

Soil erosion, agricultural terracing and site formation processes at Markiani, Amorgos, Greece

CAI French* and T M Whitelaw**

*Department of Archaeology, Cambridge, CB2 3DZ, UK

**Institute of Archaeology University College London WC1H 0PY

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<http://ads.ahds.ac.uk/catalogue/resources.html?markiani>

Introduction

During surface investigations at the Early Bronze Age site of Markiani on the island of Amorgos in the Cyclades (Figure 1), it became apparent that down-slope erosion had drastically modified the surface distribution of artefactual materials. The down-slope erosion was itself affected by the extensive construction of agricultural terraces across the site. It was anticipated that the application of micromorphological techniques could significantly enhance our understanding of the erosion processes involved, as well as the disturbance processes related to the construction, use and subsequent decay of the relict agricultural terracing. The research has contributed to an understanding of the creation and modification of the surface distribution of artefacts at the site, and has produced information about the poorly understood prehistoric environment and land-use of the Cycladic islands.

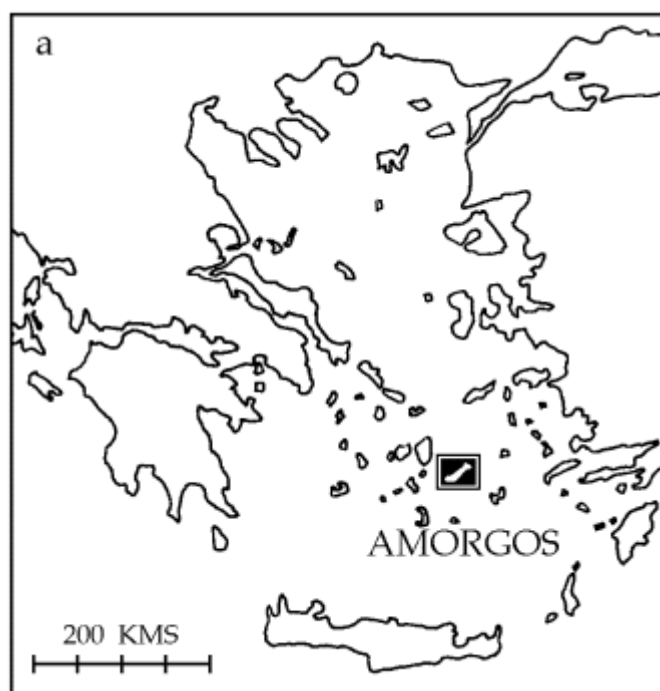


Figure 1: Location of Amorgos in the Aegean Sea.

The site is situated on a small knoll, above the precipitous southern cliffs of the island (Figure 2). It was first occupied late in the first phase of the Cycladic Early Bronze Age (ca. 3000-2800 BC). In all, four prehistoric occupation phases have been identified at the site, the latest characterised by material of the Kastri Group, late in the Early Bronze Age (Renfrew, 1972:172, 533-4; Sotirakopoulou, 1993; Manning, 1995:51-63, 81-6), approximately 2350-2200 BC.

