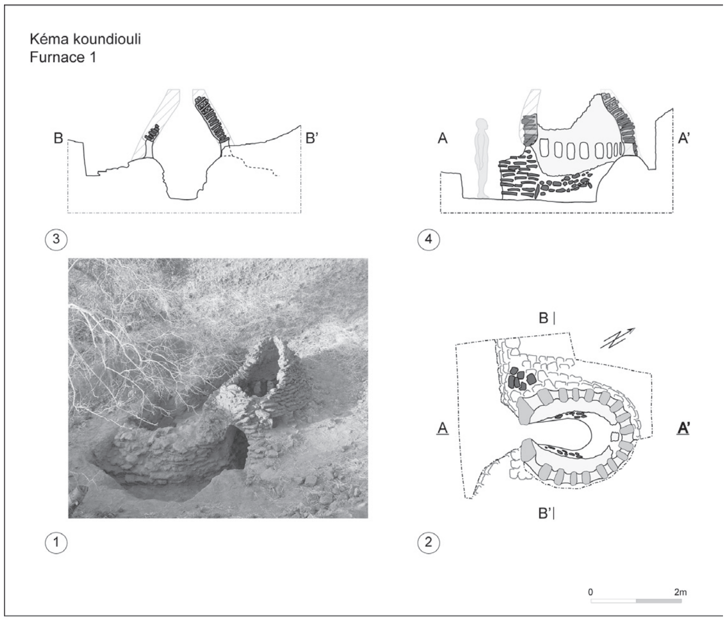

Fig. 3. Presentation of furnace 1 in Kéma Koundiouli (Dogon area, Mali; 2005 mission). **(1)** Photo of the furnace at the end of the survey; **(2)** map of the embrasures; **(3)** section BB' parallel to the charging hole; **(4)** section AA' perpendicular to the charging hole. (Photo © Robion-Brunner & Serneels.)

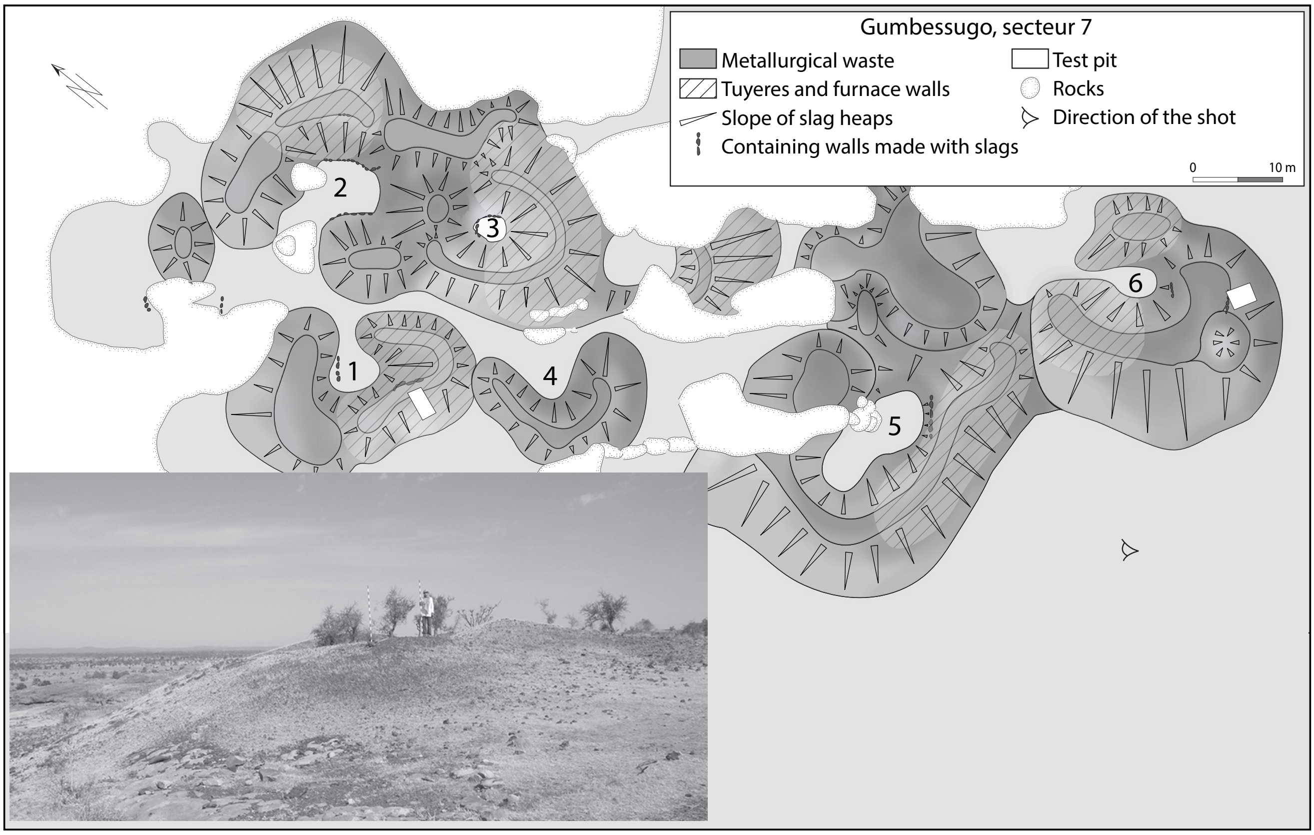

Fig. 2. Topographical survey of sector 7 in Kéma Gumbessugo (Dogon District, Mali; 2008 mission). Slagheaps have a thickness ranging from 1 to 5 m. Furnace locations are numbered from 1 to 6, from oldest to newest. (Photo © Robion-Brunner & Serneels.)

Metallurgical remains

	Sandy clay tuyeres	Dense grey tapped slags	Dense grey internal slags	Dense grey furnace bottom slag
Site 1	10%	80%	10%	-
Site 2	10%	-	-	90%
Site 3	10%	40%	10%	40%

Fig. 4. Example of metallurgical debris assemblies as a percentage for sites belonging to different technical traditions. (Photos © Robion-Brunner & Serneels.)

It is also important to describe metallurgic waste (slag and tuyeres) precisely. In the case of slagheaps, note is taken of their form (block, tapped slag, etc.), their colour (grey, brown, etc.), their appearance (compact, bullous, etc.), their apparent density (heavy, light), their weight, the presence of imprints from fuels (straw, wood, charcoal), etc. It is important to determine the orientation of the piece and to distinguish slag that has flowed in a horizontal position from one that was formed vertically. Broken surfaces showing the structure of the slag should also be noted. Homogenous materials can thus be distinguished from those that have inclusions; those that are compact from those that are porous. The quantity, size, and distribution of bubbles can be characteristic. We determine if the material is vitreous or crystalline. Several types of slag are present on a single site, and make up an assemblage. Each type must be described and the proportion (in %) of each type calculated.

It is useful to systematically describe at least twenty tuyeres, noting the shape of the section and measuring the diameter of the pipe. We can also note the distribution of thermal impacts on surfaces in order to deduce information concerning the position of the tuyeres in the furnace. It is also an occasion to note the presence of double tuyeres or linked tuyeres. It is not often possible to measure the length of the tuyeres, as they are almost always broken. As a default, we note the length of the longest unbroken section.

