Introduction

The first season of research aimed at exploring the potentials of applying geoarchaeological and archaeobotanical techniques to investigate the use of indoor and outdoor space at ancient Songo Mnara.

Systematic soil/sediment recording and sampling was performed in open areas and indoor deposits were sampled by context. The geoarchaeological fieldwork was conducted in parallel with excavation and this allowed ongoing interaction and consultation between different team members.

The use of domestic and urban space in archaeology is commonly investigated through the study of cultural materials (e.g. pottery), architecture and organic remains (e.g. seeds, bones, etc). With the aim of extending the data range and, possibly, acquiring different information, research at Songo Mnara sought to investigate the records provided by soils/sediments as well as microscopic plant remains.
Methods

Soil/sediment samples were processed for pH, Electrical Conductivity, and ICP-AES multi-element analyses in order to characterise their chemical properties. In addition, a selected number of samples were processed for micromorphological analysis. Soil analyses aimed at identifying environmental and anthropic markers, including features and processes associated to particular activities and/or conditions.

Phytolith analysis was chosen as a suitable technique to begin investigating the types and uses of plant resources at ancient Songo Mnara. Phytoliths are microscopic silica particles that originate in different parts of the plant body. Upon decaying of the plant, phytoliths are released into soil and, being made of silica, preserve in most conditions. Phytolith morphology is often diagnostic of plant genus. For instance, some tree species produce diagnostic phytolith types, such as it is the case of palm trees that produce globular echinate phytoliths. On the other side, identification down to species is still not possible for most grass plants unless suitable reference material is available. However, it is possible to distinguish between grass sub-families. For instance, we know that trapeziform polylobate phytoliths are produced by Pooid grasses, which include several types of wheat (Triticum sp.).
**Target areas**

Research targeted four main areas:

1) large open fields in between main building compounds, designed as ‘Open Areas’

2) domestic deposits from two houses

3) funerary contexts (graves and tombs)

4) areas of specialised activities (well)
Open Areas

The first step entailed the identification of the regional sediment and the main soil cover at the site. The simplified map above shows the distribution of the sampling transects across the main open areas investigated. A grid of 5x10m square was superimposed over two open areas and the soil cover was recorded at 5m intervals over four EW transects. A total of 79 samples were collected from approximately 10cm below the ground surface.

The regional sediment is a reddish medium to fine textured sandy loam that originates from the weathering of the main geological unit of the island: coral/limestone. The latter is also responsible for the generally alkaline conditions of most sediments and soils analysed. Noteworthy, the regional sediment was found unevenly distributed across the study area. A brown silty sandy loam material was repeatedly recorded on surface as well as within structures. At places, such as in Transect 2 of the South Open Area, this material exhibits a predominant ashy colour and high content of charcoal.

Multi-element analyses provided further insights into the characteristics of the sediments and soil types recorded. Without going too much in details, it is worth mentioning some interesting pattern.
North Open Area (NOA)

The concentrations of phosphorus and calcium were relatively high in the eastern sector of the NOA.

Other elements, such as iron, were found in much lower concentrations with no significant variability across the area.
South Open Area (SOA)

The distribution of the same elements shows significant differences in the South Open Area. Phosphorus concentration is significantly higher in Transect 1, while calcium is relatively abundant across the whole area.
The phytolith signature of the open areas

Grass phytoliths are predominant in the assemblages from the open areas and no significant difference in the concentration of grass sub-family types was recorded. On the other side, the distribution of the so-called ‘non-grass phytoliths’ – i.e. those produced by woody plants, herbs and palm trees – varies between the two open areas.

In general, non-grass phytoliths are significantly more abundant in the North Open Area, where woody types were found in relatively high concentration.
Domestic contexts

Domestic contexts were investigated at House 44 and House 23. Key contexts were sampled for chemical, micromorphological and phytolith analyses.

House 44
In House 44, the samples from several room fills revealed a concentration of plant macro-nutrients and a predominance of grass phytoliths with few woody types. The room fills resulted generally rich in calcium, sulphur and strontium and yielded low contents of metal elements (e.g. arsenic, chromium, copper). The sample from the Back Room (SM010), instead, revealed a quite different picture. This context yielded the highest concentrations of phosphorus and zinc together with palm phytoliths across the entire sample set.

