Papadiokambos: new evidence for the impact of the Theran eruption on the northeast coast of Crete

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The study of the effects of the Minoan eruption of Santorini on Neopalatial Crete is still plagued by the small number of archaeological sites with volcanic material in primary context. The list of settlements with undisputed secondary evidence for damage generated by the eruption (that is earthquake, tsunami or flood) is equally short. In east Crete primary evidence has been found at both Pseira and Mochlos in the Bay of Mirabello and at Palaikastro.[1] In striking contrast not a single site from the Siteia Bay, including Achladia, Petras, Klimataria, and Zou, has so far produced more than a few fragments of pumice.[2] What makes this pattern particularly interesting is the subsequent response of the Mirabello, Siteia and Palaikastro regions to the destruction horizon observed at these sites at or towards the end of LM IA (*i.e.*, following the eruption). Sites in the Mirabello and areas surrounding Palaikastro (*i.e.*, where tephra has been recorded) are substantially rebuilt in LM IB while several sites in the Siteia region (Achladia, Klimataria and Zou) appear to have been partially or perhaps completely abandoned.[3] Petras alone has clear evidence for an LM IB reoccupation, but there are even signs there of declining fortunes. Petras House 1 was abandoned, along with portions of House 2 and the palace.[4] While it is clear that Neopalatial east Crete witnessed and largely survived the Theran eruption, there remain nagging questions about the Siteian response. Could the eruption have had a particularly devastating effect there even though there is little physical evidence for the event itself?

This paper re-examines the cause of the LM IA destructions in the Siteia region with the help of an LM I settlement recently discovered at Papadiokambos. The site occupies a remote coastal plain spreading west of the Trachilos peninsula, 10 km west of Petras and 14 km east of Mochlos (Fig. 1). Excavations there by Chrysa Sofianou and the

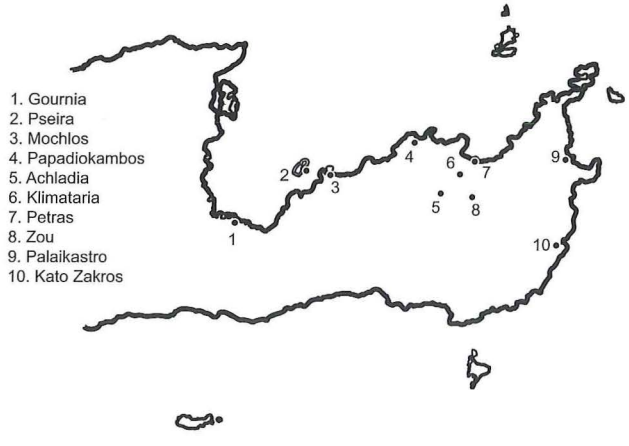

Fig. 1. Map of East Crete (Y. Furuya).

[1] For Mochlos, see Soles, Taylor & Vitaliano 1995 and Soles this volume; for Pseira, see Betancourt *et al.* 1990, 96–9 and Betancourt this volume. For the most comprehensive discussion of the evidence at Palaikastro, see Bruins *et al.* 2008.

[2] For a review of the evidence in the Siteia Bay, I would like to thank Dr. M. Tsipopoulou for her personal communication.

[3] For a thorough discussion of the Neopalatial settlement patter in the Siteia Region, see Tsipopoulou 1991, 105–21, Tsipopoulou and Papacostoploulou 1997, 203–14 and Tsipopoulou 2002, 134–44. N. Platon, the excavator of Achladia, Zou, and Klimataria and M. Tsipopopoulou, the excavator of Petras have found evidence for discontinuity and complete or partial abandonment of sites in the Siteia region following the late LM IA destructions. In agreement with this dating, see Driessen & Macdonald 1997, 222–27; for the suggestion that some of the sites continue in use in LM IB (*e.g.*, Achladia), see L. Platon 1997, 194–95.

[4] Tsipopoulou 2002, 134–44.