To characterise the materials that remain, interpret the physico-chemical conditions for slag formation, calculate production yields, and identify the minerals used, chemical and mineralogical analyses can be performed by a laboratory. In such cases it is necessary to collect samples characteristic of the waste. In the event that the pieces are too big to be removed in their entirety, sketches are made or photos taken. A sufficient number of pieces is required for each category, but laboratory analyses are costly. Experience teaches us that the analysis of five samples per category allows for interpretation. A finer characterisation requires twice as many.

C. Dating activity

To date furnaces, it is essential to localise samples precisely. Charcoal from fill (posterior) must be differentiated from that of the layer of use inside the furnace (contemporary) and that coming from layers that pre-date the construction. The question must be asked: is what we are dating from the last reduction, the construction of the furnace, etc.?

For dating in waste areas, the general map helps establish a relative chronology. Stratigraphic surveys of these areas are needed. In practice, these surveys are relatively delicate to perform owing to poor wall stability. A useful technique is to quickly open stepped trenches with steps of 1 to 1.5 metre in the slope along the edge of the cluster. At the foot of the cluster, the survey must reach as deep as the natural substratum, in order to judge the depth of recent sediment cover. The best charcoal samples are taken when the stratigraphic section is being diagrammed, and are linked precisely to the stratigraphic units shown on the drawing. It is best to take as many samples in the field as possible, even if only a portion will be used. We try to obtain two dates in each cut in order to obtain the start and end of operations and evaluate the slag accumulation rate.

D. Evaluating production

The evaluation of the amount of iron produced is a fundamental data point. To quantify the volume of slag, we use a map, which allows the calculation of the covered surfaces, and the altimetric reading, which provides depths. To calculate tonnage, the weight of some slag must be measured by volume (m^3).

Some sites have subsided, and the mass of slag is from 1000 to 1500 kg per m^3. In mounts that have not been compacted, it is generally from 500 to 1000 kg for the same volume. Proportions (in %) of the different types of waste must also be estimated.

The 'cubing' technique consists of excavating a known volume, for example an eighth of a cubic metre (a cube of 50 cm on each edge), and storing the material contained in that volume. Waste is then sorted according to a pre-established classification. Each category is weighed using a scale. Quantities per cubic metre are calculated based on the estimate for 1/8 cubic metre. If the waste appears homogenous, then one test pit is enough, but it is preferable to perform the operation at least twice.

Fieldwork establishes the tonnage of slag with relative precision. The number helps to establish the order of magnitude and make comparisons with other sites or other regions. On the other hand, the quantity of ore and the efficiency of techniques are variable. It is therefore not possible

Fig. 5. Example of 'cubing'. All metallurgical waste from a known volume are sorted by category and weighed with a balance. (Photos © Robion-Brunner & Serneels.)

to calculate the quantity of iron produced directly on the tonnage of slag. For that, chemical analyses of the ore and the slag are required to establish the materials mass balance. On the basis of current knowledge, however, one can say that the amount of iron is of the order of 10 to 20% of the slag (100 to 200 g of iron for 1 kg of slag). Only extremely efficient techniques and rich ores allow superior proportions, sometimes as much as 1 kg of iron for each 1 kg of slag.

E. The environmental impact of iron production

Iron production consumes wood. Five kg of wood are needed to produce a single kg of charcoal. The mass of charcoal used is, normally, about once or twice that of the ore. Then there is the fuel needed for smithing.

These activities therefore have an effect on forest cover. This can be evaluated if the tonnage of slag, the length of activity, and the area's forest productivity are known. For metallurgy, preference is theoretically given to species with high calorific value, which is to say, dense woods. In some traditions, certain species were reserved exclusively for iron work.

Anthracological study helps identify the fuel-supply strategy by determining the types of wood used. For this, as much charcoal as possible must be collected during the survey excavation, and grouped by stratigraphic units. It is important to take charcoals of every size, as different species fracture differently. These are collected with the aid of a sieve (0.5 cm).

CONCLUSION

There are numerous metallurgic sites in Africa. They leave durable traces that testify eloquently to an essential activity of production that developed and diversified over two millennia. They are an integral part of the archaeological heritage and should be studied as such. Beyond a simple but vital census, they deserve deeper study (spatial organisation, technological characteristics, tonnage estimation, and dating). Laboratory methods (archaeometallurgy and anthracology) provide additional information.

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Also see

The reference list created in 1994 by D.E. Miller and T. Maggs: http://projects.exeter.ac.uk/mhn/Africa.html

The Metal Africa association's website:
http://www.metalafrica.info

EXCAVATING FUNERARY SITES

Isabelle Ribot[1]

INTRODUCTION

Whatever the age, the location of the site and the continent, there are some basic procedures when conducting archaeological excavations of human remains. The way in which human remains are excavated is crucial for the post-excavation analyses, in both human bioarchaeology (the study of past populations from archaeological sites) and forensics (the identification of recent deaths in relation to crimes or accidents) (Steyn *et al*. 2000; Martin *et al*. 2013). Although the objectives are very different between these two disciplines, a series of similar steps (e.g. surveying, excavation, *in situ* osteological observation) have to be followed to clearly document a funerary site. However, in comparison to forensic science, bioarchaeologists are dealing in general with burials that are more ancient and less unplanned, and therefore they use very different sources of information such as historical (e.g. archives, oral history) and/or archaeological (e.g. survey, excavation) data. These are essential for a detailed understanding of funerary sites and their broad context, especially in spatial-temporal terms. Some African sites in very different climatic and topographic settings will be used as examples, in order to highlight the diversity of situations (e.g. funerary practices).

EXCAVATION AND VARIOUS OTHER ASSOCIATED TASKS

Excavation of human remains will vary according to the nature of the deposits found (e.g. soil texture, hardness, depth, type of burial). Their complexity will increase drastically, from the simple case of a primary burial (one individual or more buried during a single event) to other cases with secondary burials (multiple burial events). As excavation itself is a destructive process, everything (e.g. stone structures, burial pits, skeletal elements, artefacts, ecofacts) has to be recorded *in situ* from the start (the surface) until the end (below the skeleton to the base layer) in reference to a three-dimensional grid set up for the whole site. Written notes (e.g. field notebooks, special forms for the graves), scaled drawings and standardized photographs (e.g. magnetic north, scale, board showing date, location or square number, grave number, depth) should document all the phases of the burial excavation (**fig. 1**).

A. Key Tasks

For both archaeological sites and crime scenes, the main tasks to be followed in recovering buried bodies are to:

i) secure the site (tape off the area and establish a safe route to go to the site);

ii) record what is visible on the surface before and after clearing the vegetation;

iii) set up a grid and record all surface features disturbed or *in situ* (e.g. eroded deposits, soil differences, structures);

iv) locate the grave pit *via* test pits and trenches, and uncover and document everything (e.g. human remains, artefacts, ecofacts, large stones, soil differences);

v) uncover and document the human remains;

vi) exhume, sample and bag the human remains.

The key tasks from iv) to vi) are developed below to illustrate the approach.

