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Poseidon's Horses: Plate Tectonics and Earthquake Storms in the Late Bronze Age Aegean and Eastern Mediterranean

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In light of the accumulated evidence now published, the oft-denigrated suggestion that major earthquakes took place in the Aegean and Eastern Mediterranean areas during the late 13th and early 12th centuries BC must be reconsidered. A new study of earthquakes occurring in the Aegean and Eastern Mediterranean region during the 20th century, utilizing data recorded since the invention of seismic tracking devices, shows that this area is criss-crossed with major fault lines and that numerous temblors of magnitude 6·5 (enough to destroy modern buildings, let alone those of antiquity) occur frequently. It can be demonstrated that such major earthquakes often occur in groups, known as "sequences" or "storms", in which one large quake is followed days, months, or even years later by others elsewhere on the now-weakened fault line. When a map of the areas in the Aegean and Eastern Mediterranean region affected (i.e. shaken) by 20th century AD earthquakes of magnitude 6·5 and greater and with an intensity of VII or greater is overlaid on Robert Drews' map of sites destroyed in these same regions during the so-called "Catastrophe" near the end of the Late Bronze Age, it is readily apparent that virtually all of these LBA sites lie within the affected ("high-shaking") areas. While the evidence is not conclusive, based on these new data we would suggest that an "earthquake storm" may have occurred in the Late Bronze Age Aegean and Eastern Mediterranean during the years 1225–1175 BC. This "storm" may have interacted with the other forces at work in these areas *c.* 1200 BC and merits consideration by archaeologists and prehistorians.
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Introduction

Scholars have long noted a series of destructions, datable between 1225 and 1175 BC, which are usually attributed to human actions (Figure 1). Claude Schaeffer's suggestion that an earthquake might be responsible for these destructions (Schaeffer, 1948, 1968: 753–768) was not well received by his peers (Hanfmann, 1951, 1952; Ambraseys, 1971; Rapp, 1986: 371, 374; French, 1996), in part because these catastrophic events at the end of the Bronze Age were spread over a 50-year period and could not have been the result of a single geological event.

The present article surveys the available geophysical and archaeological evidence and suggests that this 50-year period of destruction in antiquity could have been the result of a *series* of related earthquakes, known as an "earthquake storm" (Nur, 1998). While such a "storm" is unlikely to have been the sole cause of the end of the Late Bronze Age in the Aegean and the Eastern Mediterranean, it may have interacted with the other forces at work in these areas *c.* 1200 BC and merits consideration by archaeologists and prehistorians.

Geophysical Evidence

All earthquakes of maximum intensity of VII and larger which occurred between *c.* 1900 and 1980 in the Aegean and the Eastern Mediterranean have been recorded by modern seismic instruments (Armijo, Deschamps & Poirier, 1986) and are depicted graphically (Figure 2). The epicentres are easily calculated, as is the magnitude (strength) of these earthquakes. The latter are measured on the well-known "Richter magnitude scale" (Rapp, 1982, 1986; Rapp & Hill,

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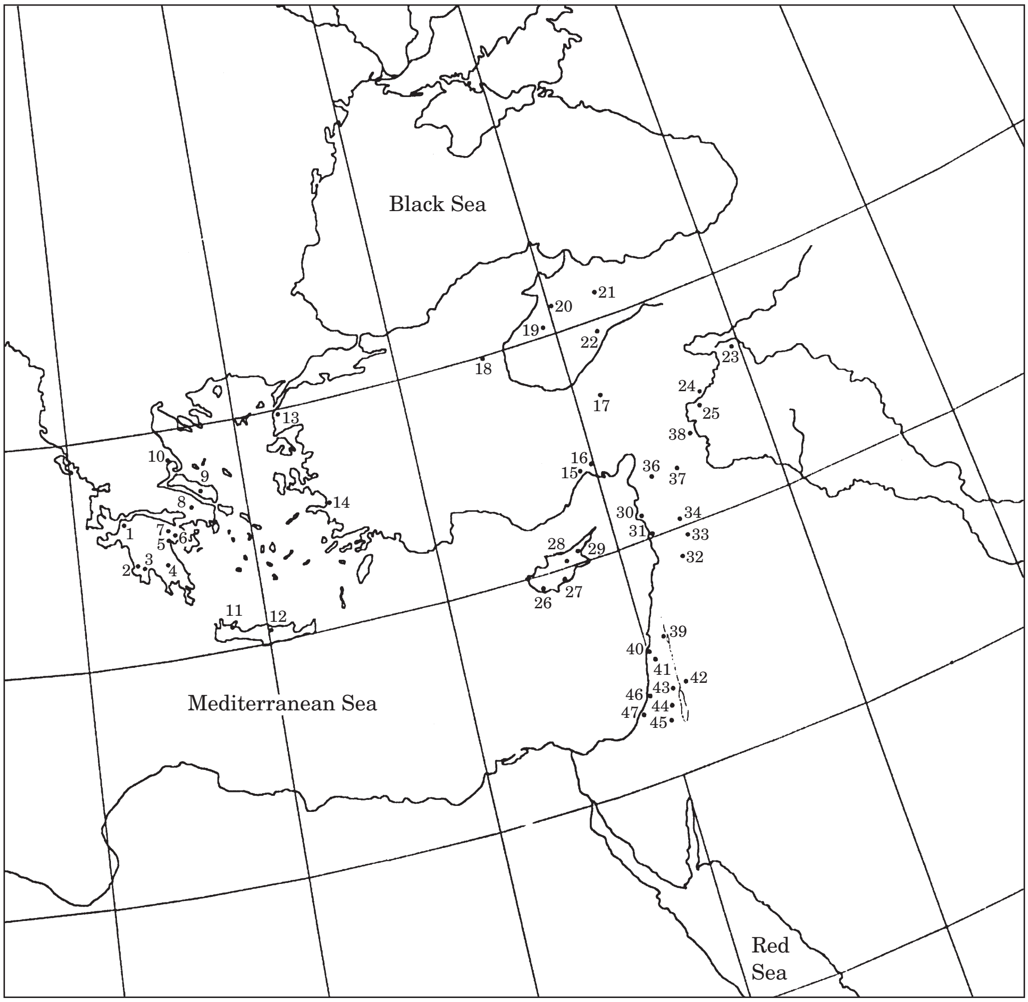

