Chapter 8. Conclusions and future directions

8.1 Introduction

This thesis has examined the impact of the Minoan eruption of Santorini in the Late Bronze Age on the cultures of the Aegean area. The eruption has been examined piecemeal by a number of authors before. I have shown that there is no simple cause and effect between the eruption and civilisation collapse, and that much of the data often cited is of poor quality, ephemeral, not critiqued or simply wrong.

To examine the problem I felt it was necessary to take an holistic approach and to examine all aspects of the interaction between the eruption processes and the culture systems. To achieve this I broke the overall problem into four conceptual groups relating to the elements of Earth, Air, Fire and Water. This chapter will bring those elements back together by firstly reviewing the main conclusions from previous chapters and then combining them to allow further insight into the problem.

Finally, this chapter will highlight those areas where I feel there is a need for new research, either to take the study forward or to address those areas which have been poorly dealt with in the past.

8.2 Summary of chapters

8.2.1 Chapter 2. Earth - the eruption and the archaeological landscape

- The relative date of the eruption has been fixed to the mature LM IA, and on this basis the eruption cannot be directly associated with a number of site destructions that occurred towards the end of the succeeding LM IB phase.
- The absolute date of the eruption has not been fixed. Evidence has been presented for two rival theories, termed the High and Low Chronologies, which differ by approximately 100 years. The Low Chronology is the more traditional date and fits well with the comparative Egyptian chronology with little adjustment. The High Chronology would need some adjustment of comparative chronologies but a number of scientific dating methods statistically show this system to be more likely. Having

considered the present evidence I have not yet been convinced by the arguments of either side but more material is being added to the debate all the time. I feel that it will be a long time before there is a consensus on this issue.

- The island of Santorini, and the main settlement at Akrotiri, appear to have played a major role in the complex inter-relationship of trade and exchange within the Eastern Mediterranean cultural sphere. The minimum effect of the eruption is the destruction of this link. This destruction would have had a significant impact on trade, not only at the physical, but also at the meta-physical level with the disruption of the elite's ability to provide and receive foreign goods.
- The Minoan culture was based on a redistributive system; it is debatable whether this made it more rigid and less able to deal with problems or whether one of its main purposes was to deal with shortages and emergency.

Three areas were presented which I felt were most at risk from the eruption:

- Buildings.

- There was a range of buildings within Minoan sites from sheep shelters to palaces.
- The area of a building most at risk was the roof through the accumulation of tephra eventually leading to a collapse. The thickness of tephra would have had to be in excess of approximately 10 cm before any collapse would occur, though this would be reduced if the tephra was wet.
- There is very little data on Minoan roofs since none survive. The best evidence comes from Akrotiri itself and iconographic sources. These suggest that they were flat and similar in construction to the vernacular style in use in the area until the advent of reinforced concrete.
- The roof was a key area of the building and one which was heavily utilised for a variety of functions: storage, food preparation, craft activities and sleeping. There may have been a number of obstructions that could have led to drifting of tephra and therefore increased load over a small area.

- Crops and subsistence.

- The Minoan diet appears to have centred on the exploitation of sheep/goat, pig, cattle, wheat, olive, vine and pulses.

- The main subsistence items were supplemented by a range of other crops, animals and marine resources. The particular resources exploited would depend upon the individual site location.
- The majority of marine resources exploited by the Minoans appear to have come from the shallow water and near shore areas.
- Much of the subsistence system was aimed at creating enough storage of food in a number of different forms to deal with unexpected downturns and crop failures.
- Storage of foodstuffs was centralised, as well as held at the household level. Most individual households only had enough stores for a season.

- Coastal zone.

- Crops and animals within the coastal zone may have been destroyed by tsunamis.
- The effect of the inundation of coastal land could have been long term with the saline poisoning of wells and fields.
- Minoan ports and harbours may have been destroyed or suffered damage. The complexity and the construction of these structures are largely unknown and significant resources may have been tied up in them.
- Any tsunamis could have caused the loss of ships and boats moored within a harbour or beached on land.
- The timing of the event may be significant; in winter a large majority of ships may well have been over wintering on land and might have been severely affected.