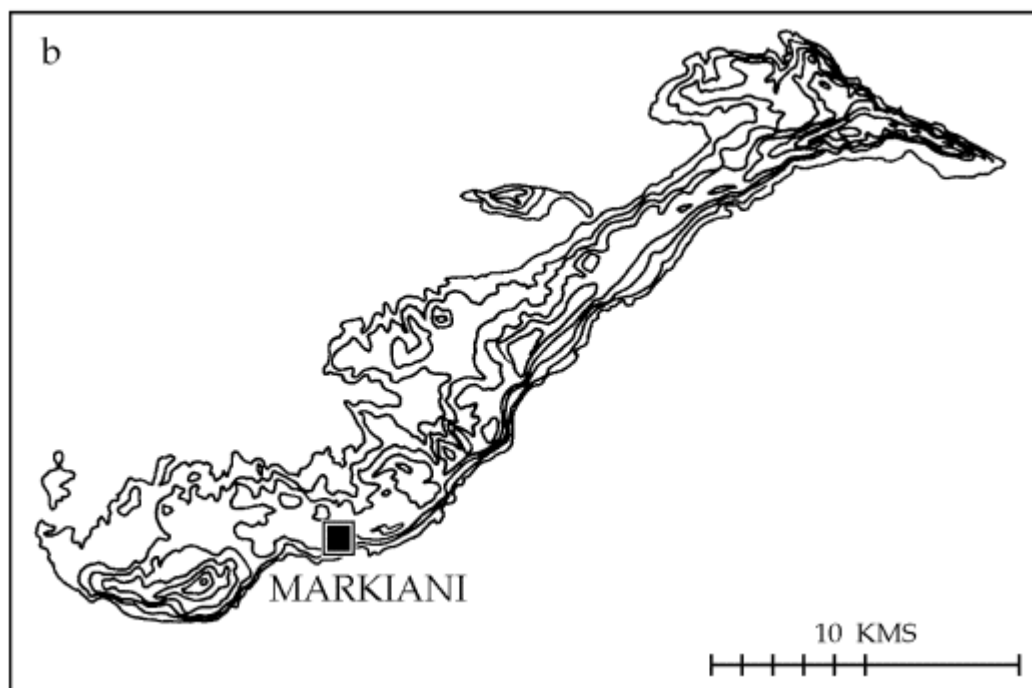


Figure 2: Location of the site of Markiani on the island of Amorgos.

Later use of the site is represented by material ranging from the Geometric through the Classical, Hellenistic and Roman periods (ca. 800 BC-AD 500), principally recovered through surface collection, but also represented in the superficial levels of many of the excavation trenches. After this, use of the site appears to be limited to the system of agricultural terraces (cultivation ceased during the 1960s), while at present the slopes around the site are grazed by sheep and goats, with small folds on the summit of the hill.

Approximately 9,000 sherds were collected from 707 survey units, distributed over 25ha of slope at Markiani, constituting a 1.6% sample of the site's surface. Initial analysis suggests that the ceramics have spread, through erosion processes, from an

occupation area of only ca. 0.25 ha, on the top and upper southern slope of the site (Figure 3). This study of the site and slope sediments provides sedimentological information that aids the interpretation of the erosion history of the site, and contributes to our understanding of the nature and effects of terrace construction on the slope deposits and the archaeological materials embedded within them.

