New York University

Excavations at Amheida 2012

Geological Investigations

The description that follows is based upon observations during the 2012 season that have built upon, and in some cases have slightly altered the details of, previous work at Amheida, conducted by the site topographers as well as myself. It should be noted that a Munsell color chart was not available during this survey, and colors are therefore described as closely as possible based on observer bias. In addition, because the region of Amheida is one of active dune activity, local geology has been described as best as possible using current sedimentary exposures. Future dune movements may provide additional opportunities to describe and correlate local outcrops, and sand movements have in fact covered portions of sections described previously, preventing validation of those descriptions. Also, this field report reflects initial data and impressions at the end of the 2012 season, which are subject to revision through additional data collection and analysis.

Geologic survey during 2012 built upon the geologic survey of 2010 and a more limited survey in 2011, and focused on obtaining elevations for charcoal samples taken in 2011 (Figure 1) as well as describing stratigraphy relevant to these samples where necessary. Previously-described sections were also re-visited in light of new hypotheses, in order to verify descriptions. Areas where Mut bedrock is found at the surface have been included in the GIS map and are indicated in Figure 1 as areas of pink coloration. This year's investigations provide additional support for probable well-digging in the past, and reveal a paleosurface several meters above the modern surface that was anthropogenically altered.

STRATIGRAPHY

In general, units previously described were revisited and verified, and sections were updated where necessary. These updated sections have been uploaded to the Amheida server, regardless of whether they appear in description below. Those that have not been updated can be found in the 2010 sections currently available on the server.

Southwest (GS001-GS006)

Reinvestigation of these units (Figure 2) verified the sandy nature of all units in question, including the lowermost unit at GS001, which had been interpreted as "Unit 1" in our three-unit sequence of Holocene sedimentation. See the 2011 report for a more detailed description of these three units. GS002 was found to be significantly sanded-in by a south-moving dune, and was difficult to examine. GS004 was re-measured in light of an anthropogenic interpretation for the uppermost units, significantly simplifying the stratigraphy. The nodules present in this area (sometimes referred to as a "well" or as M7) did not react to HCl, suggesting that they are likely quartz nodules deposited as part of spring activity. A mud brick feature was also noted down slope from GS004, which may have been related to groundwater extraction here. GS006 experienced a failure of the uppermost units since last year, leaving a clean section exposed for sedimentary description on a more detailed level than was previously possible. These section sketches have been updated and uploaded to the Amheida server, and the fence diagram has also been updated to reflect the more recent hypotheses regarding the environmental origin of these sediments (Figure 3).

Pottery obtained from these sections during the past few years were interpreted by Pascale Ballet, a visiting scholar to the site. These identifications included Pharaonic pottery in the uppermost units of GS001 and GS005 as well as the lowermost unit of GS003. Bronze Age pottery was found in association with the excavated Mut formation clays in GS004. Most interestingly, the top of GS003 revealed Old Kingdom pottery, while the in situ pottery associated with the

excavation of the bedrock was Roman in age. This reverse stratigraphy in the artifact assemblage supports the similarly reversed stratigraphy of the sections here, indicating excavation of bedrock as well as any artifacts already present in the area during what appears to be a Roman period of well excavation. Older pottery was then worked into the surface as water interacted with the surface and potentially while people irrigated for agriculture in this area. Pascale Ballet also suggested that the mud brick rubble at AM65, above a charcoal sampling point, were more likely from a pigeon house than part of a cemetery, which fits well with the idea of local agricultural activity as well as the fact that this surface is significantly higher than the surface where the cemetery was built nearby.

The fence diagram (Figure 3) suggests a highly variable, likely erosional surface of playa sediments (Unit 1) that were covered by dune sedimentation (Unit 2). The alteration of the surface and excavation of the springs occurred on a more regular surface, likely due to the nature of dune preservation and/or alteration of this surface for use by people (Unit 3, rich in snails, pottery and charcoal).

Southeast (GS007-GS010)

Closer re-examination of sediments to the SE of the Pyramid revealed Mut formation inclusions and a gray shale within the upper sand units in areas where these features had not be described during the initial sedimentary descriptions. Sketches have been updated and uploaded to the Amheida server.