8.2.2 Chapter 3. Fire - the eruption

- Before the Minoan eruption there was a caldera in the centre of the Santorini archipelago, rather than a strato-volcano. As a result of this the amount of material displaced was less than initial estimates used in some of the literature.
- There were a number of phases but the important ones for the distal tephra are the Plinian phase and the co-ignimbrite deposits which elutriated off the pyroclastic flows forming a widespread blanket of fine tephra.
- The eruption lasted a short time, around four days, and was not spread over many years.
- There were a variety of ways that tsunamis could have been generated by the eruption process.

- The main way that a volcanic eruption can have a global effect is through the amount of sulphur products injected into the stratosphere. This had been thought to be relatively minor, but recent work suggests the figure could be higher than previous estimates.
- There is not complete agreement among volcanologists as to the process of the phases in the eruption or in the amounts of products.

8.2.3 Chapter 4. Earth - evidence of the eruption outside Santorini

- Many samples from stratigraphic layers have been reported as originating from the Minoan eruption of Santorini. Various scenarios and conclusions have then been based on these reports. Many of these samples have not been critically reviewed or scientifically assessed.
- Analysis of the data shows that some samples should not be assigned to the eruption, the four most important of these are:
    - Tephra shards from the Nile Delta: isopachs and distribution based on these findings should be ignored.
    - Anaphi: the size of a tsunami based on this data should be ignored.
    - Tel Nami: the propagation and size of a tsunami based on this data should be ignored.
    - Alabatross-192: the 4 cm of tephra from a marine core south of Crete, isopach distributions for the amount of tephra that fell on Crete should be ignored.
- It does not look as if significant quantities of material fell on Crete. No area has shown the 10 cm level needed to cause structural collapse. Only at Mochlos, Crete has material from a distinct layer been positively identified as Santorini tephra. Other material, such as that reported from Pseira or Palaikastro, has not been positively identified in the literature.

8.2.4 Chapter 5. Water - tsunamis and sea level change

- Postulations of a tsunami wave with a vertical run-up of 12 m cannot be used to determine ideas of culture wide collapse. Individual sites will have been affected in different ways depending upon individual site location and topography.

- The generation method of tsunamis from the eruption is poorly understood. Many tsunamis of relatively small strength might have been generated rather than a single large wave.
- The two main strands of evidence put forward for a major tsunami event are the pumice material found on Anaphi, and the displacement of the orthostats at Amnisos. Evidence has shown that these arguments are false and they provide no positive evidence for the existence of a tsunami.
- Changes in sea level, particularly the tectonic changes on Crete, from site to site make investigation of this area difficult.
- There are few places to test the changes in sea level using archaeological evidence from the Bronze Age.
- Specific tsunami signatures should exist in the stratigraphic record and trenching and coring of coastal marshes and lagoons would appear to be the best methods to identify these if they exist.
- There is some evidence for a major tsunami event to the west of Crete. The hypothesis put forward is for a major tsunami striking the coast of North Africa and the Gulf of Sirte.
- Tsunami evidence has been reported on Santorini, stratified in the Minoan pyroclastic sequence.

8.2.5 Chapter 6. Earth - field work and analysis

- Tephra has been positively identified from the sites of Paradeisi (Rhodes), Seraglio (Kos) and Iasos (Anatolia).
- Grainsize distribution of tephra layers confirms the bi-modality indicated by Sparks and Huang (1980). This bi-modality appears to decrease to the north, possibly indicating that the Plinian phase was directed more to the south east of Santorini.
- Coastal deposits at Gouves, Crete appear to have important data and evidence of marine inundation.
- Evidence in the area of Trianda, Rhodes suggests major erosion since the LM IA period.
- Mallia, Crete, has pumice deposits stratified with archaeological material in an area being rapidly destroyed by tourist activity.

- There is important evidence of Minoan activity in the coastal zone that is at risk and a programme of survey and recording is recommended.

8.2.6 Chapter 7. Air - computer model of tephra fallout

- The eruption probably occurred in the summer months.
- The main axis of dispersal was directly to the east from Santorini
- The initial wind direction may have been to the south east and deposited tephra over easternmost Crete.
- The central and western parts of Crete may have received only very slight amounts (less than 1 cm) of tephra.