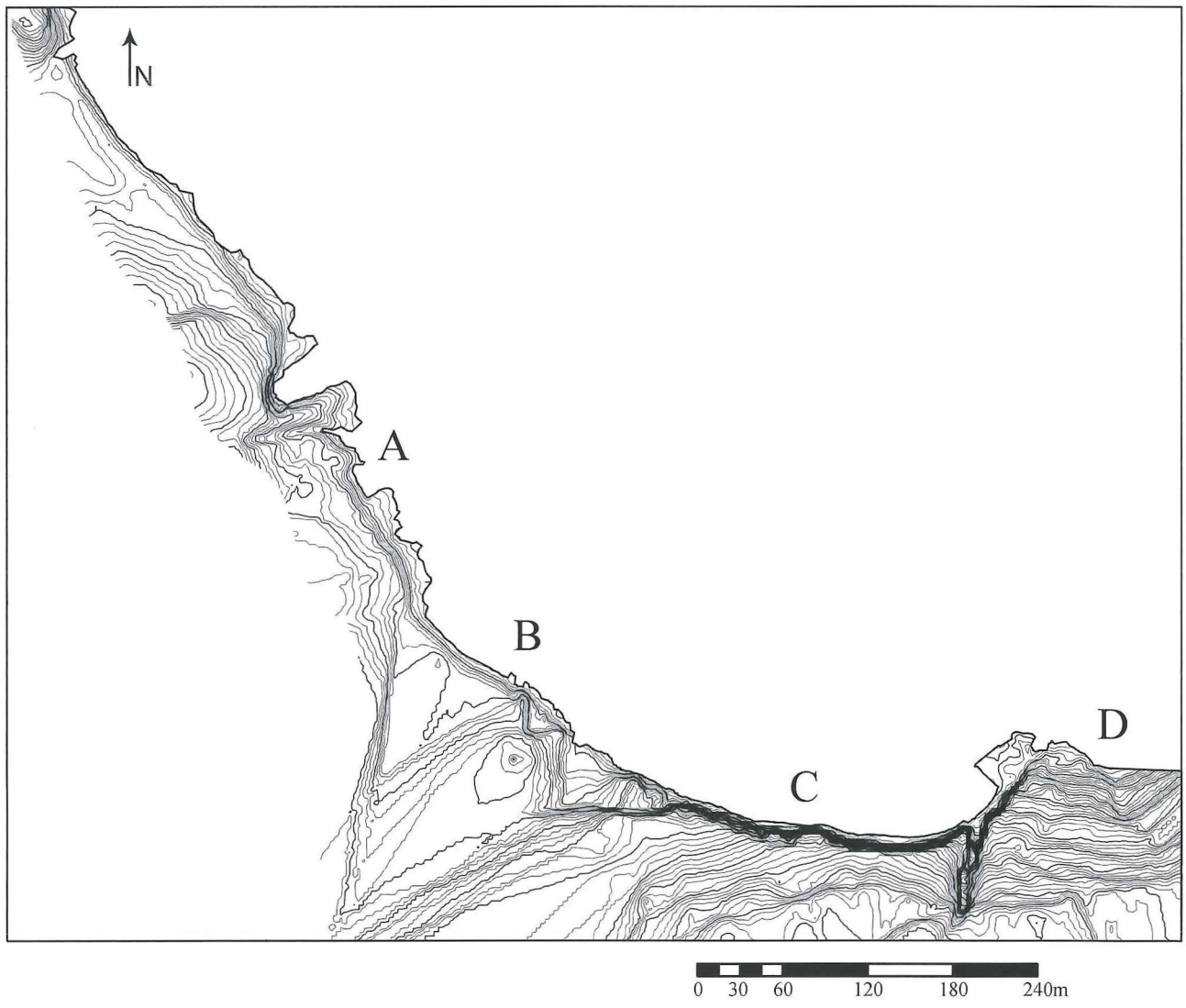

Fig. 2. Topographical map of the coastal plain at Papadiokambos (Stamos).