The phytolith assemblages from House 44 are dominated by grass types, of which undifferentiated and Pooid types are the most common. Non-grass phytoliths are generally few but present in all the samples. In particular, the samples from the Central Room (SM004) yielded a considerably lower concentration of palm phytoliths, which are relatively abundant in the other samples from House 44. A remarkable exception is represented by the high amount of non-grass types in the midden deposit of the Back Room (SM010), which is associated with an earlier occupation of the site. The peak of non-grass phytoliths reflects the presence of a significant number of palm types. These contexts are also characterised by the lowest concentration of woody phytoliths, which are found in slightly higher number in the other samples from House 44.
Soil micromorphology: wall & floor plaster

The excavation of the Central Room (SM004) revealed an ashy deposit with a concentration of potsherds in the NW corner. Multi-element analysis results provided further evidence for burning. Numerous plaster fragments were observed in the thin section from this deposit. The fabric of the plaster is ‘calcined’, a condition produced by burning; also known as a process employed to produce calcium oxide or quicklime from calcareous material, such as limestone and tufa. The process of burning limestone to produce quicklime requires rock fragments to be heated to a consistent temperature (800-900°C) with the duration of burning dependant upon the volume of limestone. During heating, the decomposition reaction begins at the surface of the rock fragments and slowly penetrates in the core of the fragments.

The sample from the Central Room included both ‘heated’ and non-heated fragments of limestone. In addition, charred wood remains were occasionally observed.
House 23

Three units were investigated in House 23 and all yielded high contents of metal elements (chromium, manganese, barium, and zinc). Plant nutrients such as calcium and strontium were found in much lower concentrations.

Staircase: The concentration of metal elements suggests the presence or the processing of metal-bearing material (e.g. metal objects, pigments, tanning salts) or may be the result the trampling of people (and animals?) who were in contact with or involved in metal-bearing resource processing.

Courtyard: A significant concentration of metal elements was also recorded in the courtyard. In addition, calcium content is relatively high content suggesting the presence of lime material in the courtyard. Noteworthy, manganese is also relatively abundant, pointing in this instance to burning or waterlogging conditions. The low concentration of phosphorus and strontium may indicate that activities involving the use of plant/animal resources were not practiced in the courtyard or, if so, this open space was kept relatively clean.

Central Room: The high concentration of plant nutrients (e.g. barium, manganese, potassium, zinc) together with a low content of calcium recorded in the Central Room may be associated with wood ash and low-temperature burning (< c. 400°C). The high concentration of iron may also be related to burning, rather than biological activity.

The phytolith assemblages from House 23 are consistent with the evidence recorded elsewhere: a predominance of grass types with a few non-grass phytoliths. The proportion of grass subfamily types shows very little variability. The concentration of non-grass types changes slightly from the very low value recorded in the courtyard sample to the comparatively much higher one recorded in the Central Room. Despite different concentrations, herbs & woody phytoliths are the predominant non-grass type in all deposits, but woody and palm cells are also relatively common.
Soil micromorphology: food processing and/or consumption?

The micromorphology sample from the Central Room revealed the presence of ‘soil fragments’ characterised by a very fine iron-rich fabric and high amount of charcoal, micro-charcoal, pollen and fungal spores. The abundance and nature of organic matter, such as bone fragments (burnt and not burnt) and plant remains, point to either processing or consumption (or both?) of food inside the house.
Funerary contexts

Graves

A grid of 2 x 2 m square was superimposed over the so-called Grave Area and 8 samples were collected from approximately 10cm below the ground surface.

The soil cover is a dark, fine sand silt loam with common pebbles, medium to fine size charcoal, and very fine shells.

Two samples were processed for multi-element analysis: one sample from inside the grave area and another one from the entrance. The entrance sample is characterised by twice the amount of barium and slightly increased phosphorus suggesting localised activities taking place at the entrance of the grave area.

Given the number of samples analysed and the degree of variability in the chemical composition, the possibility that these slight differences are part of the same chemical signature cannot be ruled out. Noteworthy, these values are slightly lower than those obtained from Tomb 12.

Tomb 12

Three main contexts were examined. Multi-element analysis results indicate a moderate amount of nutrients in most contexts. Noteworthy, the comparatively nutrient-poor environment associated with contexts 12007 and 12008 may be the result of particular activities taking place (?). On the other side, context 12005 yielded high content of nutrient elements (barium, calcium, phosphorus, and strontium) that suggest some sort of resource processing and, possibly, involving the burning of plant and/or animal Material.

Phytolith signature of the funerary contexts

The funerary contexts are characterised by a predominance of grass phytoliths. However, woody phytoliths account for most of the non-grass component in the grave area and different contexts of Tomb 12 (#12003, #12007 and #12009). The presence of palm phytoliths is restricted to the northern and southern ends of the trench (#12003 and #12005). The main context (#12005) yielded a particularly high concentration (60%) of palm phytoliths.
Activity areas

Well
A 2x3.5m trench was opened to ascertain the stratigraphic sequence of the well located to the East of the South Open Area. The results of chemical analyses on samples from the main contexts (6002, 6003, and 6004) are consistent and reflect an alkaline environment and fair amounts of nutrients. The concentration of a few key elements registers a slight increase in context 6002 (calcium, manganese, phosphorus, and strontium).

