THE OLIVE INDUSTRY OF BRONZE AGE CRETE: EVIDENCE FOR VOLCANIC DAMAGE TO OLIVE GROVES AND PROPERTY IN CENTRAL AND EASTERN CRETE

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Olive wood, stone olive presses and clay spouted tubs, used for separating olive oil and water, are found on Crete in association with the Late Bronze Age archaeological evidence for earthquake and fire damage to property. Recovery of these artefacts suggests that the Cretan olive industry was adversely affected by the volcanic eruption on the neighbouring island of Santorini. The intention in this paper is to sketch the background to Minoan olive farming, and then to examine the archaeological evidence for connections between the Santorini eruption and the Cretan olive industry in the Late Bronze Age.

1. *Introduction*

Olive cultivation and olive oil production on the Aegean island of Crete are two Bronze Age activities that span some 4 000 years, and today remain cornerstones of the island's economy. The onset of olive growing on Crete was a gradual process, primarily a consequence of favourable climate change. Transformation to a Mediterranean climate, characterised by hot dry summers and warm wet winters, began during the latter part of the Pleistocene, the shift being completed by the middle of the first millennium BC (Rackham and Moody 1996:39). The similarity of the Late Bronze Age climate to the present is confirmed by finds of olive, pine and oak amongst the ruins of the Minoan town of Pseira (Betancourt and Hope Simpson 1992:49).[1] This transformation to a Mediterranean climate in the Aegean Bronze Age is also borne out by recoveries of olive and pine debris in recent excavations at Santorini, 120 km to the north of Crete (Asouti 2003:474).

The origin of the Cretan cultivated olive *Olea europaea* (see Figure 1) is uncertain, but it probably derives from the wild olive *Olea chrysophylla* (Renfrew 1973:131-132), today widely distributed over Asia and Africa. Olives from their inception proved a beneficial crop for the Minoans, since olive growing enabled marginal agricultural land to be brought into use for food production. From about 2000 BC, the olive groves of Crete provided the Minoan population with fruit, oil for culinary purposes and lamps, timber for roof construction, and firewood for cooking and heating. The olive oil made in Crete in the Late Bronze Age was of good quality, the nutritional and storage properties probably equal to those of olive oil made today in the Western Cape and Greece (Riley 2002:63-75).

Evidence for cultivation of the domestic olive *Olea europaea* on Crete in the Early Minoan period is scanty. Olive charcoal and four clay spouted tubs, recovered from the Early Minoan II settlement of Myrtos, indicate that olives were grown on Crete as early as *c.*2200 BC (Warren 1972:255, 138). This early date for the introduction of olive cultivation in the Aegean Bronze Age is supported by olive charcoal recovered from Early Bronze Age excavation strata on the island of Santorini (Asouti 2003:474). Some 50% of the charcoal identified is olive wood, probably pruned offcuts used for firewood, suggesting that olive

1. Cretan olive trees yield more olive oil than those grown in Italy, Turkey and mainland Greece (Hutchinson 1962:41).

cultivation prior to the Late Bronze Age volcanic eruption on Santorini was fairly extensive. The evidence for olive cultivation in the Middle and Late Minoan periods is more extensive. Apart from finds of olive stones and artefacts associated with olive oil manufacture (Hamilakis 1996:18), clay Linear B tablets detailing quantities of oil and numbers of olive trees were recovered from the palace of Knossos (Riley 1999:43-45). These various archaeological finds confirm that olive growing and oil production were well established on Crete by the Late Bronze Age.

Fig. 1: Olive trees (Olea Europaea) growing among the ruins of Palaikastro.

Fig. 2: Minoan houses at Palaikastro destroyed by earthquake damage and later by fire in the Late Minoan 1A/B period.

2. *Evidence for destruction of the olive industry*

Table 1 lists the find spots of 32 artefacts used for olive oil manufacture recovered from the ruins of Minoan houses, villas or palaces; also the regional distribution of the artefacts and the relative dates of the objects (the dates attributed to the oil presses and separators are derived from Minoan pottery found in association with the artefacts). The type designations assigned to the objects in Table 1 are those published by Kopaka and Platon (1993:68-69). Type I is the clay spouted tub used for separating olive oil and water, and Types II and III two different kinds of stone press.