KD Ephoreia of the Greek Ministry of Culture in 2004, 2005, and 2007 are exploring a Bronze Age town. Study of the material is just beginning, but already there is a growing body of evidence to suggest that the Theran eruption played a role in the destruction of the site. This material and the pottery from the LM I destruction at Papadiokambos may also offer a new window into the problematic LM IA/B transition in the broader Siteia region. Because of the workshop's focus on chronology, this current study also draws comparisons to the substantial pre and post-eruption ceramic deposits from the nearby site of Mochlos to illustrate the relative position of the eruption in the east Cretan Late Minoan I ceramic sequence.

For the past two years a survey team has mapped the coastal plain of Papakiokambos, recording walls visible along the coastal scarp and in road surfaces (Fig. 2). The substantial Neopalatial town appears to cover an area larger than 3 hectares (perhaps the same size as LM I town at Gournia), but its specific urban layout is still not understood. Three streams that cut though the site are used to distinguish four parts of the town: Areas A, B, C and D.

A discovery by the team surveying in Area D at the eastern edge of the settlement in 2007 leaves no room to doubt the impact of eruption on the LM I inhabitants. Just 25 metres from the shoreline in Area D, team members discovered a thick layer of grey ash in an eroded scarp created by winter

Fig. 3. F. McCoy cleaning the layer of tephra in Area D (Photo: Brogan).

storms (Fig. 3).[5] After cleaning, the exposed layer measured roughly 8 meters in length and 0.10-.16 m in height. Preliminary examination of the context suggests that it is a layer of tephra from the Bronze Age Theran eruption, which remains in primary context (*i.e.*, where it fell). This hypothesis will be checked when samples are analyzed by the Demokritos Laboratory in Athens, but if correct, the depth of the tephra at Papadiokambos (up to 16 cm) indicates that the amount of ash fall in eastern Crete was much larger than previously estimated by scholars studying this event.[6] A second, darker, layer of soil (0.10-.15 m) lay above the tephra. This upper stratum may represent of mixture of soil and ash, which reached this position after washing down-slope during storms, which followed the eruption.

The context of the tephra is also important. The ash layer sits immediately on top of Minoan cultural remains including fragments of LM I pottery. This material is probably associated with the Minoan house walls visible five meters to the south and east of the cutting and may offer a significant new sample for ongoing efforts to locate the position of the eruption in the Cretan ceramic sequence.

The second body of evidence for assessing the impact of the Theran eruption at the site was recovered during excavations in 2004 and 2007 of LM I House 1 next to the sea in Sector A (Fig. 4). A survey of the surrounding plot with ground penetrating radar in 2006 indicates that the house sits in an open field which was flanked on the south side by a long terrace wall that may have served as an embankment to protect the house and perhaps its gardens from the stream that flowed into the sea just to the south. Given the conference topic, this description of House A.1 will be necessarily brief, focusing on the cause and date of its final destruction and abandonment.

So far, work has uncovered 6 rooms from a two-story house with a yard built along its south side. The walls of the ground story rooms are preserved to 1.30 metres and remains of the collapsed upper story had fallen in a layer one meter thick over substantial ground floor assemblages of pottery, stone tools and metal artefacts. An entrance to the house was located on the south side where a poorly

[5] The authors would like to thank Dr. Antonia Stamos and Vangelis Fiorakis who discovered the layer and Floyd McCoy for confirming earlier observations that the material might be tephra from the Theran eruption.

[6] For a review of the various estimates (typically 1–5 cm.), see Driessen and Macdonald 1997, 92–4. Floyd McCoy (pers. comm.).

Fig. 4. Plan of House A.1 (Stamos).

built door led from the south yard into Room 6, which was carefully paved with green slabs. The finds from this room and the adjacent Room 5 include several basins, jars, jugs, cups and stone tools including several saddle querns. Carbonized seeds and shells collected from the floor suggest that the pottery and tools, including the large mortar in Room 5 (called a *gourna*), were used for the storage and preparation of agricultural produce and food. Another opening on the north side of Room 6 leads to a staircase, the return of which was excavated as Room 2 on the north side of the building. Room 1 at the northwest corner contained a large number of cooking pots and dishes and served as a kitchen or pantry; the function of Rooms 3 and 4 has not yet been determined.