Greece
1. Teichos Dymaion
2. Pylos
3. Nichoria
4. The Menelaion
5. Tiryns
6. Midea
7. Mycenae
8. Thebes
9. Lefkandi
10. Iolkos

Crete
11. Kydonia
12. *Knossos*

Anatolia
13. Troy
14. *Miletus*
15. Mersin
16. Tarsus
17. Fraktin
18. Karaoglan
19. Hattusas
20. Alaca Höyük
21. Maşat
22. Alishar Höyük
23. Norşuntepe
24. Tille Höyük
25. Lidar Höyük

Cyprus
26. Palaeokastro
27. Kition
28. Sinda
29. Enkomi

Syria
30. Ugarit
31. Tell Sukas
32. Kadesh
33. Qatna
34. Hamath
35. Alalakh
36. Aleppo
37. *Carchemish*
38. Emar

Southern Levant
39. Hazor
40. Akko
41. Megiddo
42. Deir 'Alla
43. Bethel
44. Beth Shemesh
45. Lachish
46. Ashdod
47. Ashkelon

Figure 1. Major sites in the Aegean and the Eastern Mediterranean which were destroyed *c.* 1225–1175 BC at the end of the Late Bronze Age (from Drews, 1993). At sites in italics, destruction in the Catastrophe is probable but not certain.

1997: 210). The intensity (maximum ground motion) felt at a particular location is also easily calculated, since intensity is a simple function of magnitude and distance from the epicentre, and is measured on the so-called "modified Mercalli scale" (Figure 3; cf. also Rapp & Hill, 1997: table 9·1).