East (GS011-GS013)

The Mut formation found in on these hills still has no obvious source, but Pascale Ballet did not support the idea of raw material storage for pottery-making, as this was not the usual practice at other sites. It may be more likely that these bedrock exposures result from digging similar to that found in other areas of the site, but here there is no obvious groundwater source to excavate. However, indications of this type of activity may have been built-over or simply obscured by modern sand. Pottery at the interface between sandy units and excavated bedrock here were also identified as Roman, supporting the idea that this may be a similar situation to that found to the SW. Upon closer examination GS013 was found to be composed of sediments that are not likely to be in place, and this section should therefore not be utilized for stratigraphic information in the future.

East (AM66-AM70)

A series of low yardangs within the low area between the Pyramid and the Villa were sampled during 2011 for charcoal. These were thought to represent portions of Units 1 and 2, likely to be Holocene playa and dune deposits. These sections are generally small (Figure 4) but they do reveal some areas of Mut inclusion, shale inclusion, and limited pottery. There were also *Melanoides tuberculata* snails observed nearby in the sands. The presence of these features is not inconsistent with a playa environment with limited freshwater availability, but may suggest that the presence of Mut Fm. shales worked into a sand deposit should not be taken as evidence for anthropogenic alteration or irrigation, and that the digging of bedrock alone would indicate human use of water resources. However, when the elevation of these units is compared to those found to the SW (Figures 3, 4) it may be true that the Mut-containing units are approaching the same elevation seen as excavated areas to the SW, and so we may be seeing uppermost Unit 2 instead of Unit 1 in these eastern sections. The radiocarbon dates will hopefully clarify this issue, as will the illustration of a cross-site fence diagram, which will be developed in the near future.

SPRING MOUNDS

M1

Pascale Ballet identified much of the *in situ* pottery at M1 as Roman in age, and topographic elevations were obtained for these units as well as for a cross-section of M1 as a whole. The white root-traces and sediments at the "mouth" of this spring to the North were tested with HCl, and found to react only minimally in a few root traces at the very center, suggesting biogenic carbonate deposition within roots, but that the majority of this white material is gypsum resulting from evaporative processes in this area. Gypsum crystals are present throughout the deposit.

M6

The large spring mound to the NW of the site, designated as AM25, is topographically higher than other deposits and contains considerable ironstone, suggesting a Pleistocene age for the initial stages of spring formation and activity. However, there appear to be *in situ* spring sedimentation (yellow and red cemented sands and silts) beneath excavated spring sediments, suggesting that this area was also utilized and excavated by people. There is no good artifactual or charcoal evidence here, but this has been described by one section so far, GS024. This has not yet been sketched, but will be in the future. It appears that all of the sedimentary evidence for springs in the Amheida area is accompanied by evidence of excavation of either bedrock or spring sediments as people presumably dug for water as water tables dropped.

OTHER EVIDENCE

A remnant channel preserved as an ironstone "wall" was noted by Bruno Bazzani during a walk to the south of the main house (GPS point included in list uploaded to Amheida server, designated as "Channel"). This channel presents as a 1.5 m thick unit of ironstone surrounding a central channel-fill of orange well-cemented sand. Beneath this unit, 0.5 m of well-sorted fine sand with strong yellow and red coloration indicates spring sediment. The channel itself ends near to a more recent well dug into an area of spring sedimentation, which suggests an area of groundwater availability. The channel leaves the area of the spring and can be followed for a distance to the North. The 1.5-2.0 m of total deflation since the use of this channel matches well with the deflation we seem to have in the Amheida area since the Roman period. See the uploaded photos on the Amheida server as photographic evidence.

CURRENT HYPOTHESES

The evidence identified during the 2012 season at Amheida supports the results of the 2011 survey. The current hypothesis provides for a series of events associated with local water, culminating in the abandonment of irrigation and a need to dig wells. At some point prior to occupation, during the Pleistocene but also potentially continuing into the Holocene, spring activity was frequent and led to the deposition of iron-rich precipitates and sands. This landscape was significantly deflated, and a playa environment provided for the preservation of sandy units overprinted with large root casts and oxidation. This playa deposit was followed by the deposition of dune and sheet sands. The presence of water issuing from groundwater vents, either through spring activity or through irrigation, is evidence by massive sand units containing weak soil development, snails, pottery, charcoal, and organic matter. On top of these sediments we find excavated bedrock, indicating a later period of well excavation. The predominantly Roman-era pottery found directly beneath this excavated bedrock layer suggests Roman-era removal of bedrock and use of water, on a surface up to 1.5 m above the modern surface.