The phytolith assemblage indicates a predominance of grass types with common woody phytoliths.
Soil micromorphology: Well
The excavation of context 6004 recorded a significant amount of cultural material and the micromorphology sample revealed the presence of heterogeneous organic matter and strong iron impregnation.

In addition to potsherds, a particular crust fragment was also noted in thin section. The crust is composed of a mixture of different fabrics, potsherds, and rock fragments. Thin layers of microsparite and iron-manganese coat one side of the fragments and may indicate some sort of finishing (white wash?). The rock fragments and iron features indicate high temperature burning. The use of this material is unclear, but the inclusions and external finishing may suggest the presence of mud-brick/adobe (?).
Summary remarks

Soil analyses:
1) Coral limestone and quartz are the main rock component of the soils/sediments of Songo Mnara. The reddish sandy loam recorded at Songo Mnara is most likely a terra rossa soil, which is very common along the Swahili coast. The dark, brown silty loam, instead, is found associated with cultural deposits visible on surface and buried and its origin is yet unknown.
2) High phosphorus contents in the open areas may be related to animal browsing, possibly ruminants that would release nutrient-rich dung into the ground.
3) The room fills of the house deposits are generally rich in organic matter (plant remains, charcoal, bone, and shell fragments) and plant nutrients. The variety and preservation conditions suggest that most of this organic matter is associated with the occupation of the houses, as opposed of being the results of post-depositional processes. Even though bioturbation (by soil micro-fauna) is significant, the mixing resulting from it seems to be much localised.

Phytolith analysis:
1) The phytolith assemblages suggest that grasses were the main component of the vegetation cover at the site. Phytoliths derived from grass leaves and culm epidermis (e.g. elongate smooth/sinuate) are commonly found and they may be associated with an early stage of crop processing or other activities involving the use of grass leaves. The highest concentrations of leaf/culm phytoliths are found in Tomb 12 and at the eastern end of the open areas. The assemblages from House 44 and House 23 yielded only a relatively small number of leaf/culm phytoliths and show, instead, high concentrations of Pooid phytoliths (>20%) that may be related to storing and/or consumption practices.
2) The non-grass phytoliths are found ubiquitously across the study area, but in very different quantities. Woody types abound in the plastered floor and in the funerary contexts. This may suggest that wood was used in plaster making. The absence of palm phytoliths in the open areas may indicate that the palm trees present today are a later development. Remarkably, palm phytoliths are absent from the Grave Area and Tomb 12 with the only exception of #12005. This context yielded a significant amount of palm phytoliths, which accounted for over 60% of the total non-grass component of this context.
Lessons to be learnt
The preliminary results obtained indicate both the potential of soil micromorphology and selected element analyses to address the use of space at ancient Songo Mnara. The calcitic nature of the local sediments and soils strongly influences the pH, which is moderately to strongly alkaline across the entire sample set. As regards electrical conductivity, the domestic deposits show distinctive high values. However, despite minor variations, the values obtained from the open areas are generally very similar.

Future work
Further research should endeavour in ascertaining and mapping the distribution of the dark brown silty loam across the island. It should clarify whether the formation of this particular soil type is a result of the human occupation, associated to settlement and land use (e.g. the presence of orchards/gardens next or within house compounds, issues of domestic waste management, etc) or its origin is related to geological discontinuities within the coral reef.

The preliminary observations presented and suggest the use of quicklime plaster at ancient Songo Mnara. It is hoped that future research will explore the production, use and management of coral-limestone resources at the site.

Cultural material from the domestic contexts suggests the use of cotton at the site, phytolith analysis cannot provide supporting evidence at the moment as the production of opal silica by Gossypium sp. plants is poorly understood. On the other side, relevant information on the presence of and use rice (Oryza sp.) in could be detected via phytolith analysis. The epidermis of the rice glume produces distinctive hair cell phytoliths as well as morphotypes not unique to Oryza, such as bilobate and bulliform types. The identification of rice phytoliths is performed by means of morphometric analysis, which was not undertaken for the present study. However, the relative abundance of phytolith types (bulliform and bulliform) that could be associated with rice is intriguing. Even though this finding cannot be taken as evidence of the presence of rice, it encourages further research in this direction.
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