Table 1: Minoan spouted tubs (lekanai) and stone olive presses recovered on Crete

Geographic region	Settlement	Find location	Minoan period	Type designation
Central	Phourni	Cemetery	LM I	I
Central	Knossos	Palace (?)	LM I	I
Central	Vathypetro	Villa	LM Ia	I
East	Gournia	House	LM Ib	I
	Gournia	House	LM Ia (?)	I
East	Palaikastro	House	LM Ib (?)	I
	Palaikastro	House	LM I	I
	Palaikastro	House	LM Ib	I (?)
	Palaikastro	House	LM Ia	I
	Palaikastro	House	MM IIIb/LM Ia	I
East	Azokéramus	Villa	MM IIIb/LM Ia	I
East	Petras	House	LM Ia	I
East	Tourtouloi	Villa	LM Ib	I
	Tourtouloi	Villa	LM Ib	I
	Tourtouloi	Villa	LM Ib	I
East	Choirmandres	?	MM IIIb/LM Ia	I
East	Epano Zakro	Villa	LM Ia	I
	Epano Zakro	Villa	LM Ia	I
	Kato Zakro	House	LM Ib	I
	Kato Zakro	House	LM Ib	I
	Kato Zakro	House	LM Ib	I
	Kato Zakro	House	LM I	I
	Kato Zakro	House	MM IIIb/LM Ia	I
	Kato Zakro	House	LM I	I
East	Palaikastro	House	LM Ib	II
East	Epano Zakro	Villa	LM Ia	II
	Kato Zakro	House	LM Ib	II
Central	Knossos	House	LM II/LM IIIa	III
Central	Kommos	House	LM III	III
	Kommos	House	LM IIIb	III
	Kommos	House	LM I(?)/LM	III
Central	Phaistos	Palace	II/IIIa(?)	III
			LM III (?)	

(Source: Kopaka and Platon 1993:68-69)

The regional distribution of artefacts listed in Table 1 shows that olive oil production on Crete in the Late Bronze Age was widespread. In scale, it ranged from a cottage industry to a more industrialised activity focused on the larger centres. Approximately 60% of the

separators and presses listed are associated with domestic houses, with another 25% recovered from the villas. A further 10% were found in the palaces (the remaining 5% is made up of artefacts of dubious provenance). The distribution of the artefacts suggests that certain locations, such as the port of Kommos (Shaw 1998:13), may have served as depositories for agricultural products such as olive oil, thus reflecting some decentralisation away from the Late Bronze Age palaces.

Table 1 also reveals that the majority of oil presses and separators were found in Late Minoan archaeological deposits, the bulk coming from Late Minoan Ib strata. Lesser numbers were recovered in Late Minoan Ia deposits. Coinciding with these Late Minoan Ib finds of olive processing equipment is the Late Minoan Ib destruction of many Minoan towns, villas and palaces, situated mainly in central and eastern Crete. At Pseira on the beautiful Gulf of Mirabello, some 60 stone houses were destroyed, the end being "sudden and final" (Betancourt and Davaros 1988:35-37). The major Minoan town of Palaikastro, situated at the extreme eastern end of Crete, has earthquake and fire damage (see Figure 2), with scanty Minoan III reoccupation (MacGillivray *et al* 1987:154). Close by, the palace of Kato Zakro reveals earthquake and fire damage, the wealth of treasures recovered indicating hurried departure of the occupants (Platon 1970:198; Davaros 1989:13, 15). At the pretty Minoan town of Gournia Late Minoan Ib fire damage is extensive with little evidence of reoccupation (Boyd Hawes 1908:23). The fires described may relate to olive oil stored in *pithoi*, ignited by the fall of volcanic ash. Damage to these and other Late Minoan I properties, particularly in eastern Crete, is ascribed by Marinatos (1939:425-439), Platon (1970:198), Page (1970:44) and Luce (1994:61-73), to earth tremors and volcanic fall-out from the Santorini eruption.