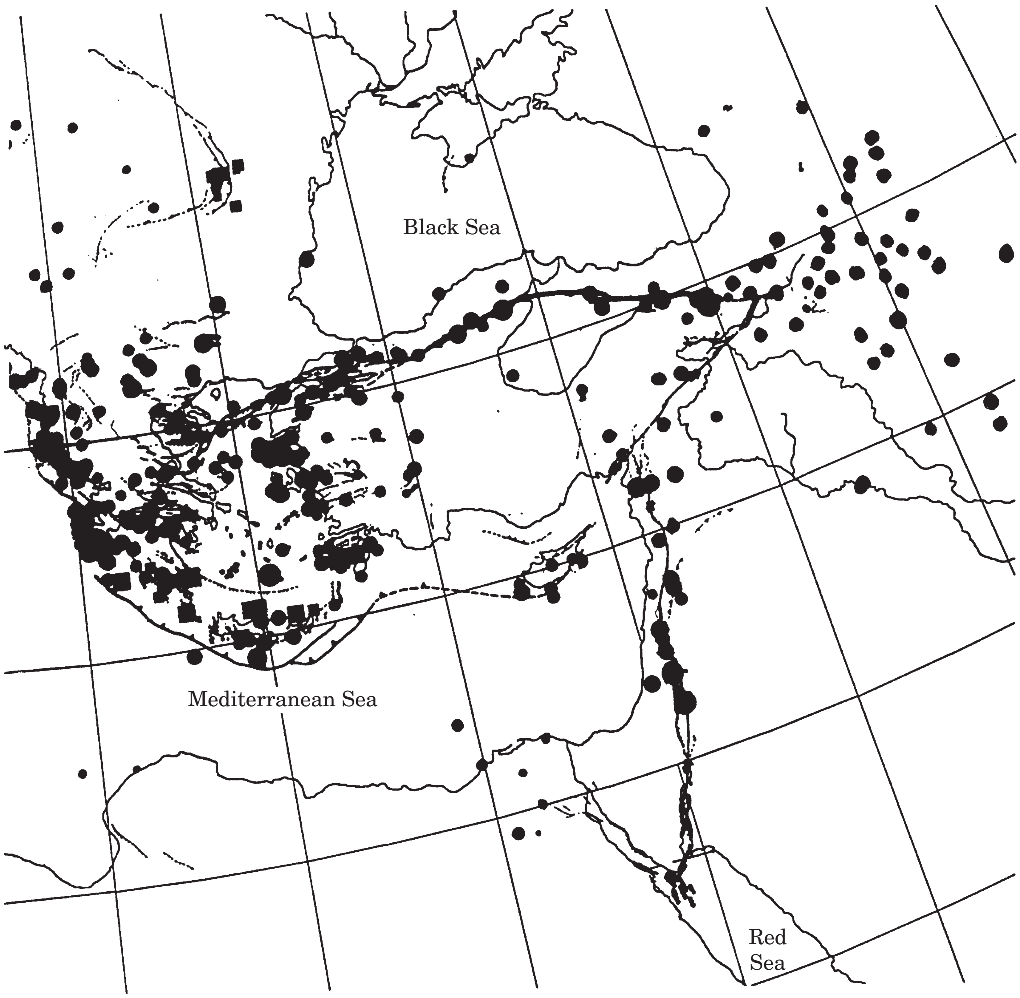

Figure 2. The Eastern Mediterranean: instrumentally recorded earthquakes of magnitude 6·5 (Intensity VII and larger) in the period *c.* 1900–1980 (after Armijo, Deschamps & Parter, 1986).

Figure 4 is a modification of a map first published by Karnik (1968) and provides our best estimate of those Aegean and Eastern Mediterranean areas subjected to Intensity VII or greater as a result of earthquakes during this 80-year period (1900–1980). This intensity is considered the threshold for significant damage to modern buildings. However, in ancient times destruction would probably have been greater because construction methods were not as sophisticated with regard to seismic shaking. In terms of damage in the Bronze Age, an Intensity VII event was probably equivalent to an Intensity VII+ or VIII event today. This short 20th century catalogue of 80 years speaks volumes about the recent seismic activity in this area, and we suggest that it can be extrapolated to much longer periods of time.

When an earthquake strikes, there is sliding along well-defined major faults; this slippage provides the basis for the Plate Tectonics model which revolutionized the field of Earth Sciences in the second half of the 20th century. The main faults along which most of the slips occur are today recognized as plate boundaries. Figure 5 (from Jackson, 1993) shows the major plates, their boundaries and the directions that the plates are moving in the area of interest. For example, the Arabian plate is moving to the north relative to the African plate (which is also moving to the north, but more slowly). The Anatolian plate is moving west, and the European plate is moving southeast. The tectonics of the Aegean region in particular are complicated, since here the end of the Anatolian plate fragments into several smaller "micro-plates" which splay out across mainland Greece from east to west (Figure 6) and which are all moving west. As a result, the Aegean region is seen as an "area of intense seismic activity" (Dewey & Sengör, 1979: 84; for additional discussions of plate tectonics and the seismicity of the Aegean and Mediterranean regions, see e.g. McKenzie, 1970, 1972; Galanopoulos, 1973; Rapp, 1982).

Obviously, plate motions did not start just in this century. The configuration of these faults and their

Intensity	Characteristic effects	Richter magnitude
I	Detected only by seismographs.	2·2–2·5
II	Delicately suspended objects may swing.	2·5–3·1
III	Standing automobiles may rock slightly. Hanging objects swing. Vibrations resemble those caused by the passing of a light truck. Duration can be estimated.	3·1–3·7
IV	Vibrations resemble those caused by the passing of a heavy truck or by a heavy object striking the building. Walls, windows, and doors creak. Hanging objects swing, and standing automobiles rock noticeably.	3·7–4·3
V	Some windows broken; some cracked plaster. Unstable objects overturned. Liquids may be spilled. Doors swing, pictures move, motion of tall objects may be noticed. Pendulum clocks may stop or change rate.	4·3–4·9
VI	People walk unsteadily. Objects fail off shelves, and pictures fall off walls. Windows and glassware broken. Some heavy furniture moves. A few instances of fallen plaster or damaged chimneys. Overall damage slight.	4·9–5·5
VII	Difficult to stand. Furniture broken. Poorly built structures damaged. Weak chimneys break at roof line. Waves form on ponds. Sand and gravel banks cave in. Damage slight in well-constructed buildings.	5·5–6·1
VIII	Difficult to steer automobiles. Considerable damage in ordinary, substantial buildings, partial collapse, great damage to poorly built structures. Some masonry walls fail. Fail of chimneys, factory stacks, monuments, towers. Heavy furniture overturned. Branches broken from trees. Wells change water level. Cracking in wet ground and on steep slopes.	6·1–6·6
IX	Poor masonry destroyed; good masonry damaged seriously. Foundations damaged generally. Buildings shifted off foundations. Reservoirs seriously damaged. Conspicuous cracks in ground. In areas of loose sediment, sand, mud, and water ejected. Underground pipes broken.	6·6–7·1
X	Most masonry and frame structures destroyed. Foundations and some bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides occur. Water splashes over banks of rivers, lakes, and canals. Flat areas of mud and sand shift horizontally.	7·1–7·6
XI	Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Extensive landslides on slopes. Underground pipes completely out of service.	7·6–8·1
XII	Damage to human-made structures nearly total. Waves seen on ground surface. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	8·1 or greater