B. Locating a Grave Pit

Once the grid and a fixed elevation datum point are set up on the area selected for excavation, several test pits and trenches should be dug in order to locate the burials. This stage is probably one of the trickiest, as the layout of graveyards, although often in rows, varies through time and space according to various cultural factors. The general layout is also related to the size of the burials themselves, which can vary from a simple trench cut into the sediments to a more complex grave shaft built with walls in mud bricks (e.g. Egyptian Middle Kingdom burials: Herbich & Peeters 2006).

If there is no evident soil stratification (e.g. soil texture and colour), the excavation should proceed in spits that are horizontal arbitrary layers of fixed thickness (e.g. 5 to 15 cm). Various tools are used when searching for burial pits. Spades and pickaxes can be used to remove the top layers containing rubble, especially in the case of historic graves that can be more than two meters deep. Once soil

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Fig. 1: Standard photograph of a double primary burial from Shum Laka, Cameroon. (Photograph by P. de Maret, from Ribot *et al.* 2001.)

Fig. 2: Comparison of two skeletons completely articulated but buried in a different manner (Cobern Street site, 18th century, Cape Town, South Africa): Christian burial no. 34 (left photograph) with traces of nails (coffin); and Muslim burial no. 32 (right photograph) with no nails (shroud). (Photographs by O. Graf.)

differences are visible (e.g. of colour between pit infill and surroundings), trowels, paintbrushes and dustpans are better tools to remove layers at a relatively slow pace.

Then, once the human remains are uncovered, fine tools (e.g. dental picks in wood or bamboo preferentially, brushes of different sizes) will help to remove the soil surrounding the bones without disturbing them. At some point, it is also very important to record the section profile where the funerary pit has been identified, in order to place it temporally within the sites' stratigraphy (see also Fig. 1, p. 95). It is also recommended to sieve the soil with a 1.5 mm and 5 mm mesh, especially when immature skeletons are found, as skeletal elements can be very small (e.g. dental buds, unfused epiphyses).

C. Uncovering the Human Remains

An excavation should be expanded little by little in order to uncover, if possible, the whole skeleton. The position in which the deceased was buried needs to be understood, as well as whether there were any traces of the body being interred within a coffin or a shroud. At this stage, it is very important to consult a bioarchaeologist, in order to identify the bones *in situ* and to conduct particular osteological observations on site (Duday 2006). Is the skeleton fully or partially articulated? In which anatomical view (e.g. anterior, posterior, lateral, medial) do the bones appear? These questions will help to understand whether the burial has been disturbed intentionally or not, and whether it corresponded to single or multiple funerary events. For example, the excavation of collective burials, often complex accumulations of disarticulated bodies in one pit (see also Fig. 1, p. 95), will require recording of the position of each bone (e.g. in reference to the grid, anatomical view) before removal and excavating lower layers (e.g. prehistoric burial with children, Cameroon: Ribot *et al.* 2001). This approach will lead to an understanding of body decay processes and burial practices during post-excavation analysis. For example, if the skeleton is very well articulated and not displaced even around the joints that quickly decay (e.g. fingers, toes, pelvic symphysis), it is often a sign that body decay occurred in a filled space and not in an empty space (Duday 2006). In fact the earth used to fill the grave prevents other elements from falling into the burial and also fills in spaces provoked by decay of soft tissues (e.g. thorax, abdomen). However, this phenomenon (body decomposition in a filled space) varies according to various factors (e.g. soil texture, coffin material). A wooden coffin can decay rather quickly, and the empty space surrounding the body can be filled up by soil (especially fine grained) coming from the surroundings outside the coffin. Therefore, the degree of skeletal articulation might be as excellent, as in the case of a body interred in a shroud (body decay in filled space). Nevertheless, if artefacts are found, it is possible to differentiate between burial types, either in coffin (e.g. wood and/or nails) or in shroud (e.g. remains of fabrics and/or pins). Body position (e.g. generally fully extended and lying on its back in a coffin burial) can also be a good indicator (e.g. intensively used cemetery with various religious traditions, Cobern Street, Cape Town: Graf 1996; Apollonio 1998) (**Fig. 2**).

D. Summary of Basic Information to Document

In sum, here is a list of data that must be recorded on a field form for each grave:

i) location of the burial (e.g. exact grid square, depth, remarks about sediment);

ii) type of burial (e.g. internment or cremation, primary or secondary burial, single or multiple burial, general position of bones, degree of skeletal articulation);

iii) presence or absence of structures with their size (e.g. pit, stones, built grave shaft);

iv) position of the skeleton (e.g. flexed or extended, orientation in relation to top of cranium and face);

v) depths taken on key skeletal areas (e.g. cranium, pelvis, feet);

vi) drawing (in reference to the grid and with a scale varying according to size of the area excavated);

vii) artefacts recovered and approximate dates;

viii) reflections on body decay;

ix) visual and/or written osteological inventory and anatomical view observed for each skeletal element in the field;

x) various taphonomic and biological remarks (e.g. state of preservation, age, sex, stature, bone measurements);

xi) list of the samples taken for special analyses (e.g. soil, bones or teeth);

xii) list of the photographs taken in black and white, and in colour.

E. Exhuming, Sampling and Bagging the Remains

In general, the removal of the skeleton is a process that starts from the feet and moves up to the skull, but it depends on how the skeleton is positioned and accessible to the excavator. In exceptional cases (when the sediments are compact and solid), small burials are sometimes lifted as a block made from a moulding agent (e.g. plaster of Paris). This procedure allows one to both excavate and analyse delicate infant burials in a laboratory. For normal exhumations in the field, containers (e.g. cardboard boxes with bubble wrap) and plastic bags of various sizes need to be prepared with indelible pens and tags showing standard information (e.g. date, site code, burial number, square number, depth, layer). At this stage, soil sampling in different loci (e.g. outside the pit, within the pit, within the abdomen for presence of parasites) is also necessary, as the burial is 'destroyed' little by little during the removal of the skeleton. Teeth and bone for ancient DNA analysis is sampled preferentially on site using gloves, in order to eliminate contamination problems that tend to increase during post-excavation (osteological work).

CONCLUSION

These recommendations are a brief outline of what needs to be done in the field, and they are of course not exhaustive. It is highly recommended that people working on a funerary site should be trained properly *via* a field school in bioarchaeology. For any site under study, a methodological approach should be well set up in advance and follow all the steps mentioned above.

In short, burial discoveries are extremely diverse, ranging from the simplest types (e.g. primary burial with one interment) to more complex ones (e.g. secondary burials such as collective burials, or multiple primary burials such as mass graves). Therefore, the methods used (e.g. speed of excavation, techniques of recording) have to be adapted according to budget and time allowed within each archaeological project. Nevertheless, none of the tasks should be neglected or omitted. The excavation of burials remains a team approach, where the bioarchaeologist has to incorporate various pieces of information from the archaeologist and other specialists (e.g. geomorphologist) to fully understand the funerary site as a whole and not only in osteological terms.