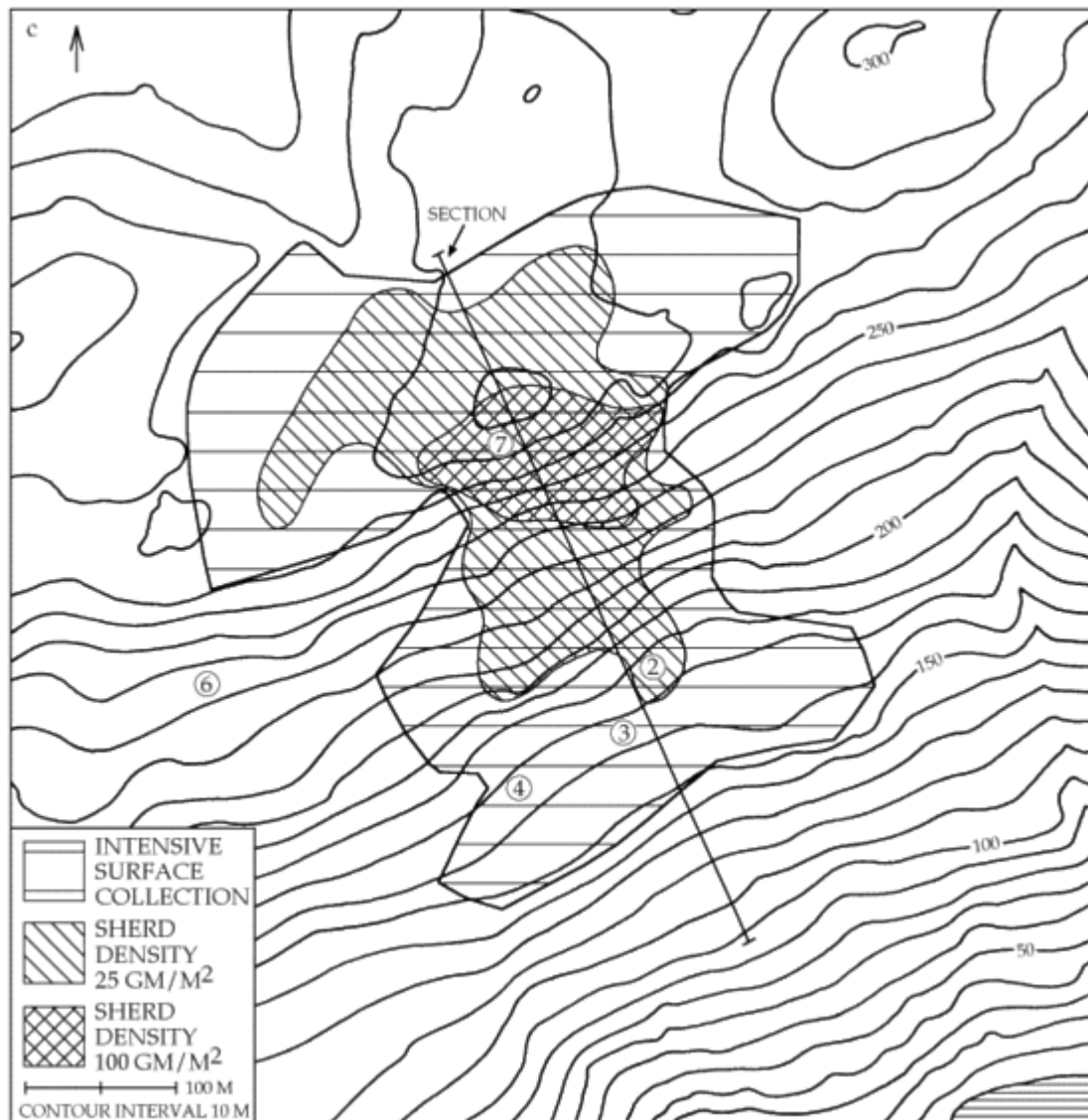


Figure 3: Markiani Site Topography and Profile Locations.

Methods

Detailed examination of the slope, undertaken during and after the surface collection, enabled the identification of a number of exposures across the site where archaeological excavation or terrace wall collapse had exposed sediments which could be investigated without further damage to slope stability. Prospection of the main area

of terraces on the slope beneath the site was undertaken with the following aims in mind:

1. identification of old land surfaces and in situ palaeosols;
2. assessment of the consistency or variation up- and down-slope of the sediment composition of the terraces; and
3. investigation of the post-abandonment modification of the site deposits.

Five profiles were selected as either the most representative and/or best preserved exposures suitable for recording and sampling for micromorphological analysis (Figure 3).

The soil blocks were impregnated and made into 'mammoth' thin sections (after Murphy, 1986) at the Geo-Archaeology Laboratory, Department of Archaeology, Cambridge. The thin sections were analysed using a Leitz polarising microscope and described using the terminology of Bullock et al. (1985).

Results of the micromorphological analyses into the pre-terrace soil

At the lowest extent of the distribution of archaeological materials are a series of broad terraces, while below this, small collapsing terraces continue down to the sea. The terraces are supported by now-collapsing or overgrown walls, 0.5 to 2.0 m in height, creating wide cultivation surfaces. The change in slope represented by these shallow, broad terraces, in the otherwise steep and rocky slope, has acted as a sediment trap, witnessed by the dearth of surface archaeological materials on the lower slopes down to the sea.

The archaeological materials on these terraces are predominantly post-Bronze Age - almost entirely Hellenistic in date. This may represent material eroded down-slope from the concentration of similar material on the hill-top, but given the relatively good preservation of the sherds, at least some of this material probably represents an area of localised activity (such as cultivation), on what would in the past also have been the most easily worked section of the slope.

Relatively few Early Bronze Age sherds were recovered this far down-slope, and most are small and heavily abraded. The densities of obsidian, contemporary with and

eroding from the same deposits as the Early Bronze Age ceramics, are significantly higher, indicating, as on other early prehistoric sites in the Cyclades (Whitelaw, 1991), the preferential survival of obsidian during weathering and down-slope movement, whereas relatively low-fired Early Bronze Age ceramics comminute, abrade, and eventually disintegrate with movement down-slope. This would have been exacerbated on these terraces, if the prehistoric sherds were exposed to a period of early historic as well as more recent cultivation.

Very few archaeological materials are visible in the exposed sections where terrace walls have collapsed. The low density visible in vertical section is compatible with the low density of material visible on the surface. The absence of any clear deposition or sedimentation levels within the fills behind the terraces, suggests that (at least at the front of the terraces) the soil has been thoroughly mixed in the construction of the terraces, rather than representing a complex erosion or build-up sequence. Hellenistic as well as Early Bronze Age sherds are found through the whole vertical exposure.

At the base of Profiles 2 and 3, a pre-terrace soil was found to be preserved and exposed beneath the lowermost stones of the terrace retaining walls (Figure 4). No sherds were found in these exposures, though given the low density of sherds in any of the lower slope fills, this cannot be taken as necessarily documenting a pre-Early Bronze Age date for these palaeosols. These levels predate the terraces they underlie, differ visually from the overlying terrace fills, and could potentially represent sediments accumulating before the significant deposition of cultural materials on the slope.