Figure 3. Modified Mercalli Earthquake Intensity Scale (after Rapp, 1986: 366–367, table 1; Rapp & Hill, 1997: table 9·1).

seismic activity has been ongoing for hundreds of thousands, or perhaps even a few million years, depending on how one extrapolates the recent seismic data backwards in time. The motion of the plates is in the order of centimetres per year, so the landscape and the plate-bounding fault patterns change slowly (Ambraseys, 1970: 143). Thus, the 20th century's earthquake pattern is similar to that which has been experienced in this area throughout human history and prehistory (cf. also Drews, 1993: 37).

Strain on a fault located at a plate boundary can accumulate gradually over a prolonged period of relative inactivity, sometimes as long as a few hundred years (Galanopoulos, 1963: 38; Ambraseys, 1970; Allen, 1975: 1042; Rapp, 1982: 48). During this time the fault can be relatively quiet. Frequently the strain is then released in a single large earthquake with numerous aftershocks. However, the strain can also be released in a series of large earthquakes, each one triggering the next. We have labelled such an occurrence in the ancient world as an "earthquake storm" (Nur, 1998), while other geophysicists describe modern examples as either an "earthquake sequence" (e.g. Ambraseys, 1970), a "progressive failure" (Stein, Barka & Dietrich, 1997), or an "earthquake migration" (Mogki, 1968; Roth, 1988).

Such "storms" or "sequences" occur if the initial earthquake ruptures only a segment of the fault zone, thus putting even more stress on adjacent portions of the fault (cf., in addition to the above, also King, Stein & Lin, 1994). The strain on these adjacent sections may then be released in a second earthquake. This could occur weeks, months, years, or even decades after the first earthquake. If this second earthquake in turn then puts additional stress on the next portion of the fault, a third earthquake may be triggered, and so on down the line until the entire length of this fault line is "unzipped" and free from strain. The whole process of gradual accumulation and subsequent release of stress would then start over, leading eventually to another "earthquake storm" as much as centuries later.

A well-known example of such a modern "earthquake sequence" took place on the North Anatolian Fault in Turkey during the 20th century (e.g. Ambraseys, 1970; Allen, 1975; Wood, 1996: 225–226; Stein, Barka & Dietrich, 1997). This 30-year "sequence" consisted of a series of large (M>6·5) earthquakes in 1939, 1942, 1943, 1944, 1951, 1957 and 1967 which progressed westward along the 1000 km-long fault zone, releasing strain that had accumulated over the previous 200 or more years (Figure 7); this "sequence" might now be extended to 60 years in length, in light of the August and November 1999 earthquakes in this region. A shorter "earthquake sequence" was also seen in the six earthquakes that occurred within an 8-year period in Greece