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RECORDING ROCK ART

Benjamin Smith[1]

I. RECORDING ROCK ART SITES

When you locate a rock art site (see the section 'Finding Rock Art'), what you record will be determined by your aims and needs. Typically, you will record useful information using a site record sheet, either one that you have designed yourself or one that was provided by your organisation. Your site record sheet may be paper-based or a digital system that is inputted in the field using a tablet/laptop. If you have to design your own recording sheet then it is wise to follow an internationally used data recording structure such as the CIDOC International Core Data Standard for Archaeological and Architectural Heritage. This will ensure that your records are compatible with many databases, that you use common terminology, and that you include all mandatory data fields. One of the mandatory fields in all record sheets will be the longitude and latitude (and/or the UTM) of the site. This is generally identified using a portable GPS. For rock art sites it is important to remember to stand slightly away from a rock shelter or cliff face in order to get an accurate reading. The device needs to interact with satellites and this interaction will be obstructed by rocks and dense vegetation. When taking a GPS reading at a rock engraving site remember that such sites can span more than a kilometre and you should either take a set of readings to locate the edges of the site or record the centre point and the average radius (the distance from the centre to the edge). Another important thing to remember is to change the GPS factory setup and to choose the correct map datum. Almost all parts of Africa now use the WGS84 datum. A failure to set the datum correctly could lead to your site location having an error of as much as a kilometre.

Typical rock art specific textual data that you should record include information on the type of rock, number of rock art panels, techniques (brush painted, daubed, incised engraved, pecked engraved etc.), pigments/colours used (if any), subject matter (or motif), size, overlays, juxtapositioning of images (e.g. intention to create scenes), relative degrees of fading/patination and the number of motifs (for more details see Smith *et al.* 2012). The manner of depiction (or style) can be particularly important as this is often used to assign age and authorship. The manner is the way in which the three-dimensional subject has been transformed into a two-dimensional image. Giraffe, for example, are painted in many different African art traditions, but the style in which they are painted – their outline form, the nature of their patterned fill, their particularly emphasised/omitted details – can help determine whether they were painted/engraved by a San, Northern Sotho, Sandawe, or Maasai artist. Aspects of style, because they are culturally learned rather than 'normal' or 'natural', are necessarily local and particular and therefore identifying the rock art 'tradition' is archaeologically useful. The tradition may help you to determine whether the art was made by hunter-gatherers, pastoralists, or farmers and thereby help you to give it an estimated age (see Smith 2013). Consulting specialist rock art publications will assist you in recognising different traditions.

Typical graphic records that can all be made within a few days at a rock art site include: a site plan (**fig. 1**), a

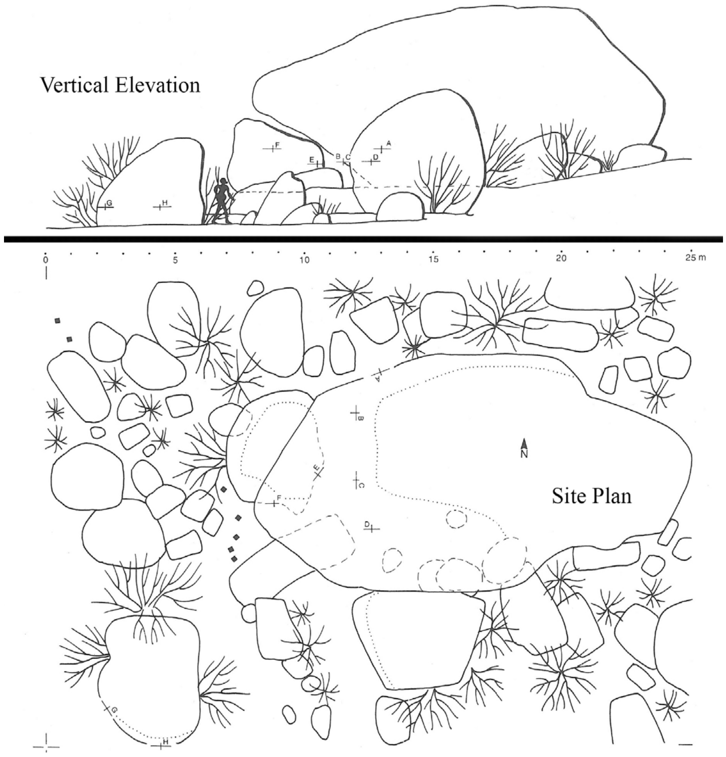

Fig. 1. An exemplary rock art site vertical elevation and plan. (After Pager 2006: 247.)

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Fig. 2. An example of a sketch of a rock painting site. Location: Chongoni Rock Art Area World Heritage Site, Malawi. (Sketch © B. Smith.)

vertical elevation if you are recording paintings (**fig. 1**), sketches and photographs. Sketches are particularly useful for rock art (**fig. 2**). They force us to look carefully at the art and ensure that we tease out the details of even the most faded image. And, do not ignore the faded art: it is likely to be the oldest art in the site and could therefore be highly significant. You will be familiar with basic photography, but rock art poses a few particular challenges. Paintings are often in poor light and look dull in photographs. Artificial lighting or bounced lighting (using a reflector) may help to draw out fine and faded details. A tripod will help to keep the camera still at slow shutter speeds. High quality SLR cameras and fixed focal lenses perform significantly better in low light conditions than standard point-and-shoots and are a worthwhile investment for anyone working regularly with rock art. Engravings are often blasted by intense sunlight and their lines show little contrast with the natural rock when photographed. Night photography, with obliquely angled artificial lights, helps to show off their finer details. If night photography is not possible, then early morning or late afternoon oblique natural light and/or the use of polarising filters may be beneficial. Because the time of day can have such a profound effect on the way rock art is recorded it is always advisable to record the time. People who later view the art under worse lighting conditions may assume that the art has 'deteriorated' when in fact the clarity of your photograph was simply a product of your good timing, lighting and skill. As in all archaeological photography, using a scale is important but it is valuable for rock art work if this incorporates accurate colour swabs (either RGB or CMYK) for later digital colour calibration.

A particularly time-consuming but also finely accurate form of recording is tracing. Tracing is a technical skill that requires specialist training in order to ensure that it is done accurately and that it does not damage the art. Tracing should not be attempted without specialist training. Three-dimensional models of rock art panels and sites can be made using a laser scanner. Again this is a specialist technique that needs to be done by a specialised team. It has proven more useful for rock engravings than paintings, because scanners record surfaces rather than colour. For paintings, photographs can be integrated with the scan to create a 3D colour model, but when done at the resolution needed to see the fine details in a rock art panel, this tends to produce such a large digital file that it cannot be manipulated on standard computers. 3D laser scanning is extremely costly and is not necessary for most research, management and conservation purposes. If 3D is desired, standard photographs can be manipulated by photogrammetric software to create cheap 3D recordings

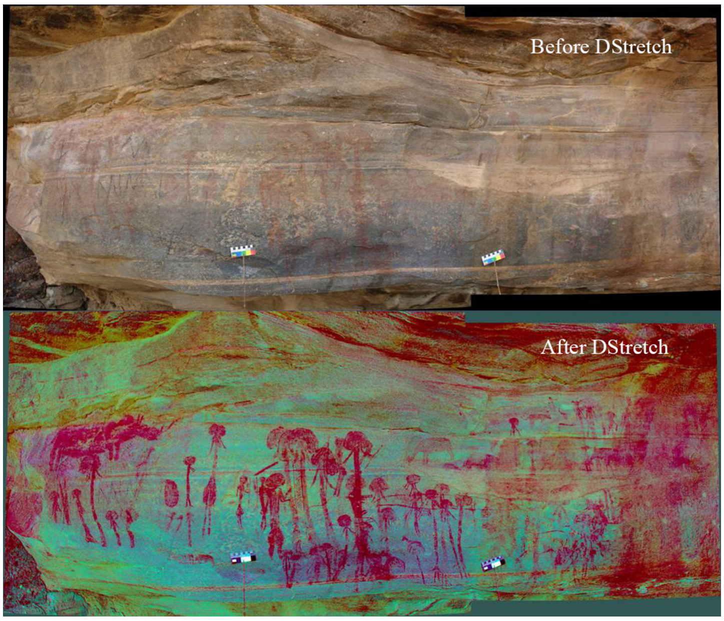

Fig. 3. DStretch rock art image enhancement at work. Location: Kondoa Rock Art World Heritage Site, Tanzania. (Photos © J. Harman.)