8.3 The impact of the Minoan eruption of Santorini

In order to fully understand the impact of the Minoan eruption it is necessary to consider evidence over a much greater period than just the four days of the actual eruption. There are a number of precursor events to take into account and the consequences of the eruption may have lasted for many years.

8.3.1 Immediate effects

We should bear in mind the major earthquake that struck the area in the early LM IA phase. The effects of this destruction have been termed the Seismic Destruction Level at Akrotiri and this event has also been identified at Trianda on Rhodes (Marketou 1998, p46). Tsunamis may have been formed by this earthquake and if tsunami deposits are found in the stratigraphic record and dated to around this period they should not automatically be attributed to the Minoan eruption.

The site of Akrotiri appears to have experienced a series of earthquakes that saw the abandonment of the excavated areas of the site. This partly explains why no victims of the eruption have so far been found at Akrotiri. I do not believe though that the whole of the island and town were evacuated. There may well have been occupation in other areas of the town that have not yet been excavated or even temporary dwellings outside the town. These earthquakes may have generated tsunamis.

The initial stage of the eruption sees the almost complete destruction of Akrotiri and other settlements on the island. The winds during the initial Plinian phase directed tephra in a south easterly direction according to the isopachs suggested by Bond and Sparks (1976). Cioni et al. (2000, fig 3, p125) show a sub-unit of phase 1 with isopachs in a more southerly direction than that for the main Plinian phase. I suggest that the winds gradually shifted during the four days of the eruption, and that the tephra was blown first to the south east, then the east, and finally the north east. This shift in wind direction could then explain the meridional distribution of the tephra fallout. This also explains why the central portion of the fallout area, in particular Rhodes, received the most tephra.

The eruption would have been accompanied by shockwaves which Latter (1981, p470) lists as one of the generation sources for tsunamis. Blong (1984, p119) suggests that deaths from shock waves are rare and that minor injuries are the most common result of shock waves.

There are two main issues for the following phases, the creation of co-ignimbrite deposits elutriating off pyroclastic flows and surges, and the possible creation of tsunamis from the ignimbrite entering the sea. Some of the surges may have travelled for some kilometres over the surface of the water before collapsing. The sea surface would have been clogged by pumice and tephra by this stage. The majority of the mass of the flows, however, probably flowed down the underwater flanks of the volcano, effectively forming debris avalanches. It is highly unlikely that any flows would be able to cross the intervening distance between Santorini and Crete as proposed by Nixon (1985, see comment by Sparks 1986). Other Cycladic islands are much closer; for example Ios to the north of Santorini is only 30 km from the vent location and may have been affected by pyroclastic flows.

The central vent area was not the only point from which tephra was entrained in a column. There may have been many columns of material created as co-ignimbrite material separated from pyroclastic flows. These columns may have risen to variable heights.

Proximally to Santorini the undersea deposits are dominated by these pyroclastic flows. The anomalous amounts of material found in some of the distal marine cores can be attributed to sediment ponding in troughs and basins.

The main axis of the distal material from the co-ignimbrite deposits is to the east of Santorini. The island of Rhodes appears to have been the most severely affected whilst the island of Kos also received significant amounts of tephra. Other major islands in the area that would have been affected are Tilos, Symi, Astypalaa and Kalymnos.

The three islands between Crete and Rhodes - Karpathos, Saros and Kasos - do not have any reported evidence of Minoan tephra, but they must have been affected. I would estimate tephra fallout of between 10 and 20 cm for these islands.

On the south west coast of Anatolia there were a number of sites that would have experienced tephra fall. Material has been positively identified from the site of Iasos. A recent report from Miletus mentions tephra from a destruction layer, though this has not been provenanced to the Minoan eruption (Greaves and Helwig 2001, p505).

It appears that sites in these areas will have experienced enough tephra fall to cause the structural collapse of buildings and the destruction of crops. If the eruption was in the summer months then it might have lain on the ground for some time before rains fell, although it would have been subjected to wind erosion.