The paved rooms on the south side appear to preserve one phase of architecture and modest remains of an upper story (a pithos clearly fell over Room 6). A more complicated history was revealed on the north side of the house, where two phases of architecture can clearly been seen. In the second phase, construction of the staircase over Room 2 necessitated blocking three doorways and opening one new door on the south side of Room 3. Rooms 3 and 4 appear to preserve both Phase 1 and Phase 2 floor levels while the floor assemblage found in Room 2 probably belongs to Phase 1 after the stair was constructed. The modest amount of pottery from the Phase 1 floors and from fills beneath the Phase 2 floors, including ledge-rim bowls, in-an-out bowls with tortoise shell ripple pattern and semi-globular cups with dark pattern of scroll, allows us to date the first phase House A.1 to MM III B and LM IA and the construction of Phase 2 somewhat later in LM IA.

The chronology and cause of the Phase 2 destruction is complicated and brings one back to subject of the paper – the impact of the Minoan eruption of Santorini on sites in eastern Crete. The pottery and the evidence for the destruction deserve careful study, and both benefit from comparison with the stratified LM I material from the Block C houses at Mochlos.[7] Most of the vases from House A.1 at Papadiokambos are plain utilitarian vessels: tripod cooking pots, cooking dishes, basins, jars, and pithoi that are broadly LM I in date. The vases

[7] The authors would like to thank Dr. K. Barnard who is studying much of this material at Mochlos. For a detailed presentation of the late LM IA and LM IB deposits at Mochlos, see Barnard & Brogan forth.

Fig. 5. Photos of P 6 and P 47 from Papadiokambos (Papanikolopoulos).

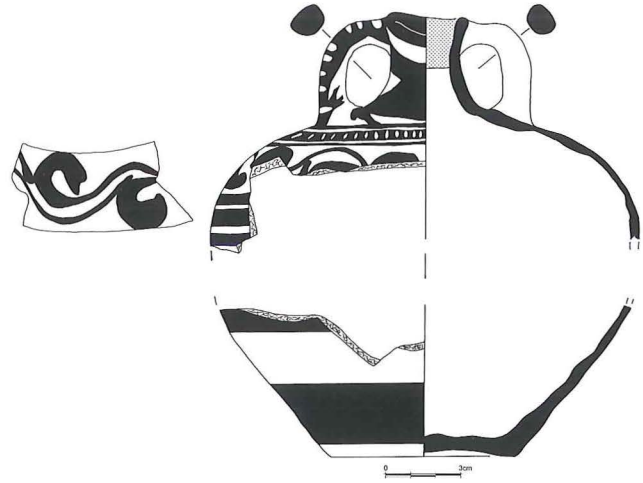

Fig. 6. Drawing of P 54 from Papadiokambos.

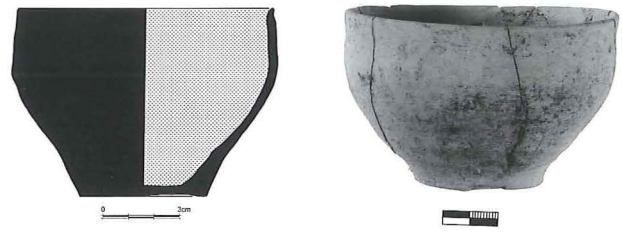

Fig. 7. Drawing of P 36 from Papadiokambos (Morrison) and photo of P6047 from Mochlos (Papanikolopoulos).