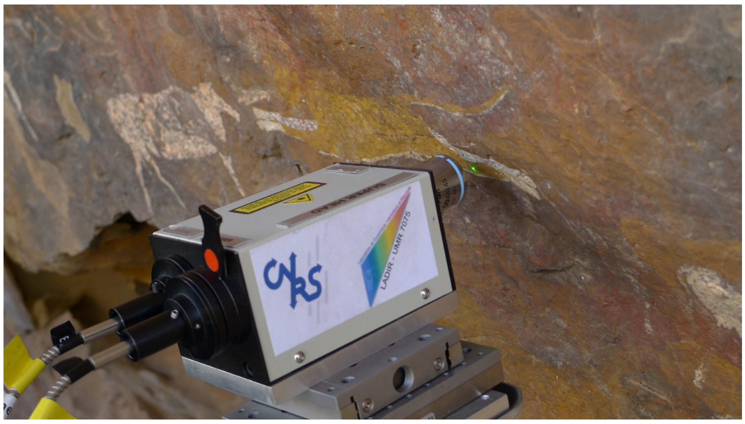

Fig. 4. Portable Raman Spectroscopy being used to identify pigments at a rock painting site. Location: Maloti-Drakensberg World Heritage Site, South Africa. (Photo © L. Ronat.)

that are accurate enough for most purposes. For the majority of purposes, you will therefore find that site record sheets, plans, sketches and photographs will meet all of your recording needs. Always take more photographs than you think is necessary. Take photographs of all sections of the site including close-up details and views of unpainted parts of the site – these may be crucial for monitoring conservation change at a later point in time. Take contextualising shots of the site in its landscape and views of surrounding vegetation/settlement – these could be vital later to relocate the site and to monitor change.

Whether for management, conservation or research, recording the context of rock art is important. Attention should therefore be devoted to recording associated archaeological materials, any ongoing uses of the site, as well as relevant local beliefs, ceremonies, histories, and traditions. To do this well it will be important to speak to most of the families who live close to the site. You should already have consulted the traditional authorities before starting your work, but a second consultation during your fieldwork will usually prove valuable. Producing local language pamphlets on the aims and outcomes of your study that can be distributed amongst the local people and schools in the area can provide an important opportunity to inform the local community about the nature and purpose of your work. The more integrated your planning around public engagement and involvement in your project, the easier you are likely to find it to continue productive work in an area.

II. SPECIALIST TECHNICAL ANALYSES

There are a number of more specialist analyses that can be conducted at rock art sites that you may wish to consider. If the art is faded and you are struggling to see it clearly then you may wish to use image enhancement software. A commonly used programme developed specifically for rock art enhancement is *DStretch*, developed by Jon Harman and made available by him for free. This programme can even be loaded onto cameras and tablets for use in the field. It helps in the observation of faded details in rock paintings (see **fig. 3**). If you wish to know the chemical composition of the pigments this can also now be done without damage to the art by using a handheld XRF analyser. These devices, when pointed at a rock painting, are generally able to identify the full spectrum of chemicals contained in pigments. You can therefore see whether two paintings were made using identical pigments and you may be able to start to trace the source of some pigments through their distinctive inclusions.

In general, sampling of rock art is not advisable and should be avoided. The only thing that one can learn from sampling most pigments is their chemical composition and this can now be done satisfactorily without damaging the art by using XRF or another technique such as Portable Raman spectroscopy (**fig. 4**). A few rock art pigments, such as organic pigments (beeswax, charcoal, and soot) and a few naturally produced microscopic layers over and under rock paintings, can be dated by using small samples. Where a section of a rock art panel is actively flaking, it may be possible to collect a small piece without doing significant damage to the panel. In such cases it could therefore be beneficial to call in a rock art dating specialist to collect samples. However, the bulk of red, yellow and white pigments contain no directly dateable material and so pigment sampling is unjustifiable. If you wish to understand more details about the art you should contact a specialised rock art research institution, the largest in Africa being the Rock Art Research Institute in Johannesburg, South Africa. They can advise you on what specialist technical analyses and recording techniques will be worthwhile at your particular site and can give you more information on the age, authorship and meaning of your rock art.

Rock art gives us a unique glimpse into the minds of long ago. Trying to unravel how and why it was painted, and what it means, is part of the magic of archaeology that captivates people from all parts of the social spectrum across Africa as well as internationally. African rock art is well known around the world and it is now strongly represented on the UNESCO World Heritage List. Working with rock art is a privilege and a pleasure but it also brings important obligations. Rock art is an especially fragile part of our inheritance from the past; with poor management a site can be lost in a single generation. Rock art requires special vigilance to curate it in a manner that maximises its value to current generations while conserving it as a resource that will also be of benefit to future generations.

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DOCUMENTING AND STUDYING A ROCK-ART SITE: THE EXAMPLE OF THE LOVO MASSIF

Geoffroy Heimlich[1]

I. CENTRAL AFRICAN ROCK ART

Unlike the rock art of the Sahara or southern Africa, that of Central Africa remains largely unknown. Although first reported in the 16th century by Diego del Santissimo Sacramento, the rock art of the Lower-Congo has never been the subject of any broad study, and even its age remains uncertain. Thus Pierre de Maret suggested I undertake a study of the Lovo massif, which he had studied in 1972 and 1973 (de Maret 1982). Since then, no other study of the rock art of the Lower Congo had been undertaken until 2007, when I had the opportunity to embark on a preliminary field research to the Lovo massif (Heimlich 2013). With 102 sites (including 16 decorated caves), this massif contains the largest concentration of rock art sites in the entire region, which represents more than 5,000 images (**fig. 1**). Hundreds of limestone ruiniform massifs, pierced with caves and rock shelters, rise across nearly 400 km^2.

In short, my study aims to go past a simple iconographic analysis by combining the data obtained with those being used by historians, ethnologists, archaeologists, and linguists. I have attempted to demonstrate that rock art, like historic sources and oral traditions, can offer historians an important source of documentation contributing to the reconstruction of Africa's past. Using the Lovo as a case study, I will now explain step-by-step my precise manner of working.

II. TECHNIQUES FOR RECORDING AND DIGITALLY ENHANCING IMAGES

The bulk of my work was creating the most comprehensive inventory possible of the Lovo massif.[2] Making no contact whatsoever with the surfaces, I generated records by processing digital images, following the image processing method developed by Jean-Loïc Le Quellec (Le Quellec *et al.* 2015). Although it is still often practiced in Africa, the technique of direct tracing, which alters works, has been completely abandoned by today's parietal art specialists in favour of digital photography and image enhancement software. Combining field notes and drawings, photographs of the whole and of details, I use Adobe's paid Photoshop software program, and, above all, DStretch, a free plug-in for ImageJ created by Jon Harman.[3] While allowing more complete inventories with more precise and objective data, DStretch's presets make possible a quick learning curve and fast results with a minimum of subjective intervention. As noted by Jean-Loïc Le Quellec, 'it makes visible information that already existed in the image but was barely or not visible to the naked eye' (Le Quellec *et al.* 2015).