The pre-terrace soil consisted of two horizons. The upper, thinner (c. 80-100mm) horizon was a pale to medium brown silty clay loam with common small (<20mm) stones. It exhibited a poorly developed, small, irregular blocky ped structure. The lower, thicker (c. 200-350mm) horizon was a pinkish-red to orangey-red clay loam which exhibited a similar soil structure, with an even mix of small stones (<10mm) and occasional larger stone inclusions (< 100mm).

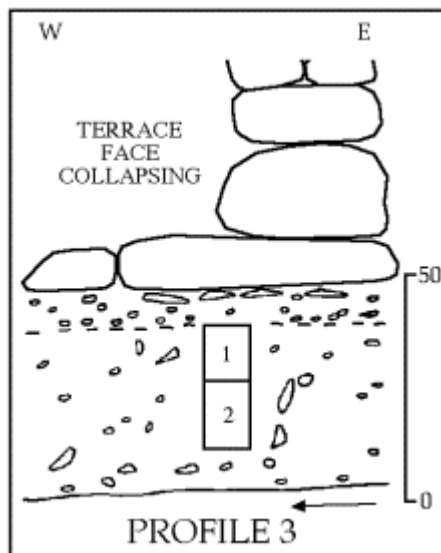


Figure 4: Profile 3 at the Markiani Site.

The unsampled upper horizon is essentially a more friable and browner version of the underlying horizon. It is probably more organic, and therefore could be considered as an A-type horizon. This suggests that there was no appreciable pre-terrace truncation of this soil. The lower horizon, with its distinctive structure, reddening and enrichment with clay and iron, probably represents a red Mediterranean soil. Red soils and in particular, terra rossa, are believed to have been characteristic of this part of the Mediterranean prior to clearance and intensive agricultural practices (Bridges, 1978:67-70; Zangger, 1992).

The substantial impure clay fraction in this palaeosol occurs both within the groundmass as an integral part of the soil fabric and in the interpedal void space. 'Dusty' or impure clay is composed of a mixture of micro-contrasted silt particles and minute fragments of organic matter (Macphail, 1987). This type of illuvial clay is particularly characteristic of disturbed soils (Slager and van de Wetering, 1977). This may be indicative of an earlier phase of incorporation of fines as a result of the disturbance of a bare soil, associated rain splash and/or slope wash erosion and the consequent addition of fines, and within-soil mass movement of fines. On the other hand, the dusty clay lining the void space suggests a subsequent phase of illuviation of fines down-profile (Macphail, 1992; Kwaad and Múcher, 1977). Consequently, there may be two pre-terrace-construction phases of disturbance and illuviation of fines. In addition, the fact that this soil exhibits no sign of any recent illuvial

movement of fines suggests that this soil ceased to receive fine material once it was buried by the sediments later reworked in the construction of the terraces.

Both phases of illuviation suggest that there was considerable erosion of open and often bare slopes prior to the establishment of the terrace system. It is probable that this illuvial dusty clay deposition was caused by rainsplash and localised slopewash erosion of fine textured, bare soils and within-soil, down-profile, mass movement of the dislodged fine material (Kwaad and Mùcher, 1979). A rare torrential rainstorm would have been sufficient to cause mass-movement of soil down-slope (Clark and Small, 1982:35-40), very much like a mud-slide. By implication it may be suggested that this bare soil was associated with past agricultural or pastoral use. Thus this soil was already much modified by gradual colluvial accumulation by the time it was buried by terrace wall construction.

Results of the micromorphological analyses into the terrace deposits

Although numerous exposures of terrace deposits were examined up- and down-slope, they appeared to exhibit remarkable uniformity in terms of sediment composition. Accordingly, four spot samples were taken from two different terraces on different parts of the slope, out of 10 profiles studied in the field. These were selected where clean profiles were available at locations where whole sections of terrace wall had collapsed or been removed, revealing the face of the profile behind. These flank the outskirts of the main distribution of archaeological materials, one profile at the base of the main slope (Profile 4), and one to the west (Profile 6) (Figure 3), principally because the terraces on the central slope are considerably overgrown, and the collapsing faces have usually been worn back by goat trampling.

The composition of the sediments comprising the terraces is quite different from the buried soil, but remarkably uniform among the terraces studied and sampled. In the field, the terrace deposits exhibited a poorly developed, irregular to sub-rounded, blocky ped microstructure. The sediments comprise pale pinkish brown silty clay loam with variable amounts of stone inclusions of different sizes in horizontal and random orientations (Figure 5).