In contrast to these areas, the island of Crete does not appear to have been affected by tephra fall in a major way. The west of Crete and the south central area may have received only a light dusting of tephra. Sites on the eastern side of the island will have seen some tephra fall and a few buildings may have collapsed, but in my opinion the direct effect from tephra was limited.

The direct impact of the tephra fall on humans is not the only factor to consider. Impact on crops and animals may have been great enough to cause subsistence problems and ultimately starvation. Blong (1984, table 7.3, p319) lists the amount of tephra fall needed to effect some crops types. There are a number of corollaries to this table since the effect can depend upon a number of factors, for example: leaf size, particle size, and the stage of plant growth. The table suggest that for falls of greater than 4 cm there will be a 50% loss of lentils and 15-30% loss of wheat, spring barley, peas and hay. For the purposes of this work it would appear that some areas of eastern Crete might have lost some percentage of

their crops. On Rhodes and Kos, though, there will have been major loss of crops and much of the vegetation would have been destroyed. Such vegetation destruction could have led to soil erosion. This might explain the abandonment of the southern section of Trianda after the tephra fall and the construction of two large walls, interpreted by Marketou (1998, p61) as flood defences.

The eruption appears to have occurred in the summer months. At this stage of the year some of the staple crops such as wheat and barley would have been in the field ready for harvesting, some might have been harvested. Much of the importance of a crop will have been to provide long term storage needs which will need preparation; the tephra fallout may have spoilt or destroyed not only crops in the field but also preparation areas.

With regard to animals, Blong (1984, p335) states that most can survive falls of between 5 and 30 cm. However, for animals such as sheep, which are close-grazers, these figures could be less, because of loss of vegetation, fluorine poisoning from ingesting tephra and the wear of teeth by tephra. Sheep formed the major animal food store for the Minoans. As well as the death of livestock, there are subsidiary issues such as reduced milk yield, loss of weight (hence loss of food), respiratory problems and early death.

The impact of volcanic eruptions on aquatic life is much less well documented. Some of the ways that the marine resources may have been affected are increased acidity, increased turbidity, change in temperature or changes in the food supply (Blong 1984, p335). Bicknell (1993) proposed that the development of the LM IB marine style ware had religious connotations and might have been as a response to the impact of the eruption on marine resources. He outlined a number of ways that environmental impact might have altered the delicate marine ecosystems (Bicknell 2000, p102). Even if marine resources were not affected, tsunamis may have destroyed or damaged small boats used for fishing in-shore waters. Ship chandlery, such as sails or nets could also have been destroyed and taken time to replace.

Tsunamis could have been generated in any direction as the pyroclastic surges flowed radially from the vent. Their individual magnitude might not have been that great. Coastal sites on the north coast of Crete would have been at risk. The bathymetry to the north, east and west of Santorini is relatively shallow and so the tsunamis may not have propagated as

much in these directions. To the south of Santorini is the Cretan Trench which would have increased the propagation of any tsunamis that travelled in this direction. Individual sites would have been affected in individual ways depending upon their location and topography. The sites most at risk would appear to be Gournia and Priniatikos Pyrgos at the head of the Bay of Mirabello.

At some stage the magma chamber of the volcano became exhausted and collapsed leading to the present day caldera. It is unknown whether this was a gradual or sudden occurrence, but a single collapse had the potential to create a large tsunami. The current topography of the island suggests that if a tsunami were generated inside the caldera then it would either propagate through the north west gap between Oia and Therasia or to the south west around Aspronisi. To the north west the bathymetry is relatively shallow whilst to the south west there are much deeper trenches. There is evidence for a major tsunami to the west of Crete around this time (e.g. Cita and Aloisi 2000). If this were the case then it would have hit the coast of Africa around the Gulf of Sirte. I have not found any published data to ascertain if there were human settlements in this area at this time.

Another product of the eruption comprised gases and aerosols, which could have local or global effects (discussed below). During the 1650 AD eruption of Columbo Bank, which is about 30 km to the north east of Santorini, some deaths were reported on Santorini as being caused by gases. There are a number of islands, such as Ios, which are within this distance of Santorini. Only Anaphi though would have been downwind of these gases, so there may not have been any loss of life from this cause on other Cycladic islands.