Using the example of a decorated panel from Songantela, I am going to describe the approach used from the taking of the photo through to the preparation of the report. The first stage involves making an exhaustive photographic study of the entire decorated panel, then the images are manipulated directly using DStretch. Using an image of the entire panel, each rock image, even if partial, is given an inventory number. Close-up photographs are then taken. In the field, other techniques can be very useful and complementary, such as high-resolution panoramas of the site (such as those obtained using Gigapan) or photogrammetry and 3D scanning, which allow the creation of three-dimensional models of decorated panels.

Figure 2 is an unmodified photograph of one of the main Songantela panels. Note how difficult the details are to discern. **Figure 3** shows the same photograph after it was processed using DStretch LRE, chosen for its efficiency in improving the visibility of red pigments. Using this software, it is possible to remove all non-red colours. These are then extracted and placed over a non-enhanced image of the wall. Finally, a scale is added and the luminosity slightly adjusted. The result is shown in **figure 4** after having modified the contrast (and lowered the saturation) and introduced a slight Gaussian blur, with a slight transparency in the layers to obtain a more natural image.

III. GIS USE IN ROCK ART

Thanks to the creation of a georeferenced database and the use of statistical methods, I was able to offer new results on the history of the population of the Lovo massif. Using the free software QGIS, a georeferenced database was

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2 Site identification was calculated automatically using Africode software, developed by Jean-Loïc Le Quellec, available for free from this address: http://rupestre.on-rev.com/page78/page624/page624.html

3 DStretch, a plug-in for the shareware ImageJ, is available here: http://www.dstretch.com/

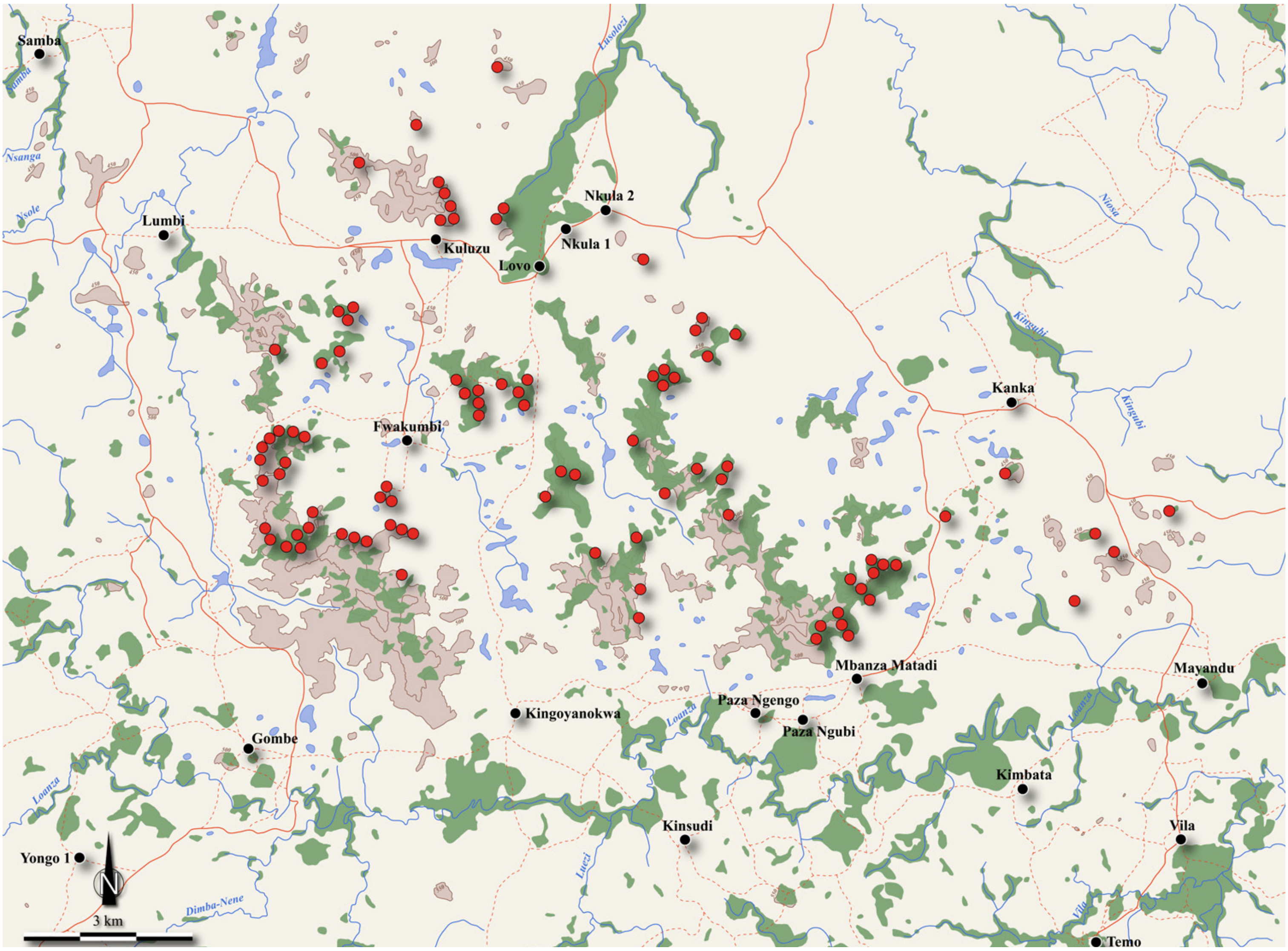

Fig. 1. Distribution map of rock-art sites identified in the Lovo massif (CAD Geoffroy Heimlich).

created for the 5,039 rock art figures found in the massif.[4] Each image was described according to theme, composition, and technique. For each of these criteria, the database allows the entry of '1' for 'present', '0' for 'absent', and '?' when the image cannot be characterised with certainty. Among the themes are anthropomorphs, zoomorphs, therianthropes, signs, alphabetical inscriptions, objects, and corporal sections. Morphological characters were chosen for the anthropomorphs, zoomorphs, and therianthropes. For anthropomorphs, for example, I distinguished the head, torso, arms, hands, genitals, legs, feet, posture, dress, equipment. In terms of composition, note was also taken of the spatial disposition, the orientation, and the situation of figures. In terms of graphic approach, the criteria considered were drawing technique and colour.

Once completed, this database allowed me to perform a general 'areology', or study of the areas of distribution. As the database is georeferenced, it can generate maps for the distribution of any selected criterion or any combination of criteria. In the case of the 224 anthropomorphs armed with a rifle found in the Lovo massif, a visualisation of all the data shows, for example, that they are all confined to the massifs near Ndimbankondo and Miangu, with a single exception at Mampakasa and Ntoto. This distribution relies in good part on a bias attributable to the state of the documentation and the criteria selected by the analyst, which must be taken into account during the study.