The regional extent of devastation on Crete can be demonstrated by plotting ocean cores taken from the seabed to the north and south of the island (Page 1970:36, Fig. 19), the distribution of volcanic sediment confirming that ash from Santorini straddled the central and eastern half of Crete. An idea of the depth of volcanic ash covering these regions can be gleaned from the quantity of ash present in certain core samples recovered from the Aegean seabed. The amount of ash retrieved suggests that the layer covering parts of Crete might have exceeded 20 cm (*op.cit.* 39). On Crete the regional seasonal rainfall varies widely, ranging from infrequent exceptionally heavy deluges to near drought conditions (Rackham and Moody 1996:34-36, 167). The erosion effect of heavy downpours in eastern Crete was seen at Kato Zakro on 14 May 1910, when agricultural terraces, mature trees and olive groves were swept away; similarly, freshly-prepared terraces were washed away at Gournia on 28 September 1986 (*op.cit.* 21 Fig. 3.7, 22). The layer of ash deposited by the Santorini eruption over the landscape and olive groves would thus probably have remained for one or more decades before being dispersed by wind and rain. Volcanic ash has however been found amongst the ruins of Minoan buildings at Kato Zakro, Palaikastro and Pseira in eastern Crete, as well as at Amnisos in central Crete (Page 1970:37; MacGillivray *et al* 1992:134-137). The ash from Pseira is chemically comparable with that from Santorini (Betancourt and Davaros 1988:37). Further afield in the Aegean, volcanic ash has been recovered from the island of Paros, 60 km north of Santorini, as well as from Anaphi, 24 km east of Santorini (Page 1970:37), these recoveries indicating the regional extent of the Santorini eruption.

The rain of volcanic ash, earthquake and fire damage to Minoan towns and houses, and the presence of abandoned olive processing equipment, confirms that the Santorini eruption adversely affected olive production on Crete in the Late Minoan I period.

This severe devastation of farmland and destruction of property on Crete fortuitously caused no long-term abandonment of the island. Furthermore, the natural catastrophe left

puzzling discontinuities in the archaeological record. There is only minor damage to the palace of Knossos and none to the Minoan part of Kommos (Dickinson 1994:304). Pottery found in the ruins of Akrotiri on Santorini is predominantly floral style Late Minoan Ia, while that associated with destruction on Crete is mainly marine style Late Minoan Ib, the difference in pottery decoration possibly indicating a time interval of up to 50 years. One explanation suggested for this hiatus is that Late Minoan Ib was a regional pottery style, of shorter duration, contemporary with Late Minoan Ia, and popular in eastern Crete (Marinatos 1939:428-429).

3. *Dating the devastation of the Minoan olive industry*

Dating the damage to the olive groves and property on Crete is problematic, since the Late Minoan chronology is complex and contentious. Conventional dating based on pottery styles advocates 1600/1580–± 1480 BC for Late Minoan Ia and ± 1480–1425 BC for Late Minoan Ib (Warren and Hankey 1989:169, Table 3.1). These dates place the Santorini eruption between 1520 and 1500 BC (Warren 2000:116; Luce 1970:68).

Researchers using radiocarbon (C_{14}) to date the Aegean Bronze Age argue persuasively for an earlier date for Late Minoan Ia, setting it at *c.*1689/1680–*c.*1610/1590 BC (Manning *et al* 2002:733-744). The end of the succeeding Late Minoan Ib phase is thus *c.*1520–1512 BC, and not *c.*1425 as with conventional Minoan dating. On radiocarbon dating the Santorini volcanic eruption is dated earlier at *c.*1650–1620 BC. This revised date would therefore place the damage to Minoan property and olive groves some hundred years earlier, perhaps about 1600 BC.

4. *Conclusion*

Oceanographic evidence for the fall of volcanic ash, together with archaeological evidence for the destruction and abandonment of property confirms the havoc wreaked on Crete by the Santorini eruption. These events undoubtedly had an adverse effect on the Minoan olive industry, particularly in central and eastern Crete.

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