8.3.2 Longer term issues

Large-scale volcanic events have been proposed as possible mechanisms for changes in temperature on a global scale (e.g. Sear et al. 1987; Briffa et al. 1998). The global impact of the eruption is mainly determined by the amount of sulphur and chloride products injected into the stratosphere. Estimates for a change of approximately 0.5^{o} C have been proposed for the Santorini eruption (e.g. Sigurdsson et al. 1990). Pyle (1997) notes that despite being a large magnitude event, the Minoan eruption is not a unique occurrence. He highlights the fact that during a thousand year period there are approximately 18 eruptions with a similar scale of sulphur injection preserved in the GISP2 ice cores (Pyle 1997, p60)

- although reference to the acidity record in the Dye-3 ice-core which has been tentatively linked with the Santorini eruption (Hammer et al. 1987; Clausen et al. 1997) would indicate a rather more significant impact. Furthermore, since this article new results from Michaud (2000) suggest that the amount of sulphur may have been much greater than previous estimates, which means that the issue is currently very much open for interpretation. The article by LaMoreaux (1995) suggesting a massive world-wide effect for the Santorini eruption is probably the worst example of selective use of data to produce a totally inaccurate picture and should be ignored.

The issue of the global impact of the eruption is bound up with that of the absolute date of the eruption, since part of the argument for the High Chronology is based upon the use of proxy data, such as ice cores or dendrochronology. Buckland et al. (1997) highlight the difficulty of using this type of data to substantiate the impact of the eruption.

Knappett and Schoep (2000) outlined the differences between the palatial organisation over the wider epochs of the first and second palatial periods. The second palatial period encompasses the LM IA and LM IB periods. What their article stresses is that the palaces specialised in the bureaucracy, accumulation and capitalisation of resources. These would be just the elements to help a society deal with shortages and disruption caused by the eruption of Santorini. The Minoan eruption although not causing major direct impact on Crete would have caused stress within this cultural system. This is the main tenet of the work of Driessen and Macdonald (1997) on the eruption. In my opinion their ideas are summed up in their section 4.13, p82 and fig 4.32, p83, this highlights the shifts in various cultural phenomena, in particular a change in the territorial, social and administration organisation, over time. Christakis (1999, p15) however, does not see the same level of change and decentralisation of storage in the LM IB that Driessen and Macdonald have proposed.

I would perceive the most important cultural change as the reduction in the number of sites from the peak of the MM III- LM IA period to decline in LM IB, and then further site loss in LM II. This does not imply though a simple linear cause and effect between the Santorini eruption and the LM IB site destructions. From some of the effects of the eruption I would expect to see a re-entrenchment of society particularly in marginal areas and the abandonment of some sites. This could then help to explain the change in

territorial levels. One important question is what happens to the people from those marginal sites. Presumably some will have died, which is the reason for the abandonment of the site, others may have been reabsorbed into the general society. Another possibility is that some became refugees living outside the Minoan society. Such a hypothesis could be supported by Driessen and Macdonald's proposal that ritual activity in the countryside lessens because of insecurity and the hoarding of bronze goods (Driessen and Macdonald 1997, p82). I believe that the social stratification and nature of the Minoan redistributive society were largely great enough to cope with the effects of Santorini on Crete. The reaction of those for whom this system failed is unknown.

Large ships and trading vessels may have been lost in the eruption and these might have been difficult to replace. The summer season was the main trading time and so some vessels may have been outside the Aegean area. The wood needed for large vessels might not have been easy to replace, however, and the trading capacity of the Minoans may have been diminished for a time.