FUTURE WORK

Relevant sedimentary exposures have largely been described within the immediate area of Amheida. Future sedimentary work would be useful, but new exposures are few, and the work to be done at this point requires excavation in many cases in order to verify stratigraphic relationships, clarify microstratigraphy, and correlate units over space. Permission to dig trenches for stratigraphic purposes will be necessary for continued work on sedimentary description.

- It appears that Unit 3, what is likely an early Holocene playa unit, sits on Mut bedrock, but a clear exposure has not been seen in the study area.
- South of M1 to the southern pyramid, the surface is composed of many quartz pebbles, and the one description into a previously excavated hole indicates fluvial sediments in this area. The relationship of this unit to those described so far is unknown, and would require trenching.
- The means and exact location of excavation of wells is not visible given current coverage of the study area by dune sands.

In some areas where sand coverage prevents a view of potential archaeology or bedrock structure, such as those areas where well-digging is suspected, it may be more prudent to pursue geophysical means of determining the morphology of the subsurface in order to identify specific places for archaeological excavation. Ground Penetrating Radar (GPR) would likely be the best option given that dune sands are the primary covering medium. Areas to examine would include:

- The M7 well area between GS003 and GS004
- South of the GS007-GS009 hills and N of the GS010 outcrop, where channelization is evident
- The area of GS016-GS017 to the North of Amheida, where the presence of bedrock on top of sand units indicates another area of well-digging. The center of these units may reveal a well or spring eye structure.

Topographic examination of any of the areas around the Amheida site proper would be helpful, but is probably not practical given the immediate needs of the project as a whole. It may be useful to map out the eroded traces of agricultural fields and channels to the North of M1, where these features are evident.

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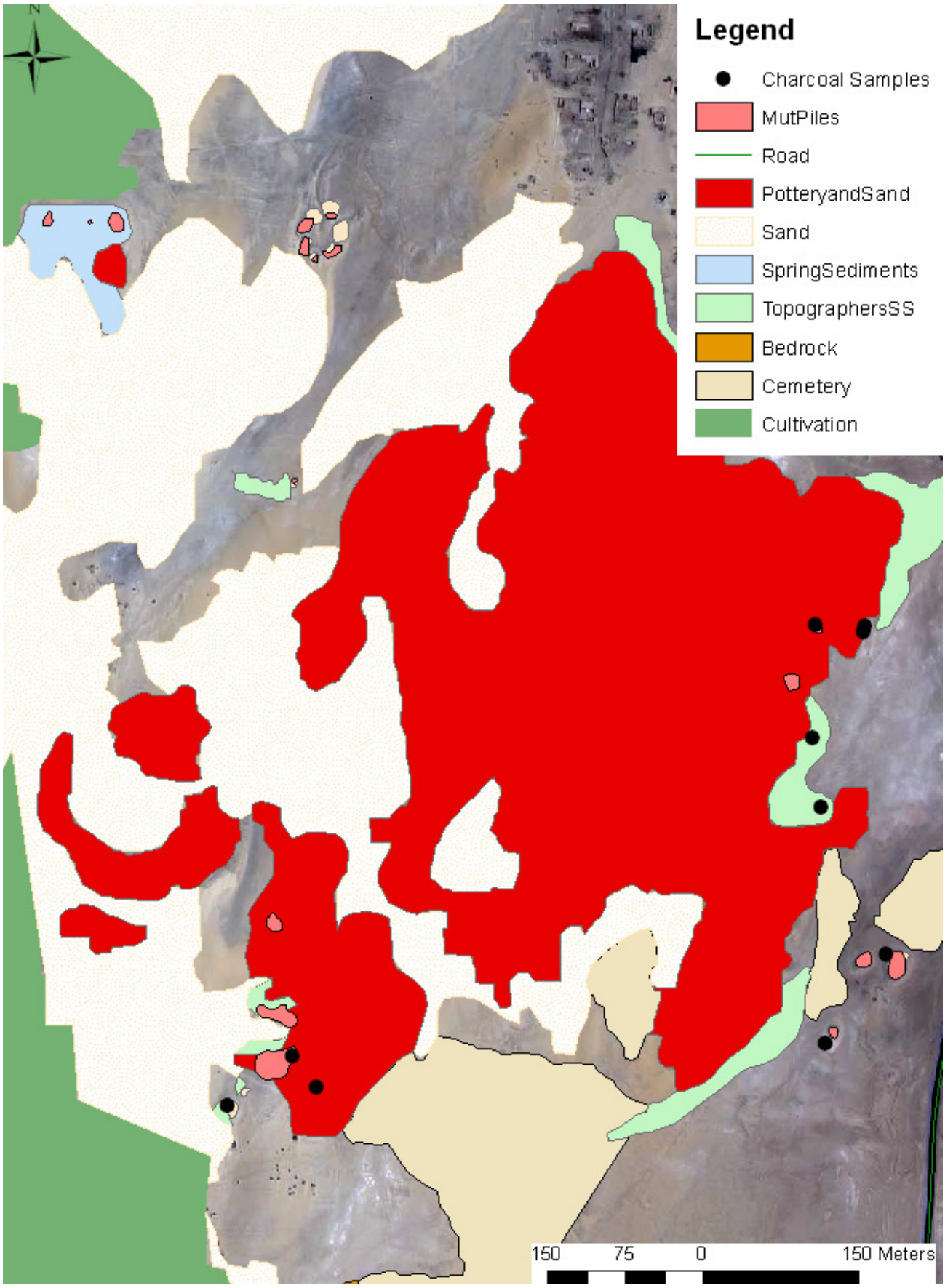

