Akrotiri on Thera and the need for interdisciplinary action

The site of Akrotiri lies at the southernmost end of the island of Thera or Santorini in the Cyclades, Greece. Its excavation was begun in 1967 by the late Professor Spyridon Marinatos[1] who aimed at proving his own theory that the decline of the Minoan civilization was due to the eruptive activity of the Thera volcano[2]. Far from having proved his theory, Marinatos has brought to light a small fraction of an extensive Middle Bronze Age urban settlement which was buried under enormous masses of volcanic ash around 1500 B.C.[3]. The size of the site, the diversity of information it reveals, as well as the present state of preservation require the combined efforts of a number of disciplines besides archaeology.

Before its final destruction the city lived for at least one thousand years, its earlier remains dating back to about the middle of the third millennium B.C., and there developed a wealthy community of merchants and seafarers who also promoted the arts. The finds from this site can only be counted in tens of thousands and modern technology is required for their recording in the archives. Indeed with the collaboration of Dr T. Constantinides from the Imperial College, London, we have installed a computer and are elaborating programmes according to the requirements of our dig.

By applying flotation, our palaeoethnobotanist has already collected at least one hundred varieties of fruits, seeds and grains, of which she has been able to identify at least fifty. They include figs, almonds, grape pips, olive stones, grains of barley, lentils, split peas etc.

The study of animal bones has shown that about 80 % of them came from sheep and goat, 10 % from pigs and very few from bovines. Bird bones, fish bones and molluscs are the subject of study by an ornithologist, an ichthyologist and an ostreologist respectively.

1. Marinatos, S., *Excavations at Thera I (1967)-VII (1973)* ; Doumas, C., in *Praktika*, 1975-1983.
2. Marinatos, S., *The Volcanic Destruction of Minoan Crete*, in *Antiquity*, XIII, 1939, p. 425-439.
3. Doumas, C., *Thera : Pompeii of the Ancient Aegean*, London, 1983.

The study of these biological remains is necessary not only because it reveals facets of the way of life of the Acrotiri community, such as its agricultural economy or dietary habits ; it also provides information about the environmental and climatic conditions prevailing in the Aegean around the middle of the second millennium B.C.

The site of Akrotiri is unique in that a prehistoric city was buried under the ejecta of a volcano. It is therefore possible to date the eruption with considerable certainty. Here the dating methods of the Natural Sciences were welcome to offer their services. From the archaeological data the chronology of the eruption is estimated around 1500 B.C. Other methods applied so far are : C-14, Thermoluminescence, Palaeomagnetism, Frozen tree ring, Ice sheet dating. Unfortunately none of these methods has given dates which corresponded with the archaeological one nor with each other. Thus, the problem remains for the scientists to find out the factor or factors responsible for these discrepancies.

Besides the chronological problems the excavation is open to other specialists like geologists and volcanologists who can detect some of the mechanisms of the eruption by analysing the archaeological evidence. During the eruption pumice was ejected first and then ash (tephra). Although the thickness of the pumice layer at the site is only one metre, in the quarries near the capital village, Phira, it often exceeds six metres.

Careful observation of the pumice layer showed that it consists of five sub-strata[4]. The lowermost sub-stratum, consisting of very fine pumice, is only about 2 cm thick and constitutes the *terminus ante quem* for any human activity on the island. Oxydization of its pumice and a crust on its surface have been taken as evidence that this sub-stratum was exposed to the air for some time, which, according to the experts, was not more than two years. That a period of time elapsed before the second sub-stratum was formed is also confirmed by other evidence : consisting of less fine pumice it contains a considerable quantity of volcanic grit which, in my opinion, was accumulated in the cone by erosion of its walls. Similar grit, though in smaller quantities, is also found in the other sub-strata of pumice which becomes increasingly coarser in the upper sub-strata. In fact, this grit found at the bottom of each sub-stratum suggests that it was ejected together with the pumice but — being heavier fell first — thus distinguishing each pumice sub-stratum. The lack of any evidence of erosion on top of each sub-stratum as well as the decreasing quantity of grit in them suggest that they were deposited one after the other in a short time and possibly represent different paroxysms of the same eruption.

Above the pumice layer lies the enormous mantle of tephra, the thickness of which is sometimes over seven metres at the site, but at the Phira quarries

4. *Praktika*, 1980, 294 pl. 175b. Also *supra*, note 3, p. 60, pl. 9.

exceeds thirty metres. The stratigraphy of this layer shows that material was deposited in two ways : the lower part was formed by action of a base surge, the upper part by the gradual setting of wind-blown dust. The latter is what the volcanologists call chaotic tephra which was ejected high into the air and travelled far away[5]. Considerable deposits of this tephra have recently been found in the Dodecanese islands, in particular Rhodes at the Late Bronze Age site of Trianda[6]. Molecules of that tephra have also been located in ice-sheets in Iceland and have been used for the dating of the eruption.

Together with the ejection of tephra large rocks seem to have been detached from the walls of the crater and were slung over considerable distances. Such rocks are often found in the tephra deposits, not in the pumice. This suggests that the eruption which produced pumice was of lesser magnitude than the one which produced tephra. Some of these boulders have hit buildings at Akrotiri, and I believe from these it is possible to estimate the force that propelled them there. Knowing the direction they travelled and the terminal of their journey it should be possible to exactly locate the site of the crater, now under the sea near Phira. Hopefully a specialist in ballistics will be able to estimate the magnitude of the force which sent these boulders to Akrotiri.