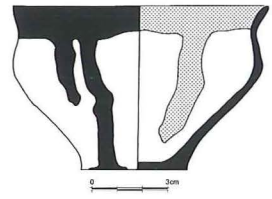

Fig. 8. Drawing of P 57 from Papadiokambos (Morrison).

that were in use at the time of the destruction (those from 50% preserved to complete) provide the best relative date for the final destruction. They include an interesting series of jugs, amphora, and cups. Among the jugs are two examples with solid centred spirals and added white dots (Fig. 5 a-b), motifs that which are found in pre-eruption LM IA deposits on Crete.[8] Two amphora from House A.1 carry a version of tendril scroll that is found in both LM IA and IB deposits at Mochlos, though it must be said that the examples from Papadiokambos are certainly earlier than the versions found in later LM IB when the motif becomes become more stylized or outlined with rows of dots at Mochlos (Fig. 6). [9]

The cups present a similar picture and have good parallels from Mochlos. The conical cup, which has proven to be a useful tool for building the LM IA-LM IB chronology at Mochlos (using a sample of 500), is rare at Papadiokambos (3 examples so far). The monochrome hemispherical cups found in Room 1 at Papadiokambos first appear at Mochlos LM IA deposits that precede the eruption and continue in the first post-eruption levels at Mochlos, which are dated to early LM IB (Fig. 7a-b, also called early ogival cups). More surprising is the discovery of S-profile or ogival cups decorated monochrome or with rim bands in Rooms 3, 5, and 6 at Papadiokambos (Fig. 8). At Mochlos

[8] Soles & Davaras 1992, 100, c-d.

[9] Barnard & Brogan 2003, fig. 55, I.B 636 (P 2772).

this shape is rarely found in pre-eruption deposits but instead has been identified as one of the most important criteria for distinguishing the early and final LM IB phases at the site. Early LM IB examples at Mochlos have profiles that vary from straight to a pronounced S-profile . In Final LM IB they achieve a more consistent S-profile. [10] The phase 2 destruction at Papadiokambos contained 3 such cups and they are among the best preserved vessels from the house. All would be early LM IB at Mochlos (*i.e.*, post-eruption). House A.1 at Papadiokambos also contained 3 fragments of what looked like stemmed cups. The shape is typically associated with LM IB levels.

One must keep in mind the preliminary stage of this study and excavations. For now the decoration and surface treatment of the decorated pottery at Papadiokambos is broadly LM IA in style (spiral, scroll, and foliate band), but the continued use of these same motifs in LM IB was carefully outlined by Niemeier's study of LM IA and sub-LM IA.[11] At the same time there are intriguing indications that the pottery belongs to a transitional moment between LM IA and LM IB and it may prove to be significant that there are a few items (*e.g.*, ogival cups) that fit better with the post-eruption horizon at Mochlos. Fortunately at Papadiokambos discussion of the date of the destruction/abandonment of House A.1 (*i.e.*, pre or post-eruption) is not limited to the pottery. There is also evidence for the eruption itself.

No traces of tephra have yet been found inside or outside House A.1; nor is there clear evidence for damages caused by a tsunami. The best documented tsunami destruction on Crete now comes from LM I Palaikastro where a team of specialists have published a list of criteria, which they have used to identify tsunami deposits.[12] None of the indicators from Palaikastro have been found in the destruction levels of House A.1 at Papadiokambos; however, one should not forget that only 5 trenches had been excavated at the site when this report was being prepared. At present, the only possible evidence to suggest the Theran eruption had a serious impact on House A.1 comes from the collapse of the wall forming the west side of Rooms 1 and 5. A photo taken with the aid of a boom and a stratigraphic section of the unexcavated north scarp in Room 5 both indicate that this wall fell in a single motion across the room and towards the sea (Fig. 9 a-b). What caused this massive shift? An earthquake or a tsunami? The geologist Floyd McCoy looked at the evidence and noted that the reverse flow of a tsunami could (in theory) have knocked House A.1 down in the direction of the sea; however, the evidence from Room 5 was not entirely consistent with such an action.