Figure 1. A map of Amheida units indicating areas of charcoal sampling in 2011 as well as areas where the Mut formation can be found at the surface as a result of anthropogenic activity, likely excavation of the bedrock for wells. These areas are pink and labeled as "Mut Piles".

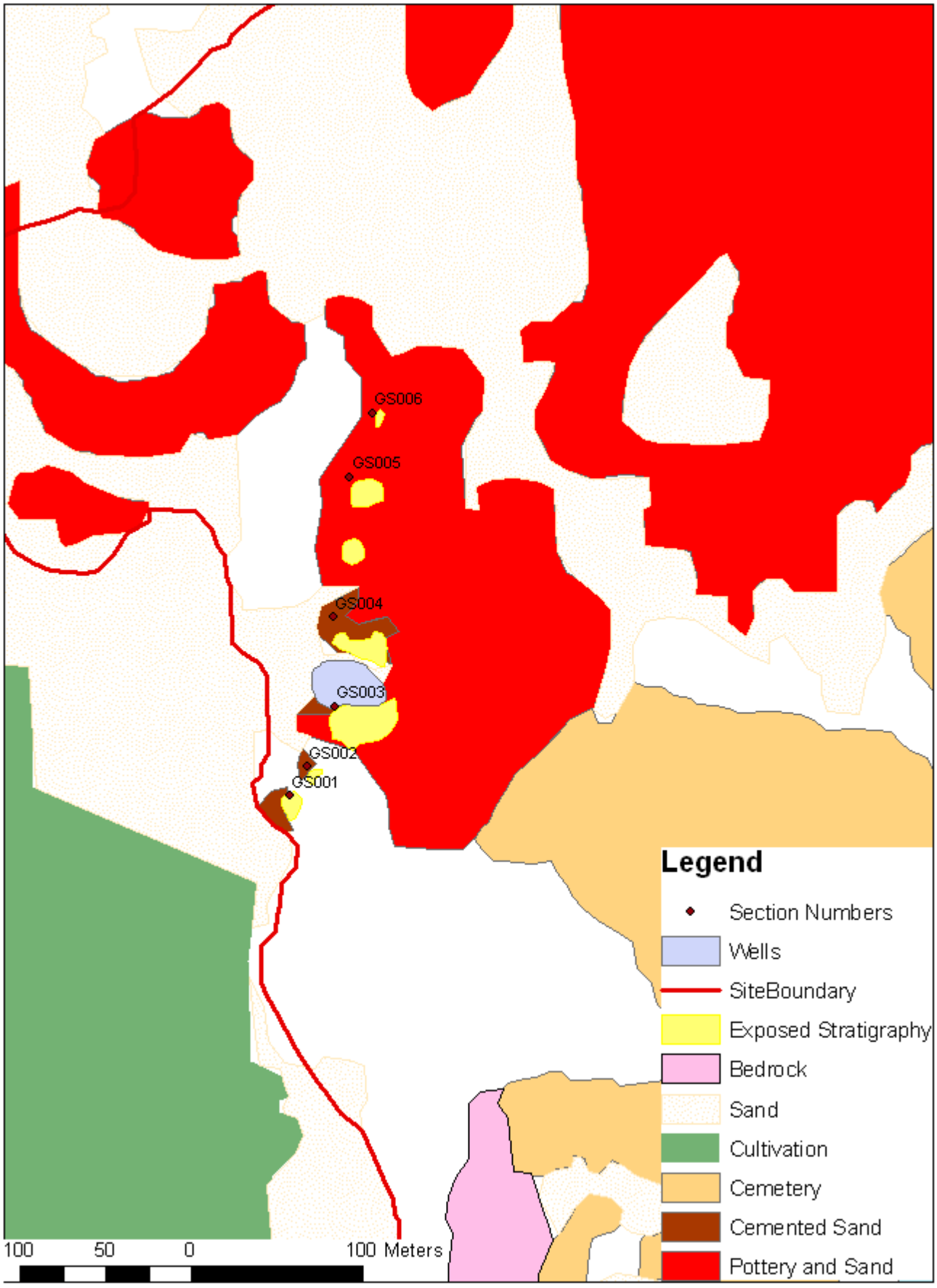