The trading network in the Aegean area would have been severely damaged. The hub of this network was on Santorini and this disappeared. The sites on Rhodes, Kos and Anatolia will also have been severely affected and these would have provided a gateway for goods from inland Anatolia and probably from Cyprus and the Levant. The Minoan centres may have been more inward looking for a time as they concentrated on re-trenchment and rebuilding. This may explain the rise in influence of the Mycenaeans in the Aegean area as they moved into the vacuum left by the loss of Akrotiri. A recent study of the pottery clays from settlements on the Cycladic islands of Kea and Melos has demonstrated that much of the LM IB pottery is a pseudo-Minoan class of Mycenaean manufacture (Mountjoy and Ponting 2001, p184). The influence of the Minoans during the LM IB on Cycladic islands and Dodecanese may have been severely reduced.

There may have been a change in religious practice. Driessen and Macdonald highlight the almost complete abandonment of peak sanctuaries, and emphasise the development of religious rites in the community during LM IB, rather than in the countryside as before (Driessen and Macdonald 2000, p89). The evidence of volcanic pumice in offerings, for example as a foundation deposit under alterations at the mansion at Nirou Chani (Driessen

and Macdonald 2000, p90), indicate at the psychological level the possible impact of the Minoan eruption.

The eruption might have brought about a benefit in the quality of the soil for a period of time. The effect will vary depending upon the location and the amount of tephra that fell on an area and how quickly it could become absorbed.

A number of articles have examined the health effects of volcanic eruptions (e.g. Baxter 1990; Blong 1996) but these have usually focused on the direct impact of volcanic products which would have largely been confined to the Santorini archipelago. Some of the health risks may have been more long-term. An on-line article produced in response to the eruption of Montserrat **http://www.geo.mtu.edu/volcanoes/west.indies/soufriere/govt/miscdocs/prelimvolcrisk.html** (on 20/8/2001) emphasised the possible impact of silicosis caused by exposure to tephra particles. On Crete this might not have been too great a risk because of the minor amount of tephra that fell. At other sites, especially on Rhodes, where there was much greater ashfall which might have remained in the landscape for a number of years, silicosis could have been a factor leading to premature death.

A major conclusion that I draw from this study is that there are many different scales of impact for the Minoan eruption. The eruption was a large event, but it could lead to a number of small-scale impacts. Individual sites were affected in different ways, depending upon, for example, how much tephra fell, the size of tsunami run-up, stores affected or crops destroyed. This means that we cannot extrapolate across the culture from excavation evidence at a particular site. The impact that I perceive from the eruption for major sites and areas is summarised below (table 8.1).

Table 8.1 Proposed impact of the Minoan eruption of Santorini on individual sites and areas.

Site/area	Effect
Akrotiri and Santorini	Complete destruction of sites and the loss of a major link in the trading network.
Trianda, Rhodes	Major structural damage, destruction of crops, possible massive erosion. Effect on port unknown.
Seraglio, Kos	Major destruction of crops, buildings and resources. Effect on port unknown..
Other Dodecanese islands	Severe effect with some building collapse, vegetation damage and subsistence loss.
Iasos, Miletus and south western Anatolian sites	Major to severe effect with some building collapse, vegetation damage and subsistence loss.
Karpathos, Kasos, Saros	Severe effect with some building collapse, vegetation damage and subsistence loss.
Palaikastro, Crete	Minor effect, sections of buildings collapse, some crop damage, possible

	tsunami inundation.
Zakros, Crete	Minor effect, sections of buildings collapse, some crop damage, possible tsunami inundation.
Mochlos, Crete	Minor effect, limited effect on buildings, small amount of crop damage.
Pseira, Crete	Minor effect, limited effect on buildings, small amount of crop damage.
Gournia, Crete	Minor to severe effect, possible major tsunami inundation, minor damage to crops.
Priniatikos Pyrgos, Crete	Minor to severe effect, possible major tsunami inundation, minor damage to crops.
Ports on north coast , Crete	Minor to severe effect, possible major tsunami inundation.
Knossos and central area, Crete	Negligible, some minor crop damage.
Mallia, Crete possible	Minor to severe, possible major tsunami inundation, minor damage to crops.
Phaistos and the Messera, Crete	Negligible effect.
Chania, Crete	Minor to severe effect, possible major tsunami inundation.
Cycladic sites	Negligible effect directly. Possibility of some damage by tsunami or gas and aerosol. Indirectly possibly major because of the loss of major Cycladic centre of Akrotiri.
Gulf of Sirte, North Africa	Possibly great effect through tsunami damage. Effect on humans unknown.
Cyprus	Very limited effect.
Mainland Greece	Very limited effect directly, some damage to shipping, but possibly beneficial in long-term.
Egypt and Levant	Very limited effect, though interruption of trade network.