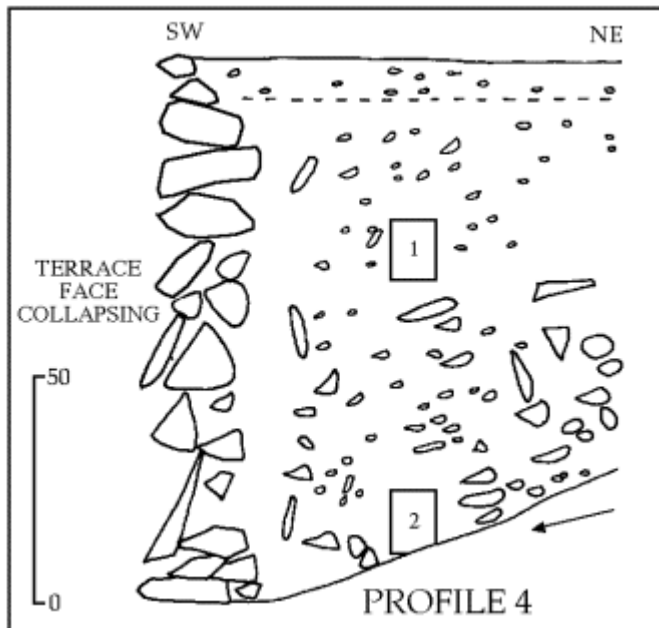


Figure 5: Profile 4 at the Markiani Site.

The mid-slope terraces below the site, but above the sediment trap of the shallow terraces considered above, are all small, 1.5 to 4.0 m in width, usually retained by walls 1.0 to 2.0 m high. The terraces are all of relatively short lateral extent, 4.0 up to 20.0 m, broken up by exposures of bedrock or large detached boulders. Many of these terraces will not have been accessible for animals to draw a plough, and will most likely have been cultivated by hand using a mattock or spade. As with plough cultivation, soil turning during cultivation will have been limited to the upper 10-15 cm of the deposit.

The make-up of the terraces is dominated by one fabric composed of poorly sorted stone and organic sandy clay loam to loam with poor soil structure. This is a mixture of soil material derived from the mass movement down-slope and illuviation of fines (silt and clay), as well as higher velocity erosion responsible for the incorporation of limestone pebbles and rocks, all subject to considerable mixing by soil faunal activity. There are also minor components such as eroded subsoil material, and past and present material derived from rainsplash and hill-wash.

The clay component suggests that there were three types of erosion occurring at different times:

1. minute, clay-sized, eroded fragments of the subsoil; these may be associated with the physical/chemical weathering of exposed (through sheet erosion) areas of subsoil;
2. illuvial, non-laminated dusty clay, well integrated with the groundmass, which is indicative of soil disturbance and probably the erosion of the original soil associated with rainsplash, within-soil mass movement and the mass movement of fines down-slope; these are probably the same erosional processes that had earlier affected the reworked red palaeosol;
3. the non-laminated dusty clay as 'linings' of the void spaces suggests that more recent illuviation of fines has occurred, but which has also resulted from rainsplash erosion of fines from a bare and exposed soil surface, such as present on these slopes today.

Conclusion

It would seem plausible to suggest that the erosion in the pre-terrace soil was initiated with cultivation and grazing on and immediately around the site at Markiani, following its establishment late in the first phase of the Early Bronze Age, ca. 2900 BC. Unlike the lower, broader terraces, there is nothing to suggest in the terrace deposits that the upper slopes of the site were ever cultivated in antiquity, though there was sufficient soil disturbance in places upslope to cause subsoil and soil erosion down-slope. The Early Bronze Age sherds on the surface and incorporated in the terrace fill, given their edge abrasion, are likely to have been eroded from the site above, and the same seems likely for the later historical material. The terrace walls themselves reveal no evidence for earlier foundations or phases of rebuilding.

The absence of any clear pre-terrace deposits on the main slope may be a function of the steeper slope and shallower soils, such that all deposits have been reworked in the construction of the terraces, or those that survive do so only in small pockets in the rock, buried beneath the terrace fills. In contrast, the sediment trap formed by the lower, broader terraces, may have been much more effective at retaining deep slope deposits that did not need to be reworked so completely in the construction of the recent terraces.

In general, the application of micromorphology to this archaeological site associated with an intrusive terrace system has demonstrated its usefulness. Soil composition, and in particular, transformations of the soil/sediment regime, are directly recognisable. Remnants of original soil types point to the existence of at least two earlier types of landscape - stabilised open but vegetated slopes and eroding/utilised slopes.

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