Figure 2. A view of the area to the SW of the Temple Hill, the subject of the fence diagram in Figure 3.

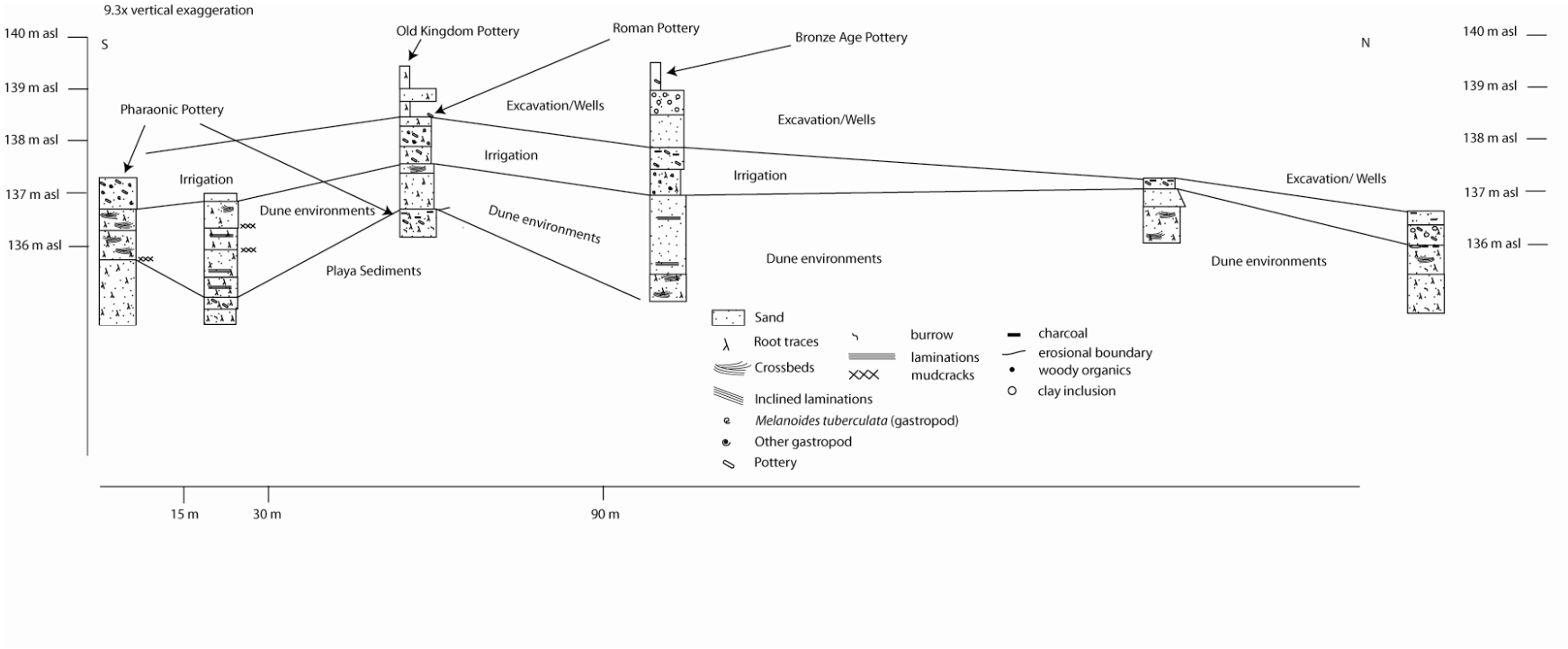

Figure 3. Fence diagram of the GS001-GS006 sections to the SW of the Temple Hill at Amheida, including updated interpretations and the locations of pottery found within the area. See the Amheida server for a higher-resolution image.