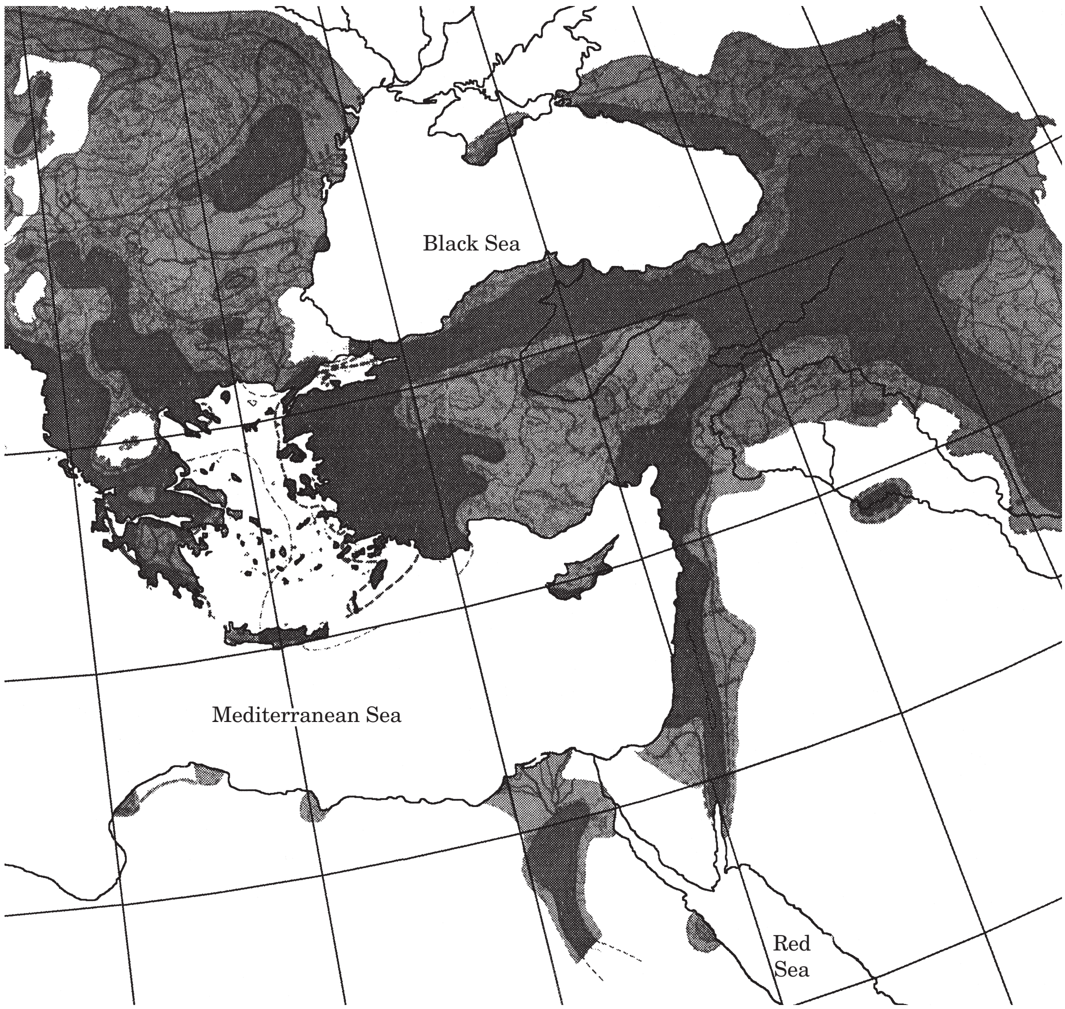

Figure 4. Map showing the maximum intensity of seismic ground motion in the Aegean and the Eastern Mediterranean during 1900–1980 (modified from Karnik, 1968). The maximum local intensity within the gray regions during this period is greater than VII.

only 1–2 decades ago: in the areas of Thessaloniki in 1978, Volos in 1980, Corinth, Athens and Thebes in 1981, and Kalamata in 1986 (Sampson, 1996: 115; cf. also Galanopoulos,1963: 45 on an earlier series from 1953–1958). A longer "earthquake storm", of more than 80 years' duration, has been reported by Ambraseys (1970: 147) as occurring along the North Anatolian Fault from AD 967–1050, during which time more than "twenty earthquakes of damaging to destructive magnitude occurred". An even earlier "earthquake storm" may also have caused the destructions of the middle 4th century AD, when a series of significant earthquakes during a 30-year period between AD 350 and 380 resulted in much damage at sites in Israel, Cyprus, NW Turkey, Crete, Corinth, Reggio Calabria, Sicily and northern Libya (Guidoboni, 1994: 504; Nur, 1998). This active period was preceded and followed by seismically relatively quiet periods of about 300 years. In view of these observations, we suggest that a similar "storm" of large earthquakes over a 50-year period could have occurred in the Aegean and the Eastern Mediterranean *c.* 1225–1175 BC.

Archaeological Evidence

Figure 8 shows Drews' map of 47 Aegean and Eastern Mediterranean sites destroyed in a 50-year period at the end of the Late Bronze Age (Figure 1) superimposed over the Intensity VII ground motion map (Figure 4). Most of these destroyed sites fall within, or close to, the high intensity regions and were probably subjected to earthquakes throughout their history of human occupation. Indeed, Kilian has previously noted that:

> "the Mycenaean sites for which there is archaeological evidence of seismic activity coincide with areas that have been hit by earthquakes with a magnitude $M_s = 6{\cdot}0$ or larger during the last two hundred years"

(Kilian, 1996: 67, citing IGME, 1989), while Papadopoulos (1996: 208) has stated that:

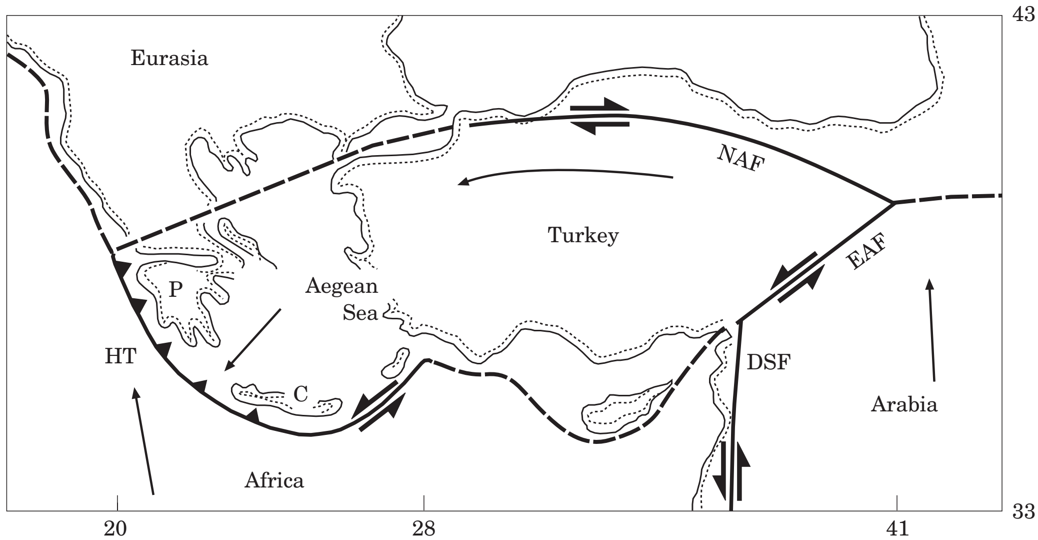

Figure 5. Sketch of the plate in Turkey and the Aegean, showing the relative motions between the Africa, Arabia, Turkey and Eurasia, accommodated by strike-slip faulting on the North (NAF) and East (EAF) Anatolian fault zones and by shortening in the Hellenic Trench (HT). Black arrows are the approximate directions of motion of Arabia, Turkey, the southern Aegean, and Africa relative to Eurasia. DSF is the Dead Sea Fault zone, C is Crete, and P is Peloponnese (from Jackson, 1993).

> "analysis of seismic intensity data, existing since the beginning of the present century, indicates that the probability of observing at least one destructive (Intensity>6) earthquake, in one or more Greek mainland Mycenaean regions, in time intervals of thirty years or more, is very high".

While it is usually relatively easy to recognize destructions and the levels at which they occurred in the excavation of ancient sites, it is frequently more difficult to assign a cause for such devastations. Potential causes of visible damage include war, accidental fire and earthquake (Mylonas, 1966: 222). Consequently, the reasons for the destructions occurring at the various sites in the Aegean and the Eastern Mediterranean in the era *c.* 1225–1175 BC have been much debated (see Drews, 1993 for summation and bibliography). Nur & Ron (1997*a*: 532, 1997*b*: 50, 52–53) have listed several diagnostic criteria which, if noticed at an ancient site, provide possible evidence for a destruction by earthquake. These include collapsed, patched and reinforced walls; crushed skeletons and unretrieved bodies lying under fallen debris; toppled columns lying like parallel toothpicks; and slipped keystones in archways and doorways. Stiros (1996: appendix 2) adds to this list walls leaning at impossible angles, walls offset from their original position and many other possible criteria. A comprehensive list is presented here in Figure 9. It should be noted, however, that Stiros and other scientists (e.g. Karcz & Kafri, 1978; Rapp, 1986; Rapp & Hill, 1997: 210) warn that such damage can also be the result of poor construction techniques, subsiding or slipping of the earth beneath the building and a multitude of other factors.

Rapp (1986: 375) states that

> "many ... have discussed the possible role of seismic activity in the 'destruction layers' found in eastern Mediterranean excavations. What is normally missing are diagnostic criteria for seismic damage that is preserved in archaeological contexts".

However, if one peruses the excavators' reports published for Late Bronze Age sites, such as those in the Aegean and the Eastern Mediterranean listed by Drews as having suffered calamities at the end of the Late Bronze Age, *c.* 1225–1175 BC, descriptions of damage which fall into the above categories can be recognized, suggesting that a number of the destructions may have been caused by earthquakes. For convenience, a number of these are collected and presented briefly below, although the catalogue should by no means be regarded as complete. Emphasis in the following examples will be given to descriptions in the original excavators' own words.

Mycenae

It is not generally realized by archaeologists that the Argive Plain is "bound by prominent faults" (Zangger, 1993: 6) and that Mycenae itself is located on a series of fault lines (Figure 10) which were seismically active during the Late Bronze Age (cf. Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996 for a detailed discussion). Indeed, the Cyclopean walls adjacent to the "Lion Gate" entrance to Mycenae are built on top of a geological fault scarp (Figure 11), which has been polished by sliding during past earthquakes. Both Mylonas (1966: 225) and Iakovidis (1986) have long argued for the evidence of a