The excavation of House A.1 also recovered substantial amounts of pumice in the building and some pieces have been sent to the Demokritos Laboratory in Athens for XRF analysis. At Papadiokambos twenty-three pumice samples (with approximately 75 pieces ranging in size from 1-12 cm) were collected by hand during the excavation. These samples come from the collapse above rooms 3, 5, and 6 and the floors of Rooms 3, 5, and 6 and the South Yard. These levels and rooms are significant because they represent the clearest areas of phase 2 occupation in the house (*e.g.*, where all the ogival cups were found). In contrast, no pumice was recovered from Room 1, which contained the hemispherical cups, which have what appears to be an earlier LM I profile.

An important compliment to this record is also being gleaned from the intensive soil flotation program conducted by the project. Small pieces of pumice were recorded in many of the 105 soil samples collected from the six rooms and south yard. A preliminary study of the distribution of pumice again indicates that no pumice was found in Room 1, while large amounts were recovered from soil samples collected over Room 3 and in the tumble and on the floors of Rooms 5 and 6. The emerging picture suggests that pumice is present throughout the Phase 2 building: on the floors and in the collapse of the upper story and the outer walls. It is absent from the Phase 1 layers and Room 1.

The quantity and size of the pumice suggests that it arrived at the site by air or sea (as it still does today in large quantities). Its distribution in the building is

[10] Barnard & Brogan 2003, figs. 4–5.
[11] Niemeier 1980, 29–36.
[12] Bruins *et al.* 2008, 191–212.

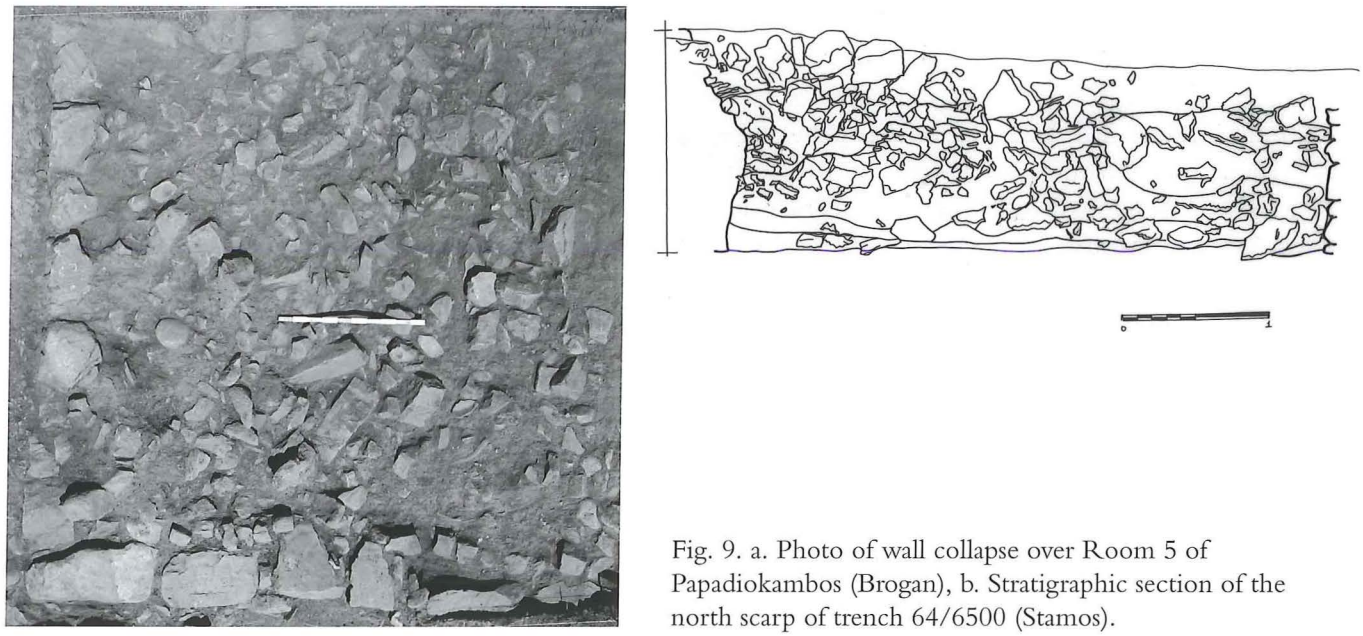

Fig. 9. a. Photo of wall collapse over Room 5 of Papadiokambos (Brogan), b. Stratigraphic section of the north scarp of trench 64/6500 (Stamos).