8.4 Constraints highlighted by the thesis and future directions

The main constraint that this work has highlighted is that our level of knowledge of environmental data from the area for the time period is actually quite poor. The lack of pollen cores from the area, and the scarcity of archaeobotanical data, means that issues of environmental impact must be hypotheses rather than conclusions. This lack of data is mirrored in the poor level of information on coastal Minoan structures.

Minoan archaeology has a long history and the quality of some of the artefactual and architectural data is impressive. Excavation has often focused on the centres of sites and those areas with the best preservation and stratigraphy, possibly at the cost of the peripheral areas. The reason for this is because those areas have the best chance of producing results, but in the long run they may not be producing the *important* results.

The highest priority for future research is in my opinion a rescue excavation of the Ayia Varvara Bay area at Mallia, before too much information is lost. This site appears to have important data that could help answer to some of the issues raised by this thesis. In a few years that data may no longer exist through the action of coastal erosion and tourist activity.

A wider survey of the other islands of the Cyclades and Dodecanese for tephra deposits, and the grainsize and geochemical analysis of such material, is needed. The main candidate for such an investigation should be Karpathos. Based on the survey work of Melas (1985), the main Minoan sites were based on the southern side of the island.

In order to gain insight into the possible impact of tsunamis on the Minoan civilisation a model of tsunami inundation for a number of particular sites, for example Gournia or Mallia could be developed.

The site of Trianda on Rhodes has been shown to have an excellent state of preservation and may be one of the few Late Bronze Age harbours in the area that could be investigated. It is thought that the Late Bronze Age harbour and shoreline are inland of the current shoreline. A system of coring may reveal the Late Bronze Age topography. If possible, the research excavation of an area of any harbour located could be carried out.

The lack of any pollen cores for the Late Bronze Age period in the area makes investigation of any proxy information about the possible destruction of vegetation by tephra fall in the Rhodes/Anatolia area impossible. A number of pollen cores in the Aegean area would be of use to a number of disciplines.

The maritime focus of the Minoan culture has been poorly examined and a multidisciplinary investigation of a port site on the north coast of Crete involving underwater work would be of great benefit. The first stage should be to record the sections that are visible now and the types of structures and their position.

The coast of Crete does not appear to be conducive to preserving tsunami deposits, as there are not many coastal marshes, lakes and lagoons to preserve the marine inundation. One area that may preserve these deposits is in the Gulf of Sirte, on North Africa. The basis for this proposal is that the homogenite layer found in the cobblestone bed area to the west of Crete could be linked to the Santorini eruption (e.g. Cita and Aloisi 2000). Following the path of this tsunami, it must have hit the North African coast. This coast appears to have a large number of marsh and coastal margin environments that may have preserved evidence for such a tsunami including environmental data that can be dated.

One of the problems faced by this work has been the lack of publication of much exciting raw data. There are many reasons for this, but it is a problem that can be addressed. My recommendation would be for a web site hosted by the archaeological research community which contains data specifically on the Minoan eruption. A key area would be the central repository of geochemical and laboratory analysis of tephra. Information could also be contained on the types of analyses that could be conducted on tephra and reasons for such analyses. Information on tsunami deposits and the recognition of tsunami deposits could also be maintained on such a site.

8.5 Final statement

The question of the impact of the Santorini eruption has become intimately bound up with the issue of civilisation collapse, site destruction and abandonment. This ignores the individual in society and their reaction to crisis. Overall, the people of Crete survived and their way of life was not fundamentally altered. Those in areas such as Rhodes must have had to fight the hardest and some must have died, but their town survived, if on a smaller basis. The belief in their gods may have been shaken, some will have lost lives, they might have had to adapt, but the society as a whole passed into the LM IB period with very little observable change at the level of the individual. The talk of a civilisation collapse dismisses and demeans the power of individuals.