Under these volcanic materials were buried buildings and artefacts but no living creatures, at least this is inferred from the lack of human or animal skeletons. The buildings were not intact when they were buried, having been damaged prior to the eruption. Usually the debris of collapsed walls is found under the pumice layer. This can be explained if we accept that earthquakes preceded the eruption. And it seems that these earthquakes were preceded by slight tremors, which warn the inhabitants heeded and evacuated the city. On the other hand we often find destruction debris enclosed in volcanic strata, suggesting that buildings continued collapsing even during the eruption[7]. In my opinion, there are three possible agents that may have caused the latter damage, and here, once again, the problem calls for an interdisciplinary approach. The first possibility is that earthquakes continued during the eruption. The second is that the pressure waves created by the gas release during the eruption were so violent that they dislocated entire walls. The third possible agent is that with the accumulation of volcanic material on the roofs these collapsed under its weight and created more space for greater accumulation of volcanic ejecta inside the buildings. These ejecta, in their turn, exercised pressure from inside which, combined perhaps with the other

5. Vitaliano, C.J., Fout, J.S. and Vitaliano, D.B., *Petrochemical Study of the Tephra Sequence Exposed in the Phira Quarry, Thera*, in Doumas, C. (ed.), *Thera and the Aegean World*, London, 1978, p. 203.
6. *Nature*, vol. 287, n° 5780, p. 322-324.
7. *Praktika*, 1980, 294, pl. 174b.

two factors, resulted in pushing the walls outwards. Indeed, the evidence is that most of the walls collapsed outwards[8].

The damage to buildings was not uniform everywhere and was seemingly related to the vulnerability of each individual structure. For there is strong evidence that the builders of Akrotiri, taking into account the seismicity of the area, had developed a certain resistant system since timber reinforcements were applied in the walls of every building. This suggests that accumulation of experience, century after century, led the prehistoric engineers of the Aegean to formulate patterns of anti-earthquake defence and dare to construct buildings at least three storeys high. Perhaps negligence of the application of the antiseismic regulations resulted in the unequal standard of preservation of the buildings. These archaeological data require further analysis by specialists because they might give us an idea of the prehistoric Aegean state of knowledge as to the magnitude of earthquakes they might expect.

So much for the measures taken in Antiquity to eliminate the risk of destruction by seismic disturbances, the problem for us now is how to protect these ruins from similar forces. Our situation is more difficult since none of the precautionary measures taken by the ancient engineers exists any more. For neither the timber nor the broken straw which was mixed in the mortar have survived all these millennia and therefore there is no cohesiveness in the building materials. More problems arise as a consequence of the complete desintegration of all wooden supporting elements, such as the beams of the roofs or of the upper floors and staircases as well as the door and window frames. In these cases interdisciplinary action of a different character is called for. Engineers, architects, chemists etc. should investigate substitute materials and techniques for those missing supporting elements before the buildings are exposed after the removal of the retaining volcanic material. Our experience in the dig has led us to take some measures and develop some techniques. First of all, in order to protect the whole site and prevent desintegration of the buildings by the action of the elements the excavated area is covered by an enormous roof of about two and half acres[9]. In those cases where walls have moved from their vertical position, retaining buttresses have been constructed of concrete[10]. Reinforced concrete has also been used to replace the window and door frames[11]. In the latter cases it is vital to proceed to the restoration of the frame before clearing away the material blocking it[12]. A special procedure is therefore applied, which has enabled us to study in detail the system of constructing doors and windows at Akrotiri. It appears that the wooden frame, in fact a wooden case, was fixed in position as building progressed and

8. *Op. cit.*
9. Marinatos, S., *Excavations at Thera IV (1970)*, pl. 6-7.
10. Doumas, C., *supra*, note 3, p. 63, pl. 16.
11. Marinatos, S., *supra*, note 9, pl. 43.
12. Doumas, C., *Praktika*, 1980, pl. 174a ; 175a.

not after the building was completed. This sort of box system was also applied for the reinforcement of the walls[13]. Only after the complete reconstruction of the door or window frames do we remove the blocking material.

The condition in which buildings are discovered furnishes the specialist scholars with evidence of the mechanism and extent of the damage and must, therefore, be preserved. Thus our aim in reconstructing missing parts is not to restore them in their original situation, but as they are found, preserving the evidence of the damage.

Interdisciplinary action is also required to prevent further damage and deterioration. Ashlar blocks are often crumbly and desintegrate once exposed to the air. Here the collaboration of the engineer and the architect with specialists from other disciplines like geologists and chemists is absolutely essential. One of our most recent problems concerning the conservation of the ruins at Akrotiri is the appearance of a species of insect which nests in the clay of the walls. Because of the volcanic nature of the present surface soil clay can only be found in the walls of the prehistoric buildings. Therefore, these insects invaded the site and every year we are confronted with new colonies tunnelling through the ancient walls. A number of insecticides have been used without success. For the last three years the Athens Entomological Institute has been engaged in research which, as yet, has not gone beyond identifying the insect. Finally, our empirical experience led us to use electric insect killers, which appear to be more effective.

Another domain where multidisciplinary intervention is required is the confrontation of rescue, conservation and restoration of the various finds. However, to deal with all the problems involved in this domain would require a special course devoted exclusively to that field. Therefore, I only restrict to the reference to wall paintings the restoration of which is closely associated with the restoration of architecture and vice versa. Besides the special restorers required for the wall paintings, mineralogists and chemists are also needed for the analyses of plasters and pigments, which will allow or dictate special treatments.

As an archaeologist aiming at the study of a past society, I have tried to present a general account of the interdisciplinary confrontation of a prehistoric site like Akrotiri on Thera. I hope I have succeeded in making clear that interdisciplinary operation is not only required for detecting the mechanisms of destruction of our site but also for the study of the society that lived in it as well as for formulating a policy with regard to protection and conservation.

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13. MARINATOS, S., *Excavations at Thera VI*, pls. 16-17 ; *VII*, pl. 21a.