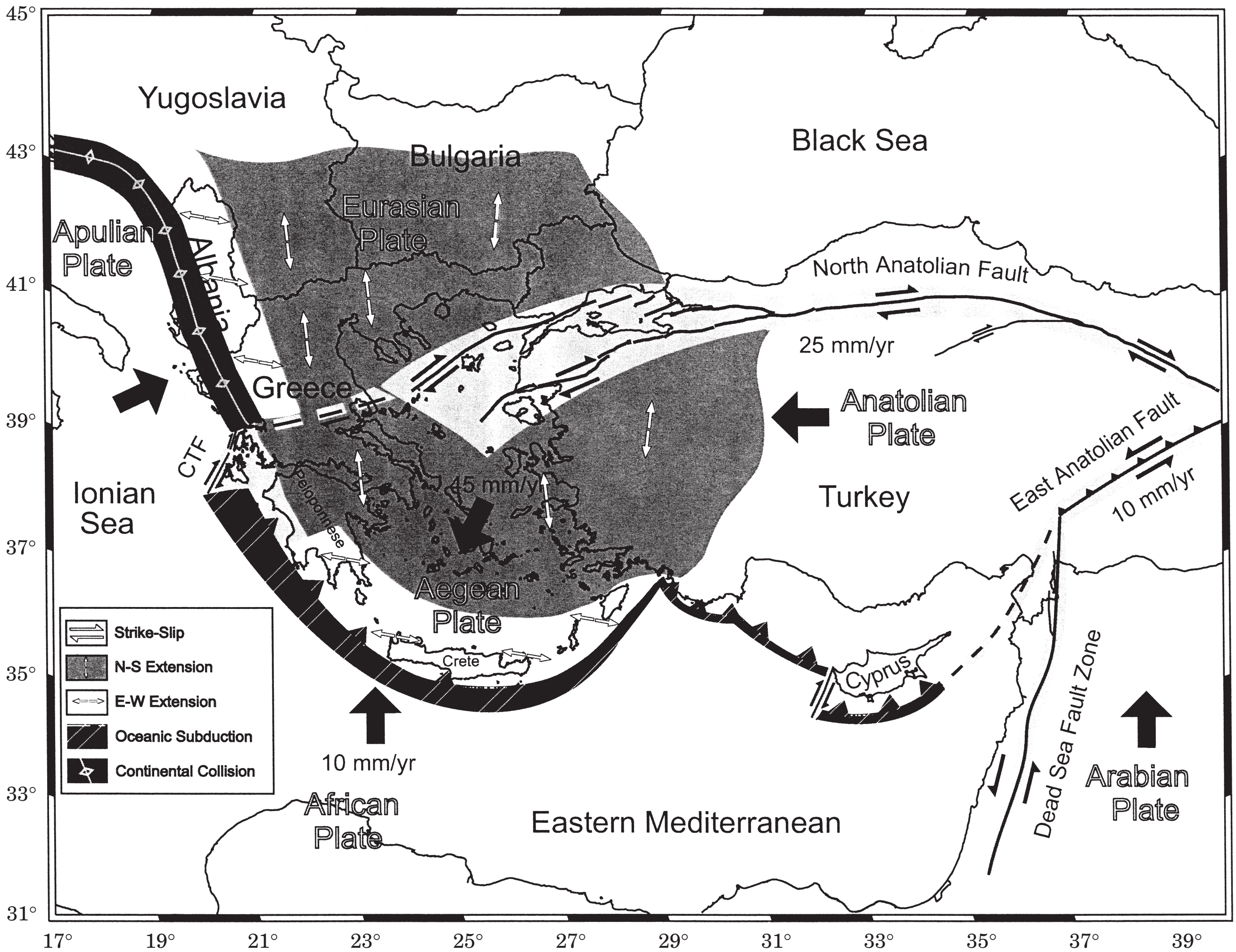

Figure 6. Splaying of micro-plates across Greece (after Papazachos & Papazachou, 1997: fig. 6·11)

destructive earthquake at the site in the LH IIIB2 period, but only recently have other archaeologists working at the site, like French (1996, 1998), reluctantly begun to agree (cf. Shelmerdine, 1997: 582).

The Cult Centre on the Citadel. Within the Cult Centre on the Citadel, two sets of destruction have been noted. From the first devastation, dated to the LH IIIB2 period, the wall flanking the entrance to the shrine with the idols was found bulging outwards, roof slates had fallen and signs of a fire were observed. Shortly after this destruction, new walls were built along the original ones in the inner sanctum, thus propping them up, original doors were walled up while new doors and windows were opened, and at least one wall in a neighbouring room was reinforced (Mylonas, 1972: 122; Taylour, French & Wardle, 1981: 9; Iakovidis, 1986: 243–244).

The second calamity, after the reconstruction and dated to the later LH IIIB2 or early LH IIIC period, resulted in a destruction and subsequent fire which burned the mudbrick walls of the sanctuary; the excavators noted that "the intensity of the fire has served to preserve these walls in their original state, though off axis . . ." (Taylour, 1969: 91–92, 95; Mylonas, 1973: 103, 1975: 158; Iakovidis, 1986: 244–245).

The South House on the Citadel. In the South House on the Citadel, which collapsed and was ravaged by fire in LH IIIB2, the SE corner of room 8 was "shifted bodily away from its stone sockle but yet retained its form and cohesion" (Taylour, French & Wardle, 1981: 31; Iakovidis, 1986: 242).

The Southwest House of the Citadel. In the Southwest House of the Citadel, destroyed sometime in LH IIIB, the north wall of room 2 was found collapsed, with the skeleton of a young man crushed under the burned debris. The south wall of the room had also collapsed, blocking the door to room 1. Huge pieces of plaster, from the frescoes lining the walls of the building, were also fallen, apparently having come loose before the