Other statistical methods can also be used in addition to area analysis in order to confirm results, such as the application of geneticists' tools to the comparison and statistical study of rock images. In the future, the same base should allow the application of this type of method to my documentary material.

4 The free QGIS software, developed by the Open Source Geospatial foundation, is available at this address: http://www.qgis.org/en/site/

Fig. 2. Red paintings from Songantela in the Lovo massif. (CAD Geoffroy Heimlich.)

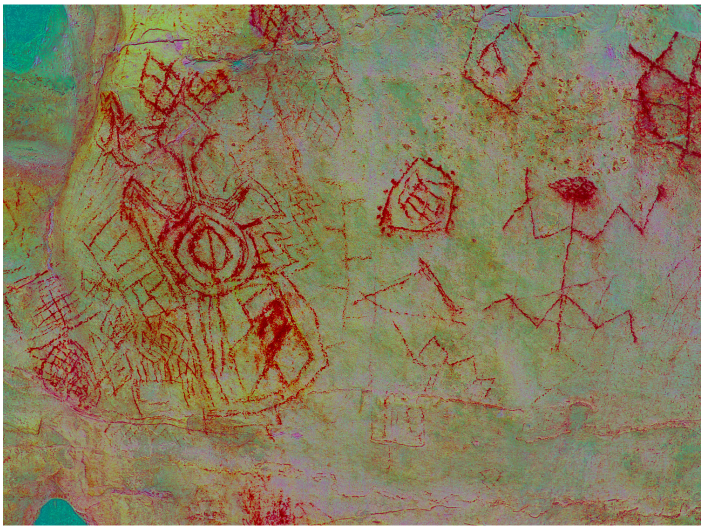

Fig. 3. The same photo, after being processed using DStretch LRE. (CAD Geoffroy Heimlich.)

Fig. 4. Final image. (CAD Geoffroy Heimlich.)

IV. COLLECTION OF PICTORIAL PIGMENTS, ANALYSES, AND DIRECT DATING

During this study, I was able to make use of recent technological developments in order to refine and improve the conditions of observation, analysis, and recording of engraved and painted traces. Over the past fifteen years, awareness of rock-art sites has been enriched with age estimations, physicochemical micro-analyses of pigments, and pictorial techniques for describing the cultural practices of the creators of this art. The physico-chemical analysis of pigment samples at the Centre for Research and Restoration of the Museums of France allowed me to study the techniques for pigment production, in order to perform direct dating of pictures made with wood charcoal, which has never previously been done in this region.

Each sample was located with the help of sketches, films, and photographs, and the sample, duly documented (date, place, various characteristics, etc.) were placed in a sample box. To take samples, previous researchers had wet and rubbed the surfaces in order to draw out images that were more or less hidden beneath a layer of calcite. As exposure to water, the use of a damp cloth on one surface then another, or contact with tracing paper had polluted the surfaces, I was obliged to concentrate my efforts on sites that had not previously been studied, where the surfaces are well preserved, in order to avoid the risk of contaminating the pigments with modern carbon, an important source of error in radiocarbon dating.

In the case of black drawings which had been sampled, observation using a scanning electron microscope with energy dispersive X-ray spectroscopy (SEM-EDX) highlighted the presence of wood charcoal. The SEM-EDX analysis also indicates that the wood charcoal was applied directly, as with a pencil or a fingertip. For the first time, I was able to date the rock images of Lower-Congo directly using carbon 14 accelerator mass spectrometry (AMS) (Heimlich 2013). Dating rock art in Africa is a challenge, as only very few direct dates have been obtained. In total, nine direct dates have been established for drawings in the Lovo massif, of which eight are from the Tovo cave, which is as yet unequalled in Africa.

Until now these analyses have for the most part been the result of direct sampling that caused alterations to the images. The recent development of portable measuring and recording devices makes certain physico-chemical analyses possible *in situ*, and without direct contact with the work, thus minimising damage from sampling. These non-invasive analyses and micro-analyses, such as X-ray diffraction and fluorescence techniques or Raman spectroscopy, refine and improve the conditions in which these works are observed, analysed, tested, and conserved.

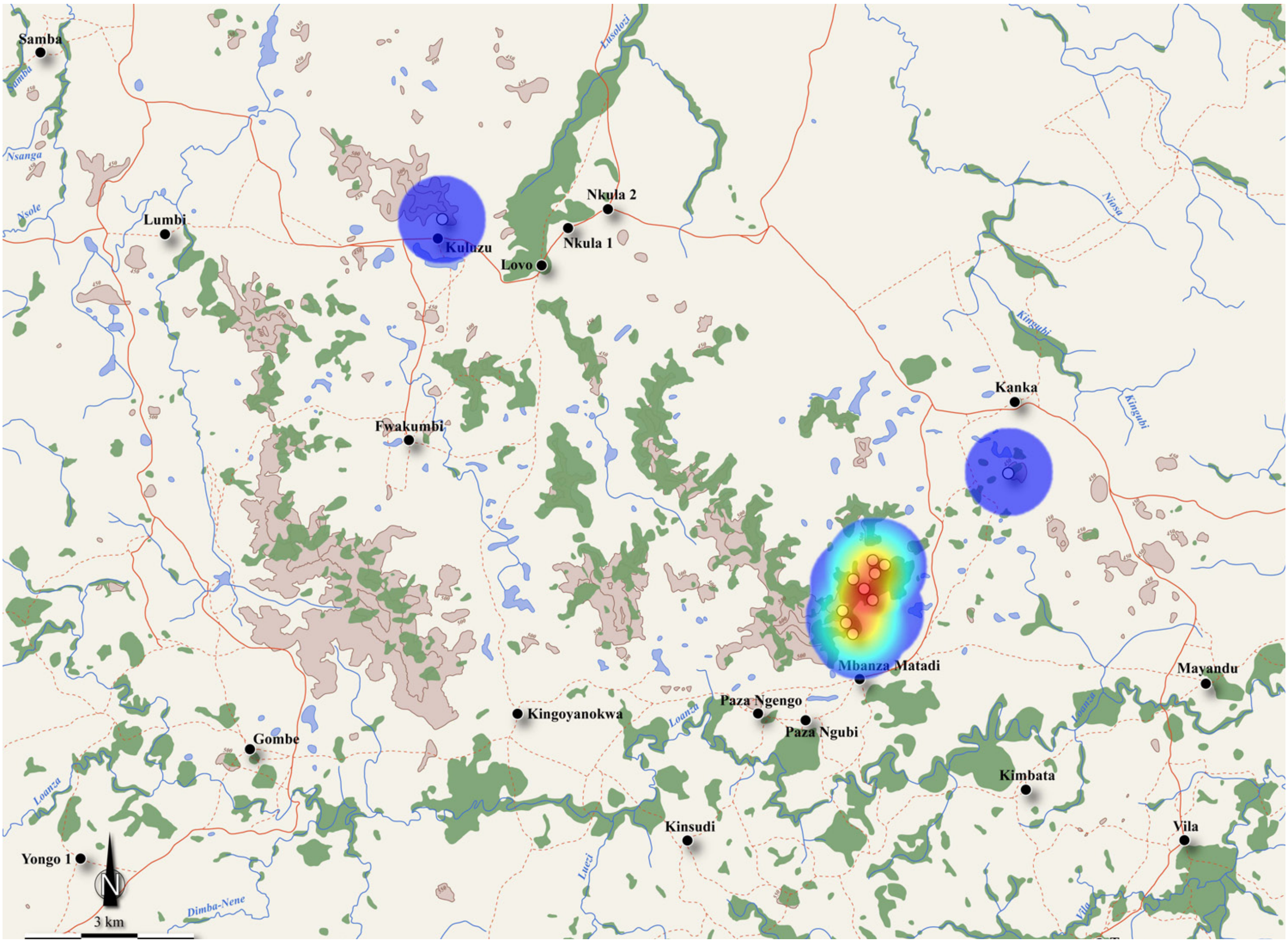

Fig. 5. Distribution map of anthropomorphs armed with rifles. Their highest density is indicated in red. Densities were obtained using QGIS software. (CAD Geoffroy Heimlich.)