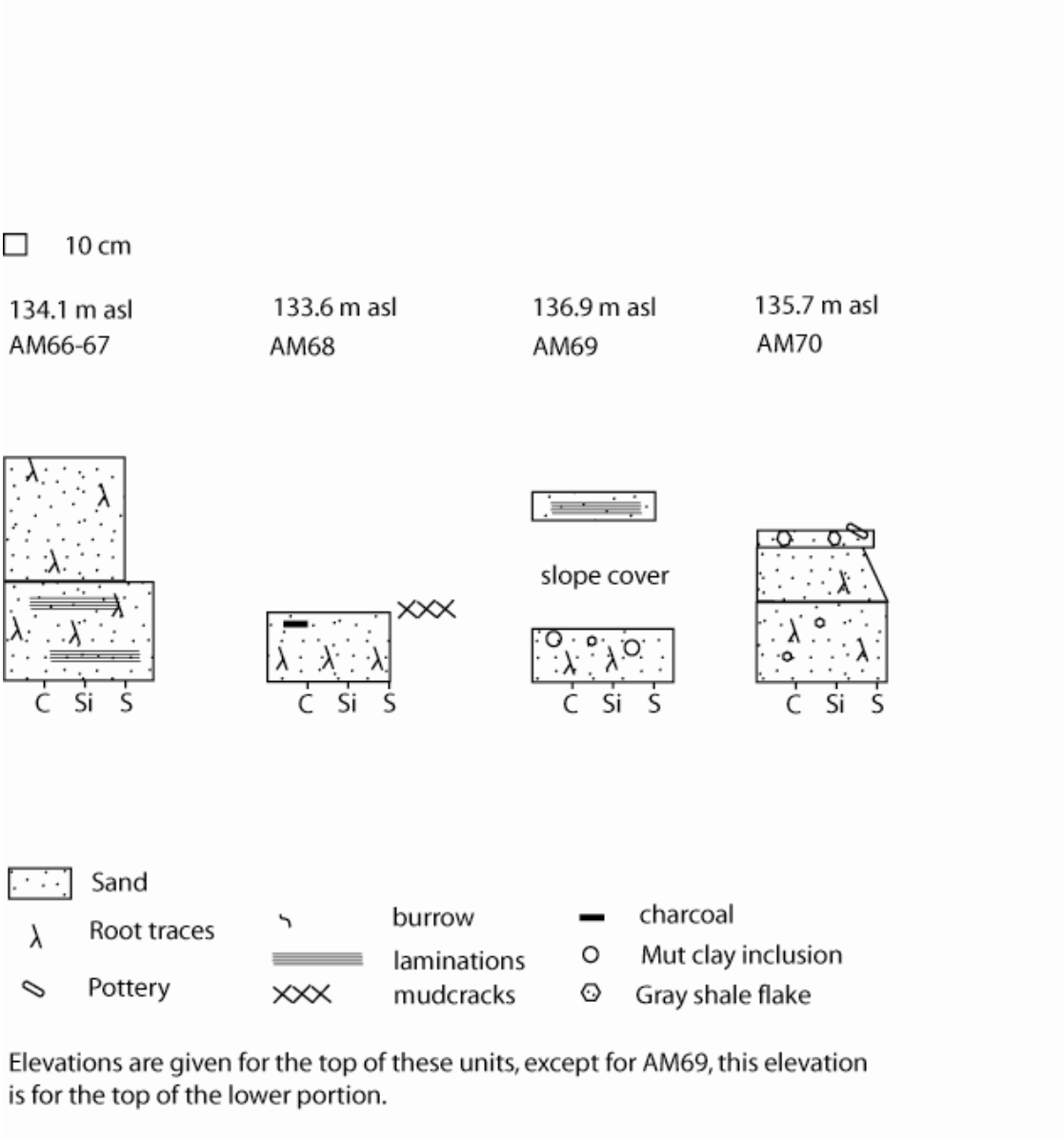

Figure 4. Sections for AM66-70, all small yardangs from the low area to the east of the Amheida site proper, between the Villa to the north and the Pyramid to the south. Sections are not illustrated according to hanging points, but elevations are given above the section names.