also significant. One possible interpretation is that the pumice arrived immediately after the eruption as part of the forces that literally destroyed the Phase 2 version of House A.1. A second hypothesis would explain the widespread distribution of pumice within the house as the result of rebuilding House A.1 after the eruption when pumice was lying all over the site. It would simply have become part of the building fabric by accident. This problem will be tested with future excavation and the collection of soil samples throughout the tumble layer (soil samples from 2007 were largely from floors). During the 2007 excavation, the authors firmly believed that the evidence supported the first hypothesis (even though one would have expected more of the pumice to have been concentrated in the upper layers of the collapse than on the floors). It was the subsequent study of the pottery, which raised the possibility a slightly later date for some of the phase 2 material, that forced us to consider the possibility of a post-eruption reoccupation of parts of the House – namely Rooms 3, 5, 6 and the east yard.

This paper has briefly covered the growing body of evidence for the Theran eruption at the site of Papadiokambos; there is considerable potential for discoveries next summer to change this picture, beginning with the opportunity to collect a sample of local pottery beneath the ash layer in Area D. For now, there are intriguing indications that House A.1 may have suffered substantial damage from the eruption and perhaps even been sealed by it. But, even if the pottery from Phase 2 is eventually found to belong to a period of post-eruption repairs, it probably would not represent more than a brief post-eruption phase. The evidence from Papadiokambos, therefore, appears to support the earlier suggestions that LM I sites in the Siteia Bay were severely damaged by the eruption and at least in some cases abandoned shortly afterwards. Before this case can be closed, however, the study of the pottery from both Phases 1 and 2 will need to be completed together with a careful reconstruction of the widely scattered distribution of pumice throughout the Phase 2 levels.

As a final comment about the cause of the destruction and abandonment of the House A.1, attention should also be given to the thick layer of sterile soil that covers the Phase 2 assemblage and the yard on the south side of the house. Could this material be evidence of flooding or mud slide which buried parts of the site soon after the eruption? Some support for this hypothesis is provided by the series of substantial erosion deposits visible in the coastal scarp east of the House and against the southern face of the terrace wall that protected

the yard surrounding House A.1 from the stream flowing into the sea to the east. The problem will be a focus of future geological study at the site and together with new excavation may represent our best opportunity to clarify how much of the site was abandoned following this major event in Aegean prehistory

As a post script to the paper, the authors would like to mention how the excavations in 2008 in House A have caused us to revise our opinion concerning the date of the Phase 2 construction and destruction. Work in Room 5 and Room 8 of House A produced more stemmed cups and one fine tall alabastron. The shape and decoration of these vessels, particularly the alabastron, fit better in the LM IB period than LM IA, causing us now to suggest that Phase 2 of House A.1 probably represents rebuilding at the site after the eruption.[13] The present evidence still allows for the suggestion that the subsequent Phase 2 destruction of House A.1 may have occurred early in LM IB and thus before the mature or Final LM IB destructions at Mochlos, Palaikastro and other sites in east Crete.

[13] Mountjoy has recently questioned Popham's earlier suggestion that the tall or baggy alabastron represents a new shape in the LM IB period; see Mountjoy 2003, 82 and Popham 1967, 341. Mountjoy's argument is based on an LM IA vase from Zou published by Platon (1956, pl. 114, second from the right in the third row down). The vase from Zou is certainly LM IA, but it is broken at the neck. It is more likely to be a jug on the basis of a very close parallel from the recent excavations of an MM III/LM IA kitchen underneath LM III House Alpha at Mochlos, which also has a surprisingly low centre of gravity like that of later LM IB alabastra. Moreover, the vase from Zou could well be an import from the Mirabello.