V. THE LOVO MASSIF, CONSERVATION AND VALUE ENHANCEMENT

The result is an entirely new reading. By crossing ethnographic, historical, archaeological, and mythological points of view, I was able to show that rock art does indeed play an important role in Kongo culture. And that very simple images, such as the cross, for example, can be made to 'speak', once they are dated and situated within a precise cultural context (Heimlich 2013).

The inventory of the zone under study is thus enriched by precious documents of great interest, as much for the archaeologist as for the historian, ethnographer, linguist, or conservationist. Unfortunately, the Lovo massif is currently under threat. Certain major sites of rock art have already been destroyed. Industrial exploitation of the massifs will continue, and even be ramped up, over the coming years. In order to save this important heritage, it is vital that measures be taken to protect it. We have therefore proposed, with the Congolese authorities, a pilot initiative to register this rock art on the list of UNESCO World Heritage sites.

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ROCK ART MANAGEMENT AND CONSERVATION

Benjamin Smith[1]

Rock art, because it is exposed and immediately accessible, requires greater management attention than most other types of archaeological heritage. In terms of planning out rock art management strategies, standard consultative archaeological, stakeholder-driven, management planning processes apply also to rock art (McDonald & Veth 2012). One must start by identifying the nature and extent of the rock art site and then determine its significance in consultation with all interested and affected parties.

I. SIGNIFICANCE

A key point when assessing rock art significance is to ascertain all of the values that the site holds within society, because it is these values that must be managed, rather than the images themselves. In this way both the intangible and tangible rock art heritage values will be included and managed. This is vital for rock art sites, where the living values are often more significant to surrounding communities that the art itself. A myopic management focus on the rock art alone can have disastrous consequences for the conservation of the site, as the case of Domboshava in Zimbabwe has illustrated (Taruvinga & Ndoro 2003). With the values of the rock art site understood in the relative regional context, one then needs to consider all of the issues affecting these values and what needs to be done to address these issues. Good rock art management planning must include thinking about how to mitigate threats, but it should also go beyond this to think developmentally about how to fulfil the potential of the rock art site within society. A simple SWOT (strengths, weaknesses, opportunities, and threats) analysis is generally useful. This management process will culminate in the writing of a rock art site conservation-management plan. This is an action plan that lays down a five-year (generally) plan of interventions at the site that will meet the collective needs and aspirations of all interested and affected parties. Every rock art site needs at least a basic management plan and large public rock art sites will need complex plans. Assessing relative site significance, and the degree to which sites are at threat, will provide you with the means to prioritise how time and resources should be allocated between rock art sites.

II. TRAINING

Most heritage managers in Africa will have to manage at least some rock art sites as part of their work. A certain amount of specialised rock art training will therefore be important. Look out for suitable training workshop opportunities. Many of the natural and human factors affecting rock art are particular. For example, you will find some rock art surfaces are actively exfoliating. This may be caused by water running across the rock, water moving through the rock, salts within the rock, heating and/or cooling, fire, wind and sand, vibration, silica decay, animal rubbing, abrasion by plants, human vandalism, or a combination of these factors. To identify the causal factor will require training and field experience. To know how to intervene successfully usually requires the engagement of a specialist. For example, if the major problems are fire and running water then cutting the encroaching vegetation to prevent fire damage could expose the site to greater levels of wind and rain and thereby exacerbate the problem. In some parts of Africa people have installed silicone drip-lines to protect rock art from water running directly over rock art. This sometimes solves the problem, but in other cases it does not. For example, the water may play a vital role in maintaining the silica skin layers that protect the art and in such case the installation of a drip-line disturbs this process and leads to the rapid destruction of the art panel. Great caution must therefore be taken before making any major management interventions at a rock art site and specialised training is always useful.

III. CONSERVATION

As a general rule, any rock art site that is thousands of years old, whatever its outward appearance, is probably comparatively stable, otherwise it would not have survived. Intervening in the natural decay of the site, given the risks, should not be attempted without the specialist advice of a conservator. A rock art conservator is someone with professional training in technical conservation

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and with a practical specialisation in rock art; to be credible, they should be a member of an international professional conservation association. If a rock art site is found to be decaying rapidly, it is most likely to be caused by a recent change in the site's conditions. This could be a human change made to the natural environment such as land clearance/disturbance (expansion of farming, mining, urbanisation), chemicals leaching into the ground water (e.g. sewage, fertilisers), changes in the water table (from dam construction or pumping) or a new burning strategy. If there has been a significant change of this kind then this change should be reversed wherever possible, or at least measures should be taken to mitigate the unwelcome new condition. Where tree clearance is the cause, replacement with local indigenous trees is almost always the best solution. Exotics such as Eucalyptus or Pine, while fast growing, also change the acidity level of the soil and can significantly affect the local water table.

The most common causes of rapid rock art deterioration in Africa are: 1) the introduction of new large mammals (cattle, sheep, goats or game animals) into a landscape, and which then rub against the art; 2) an increase in human activity within a site or its immediate environs. Damage by people most commonly comes from their touching or rubbing the art (e.g. tourists), from graffiti, vandalism, theft, small-scale rock quarrying, and the lighting of fires in shelters. Fire is an especially serious problem. An entire site can be destroyed by a single fire lit against a rock art surface. These common decay factors, whilst often the most damaging, are also the most successfully controlled by effective managers. Fences can help to control animals, but humans almost always break through or steal fences. Fire damage can often be controlled simply by trimming vegetation around the site and ensuring that there is no firewood available near a site. Appointing site custodians and site guides, erecting signs, putting up psychological barriers, building fireproof walkways (**fig. 1**) and running rock art sensitisation programs are the most effective ways to control the bulk of human damage. Experiences in many African countries have shown that a rapid rise in visitor numbers in the absence of adequate management planning creates immediate and serious rock art conservation problems. Rock art tourism development must therefore always be preceded by management planning. However, when sites are managed effectively, tourism need not be seen as being in opposition to conservation. In fact, tourism can enhance protection as it helps the sites to become an increased source of local income and pride (Duval & Smith 2014).

Fig. 1. An example of a wooden boardwalk from a rock painting site in the Free State. The wooden boardwalk and wooden signs burnt in a bush fire, causing considerable damage to the rock paintings. The site was restored using entirely non-flammable materials such as a stone floor and metal signboards. (Upper photo © G. Blundell; lower photo © B. Smith.)

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