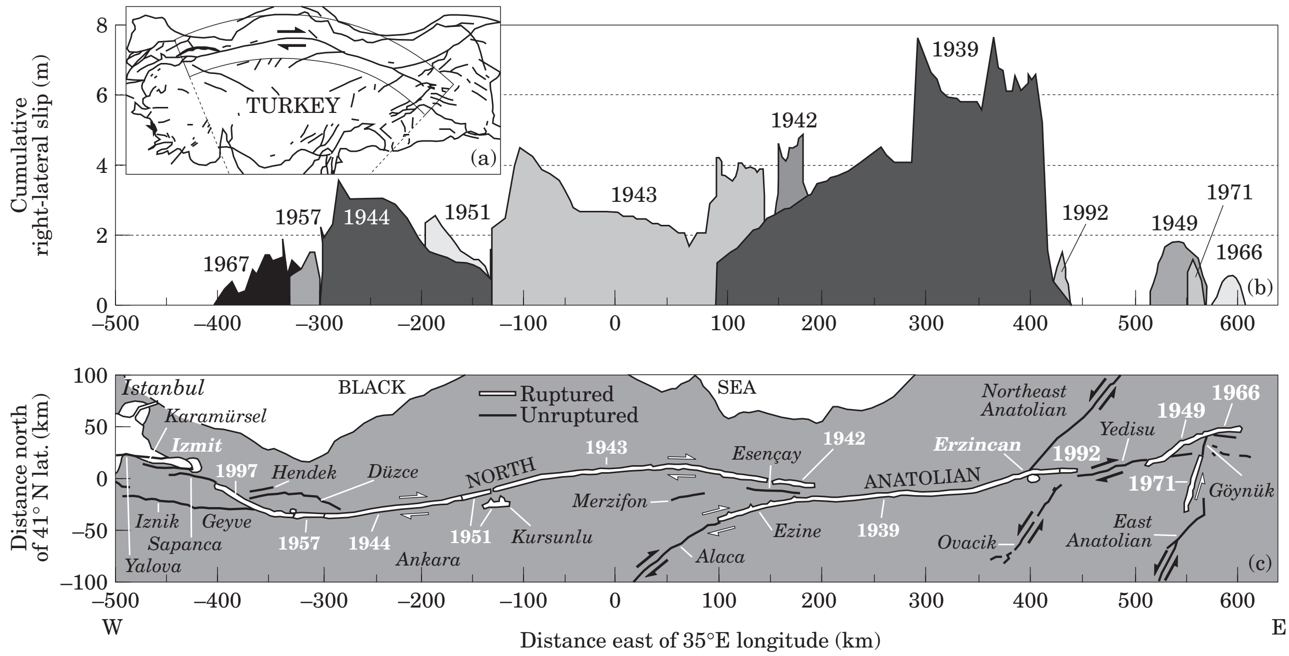

Figure 7. The mid-20th century AD "earthquake storm" that unzipped the north Anatolian fault during a *c.* 30-year period from AD 1939 to 1967 (taken from Stein, Barka & Dietrich, 1997: fig. 1).

walls themselves had collapsed (Mylonas, 1970: 122–124, 1971: 148–151; Iakovidis, 1986: 246–247).

House room north of the Citadel. In a house built 200 m north of the Citadel, on the lower slope of Prophitis Ilias at Plakes, a building which was destroyed in the LH IIIB2 period, *c.* 1250 BC, the "basements were found full of fallen stones which covered the skeletons of three adults and a child crushed beneath them". In addition, the walls of several rooms were found fallen down the slope; other walls were found leaning outwards, including one basement wall which had tilted so much that a gap was left where it had originally joined with another wall; and huge chunks of plaster, both painted and unpainted, had come loose from the walls and crashed onto the floors (Mylonas, 1975: 158–161; Iakovidis, 1986: 255–256; Mylonas-Shear, 1987: 155; French, 1996: 51; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190).

Panagia group—House I. In House I of the Panagia group, built on the west slope of the ridge north of the treasury of Atreus and destroyed violently shortly before the middle of LH IIIB *c.* 1250 BC,

> "the skeleton of a middle-aged woman whose skull was crushed by a falling stone was found in the doorway between the main room and the anteroom".

The body was then buried by the debris of the house, which included smashed vessels and a chimney pot lying on the floor (Figure 12(a), (b)). Furthermore, the excavators noted

> "the collapsed state of the doorway leading into the house and the condition of the south wall of Room 2 where the preserved portion of that wall was found leaning outward, toward the south"

(Mylonas, 1962: 66, 1963: 106, 1966: 83; Mylonas-Shear, 1969: 19–20, 1987: 154–155, pls. 4b, 5b; Iakovidis, 1986: 249–250; French, 1996: 51; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190, who mistakenly attribute this destruction to the "House of Lead" at Mycenae; Shelmerdine, 1997: 542). Mylonas (1966: 221) concluded:

> "House I was suddenly destroyed, but not by fire. The pile of stones found all over its area, the smashed vases with all their pieces in place under stones, the lack of burned remains, the discovery of a female skeleton in the doorway of its main room with skull broken by fallen stones, all seem to indicate that House I was destroyed by earthquake shortly before the middle of LH IIIB".

Panagia group—House II. In House II of the Panagia group, located at the same place and destroyed at the same time as House I (above), a party wall between Rooms 11 and 12 was found oddly askew: "the south part of the wall rests firmly on its foundations. The north and central sections, however, have buckled and shifted forward off those foundations". In the period immediately following, "some walls were strengthened and reused and a few others, too damaged to be repaired, were abandoned" (Mylonas-Shear, 1969: 19, 25, 37–38, 49–50, 53, 59, 1987: 154–155, pl. 11a; Iakovidis, 1986: 249–250; French, 1996: 54; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190; Shelmerdine, 1997: 542).

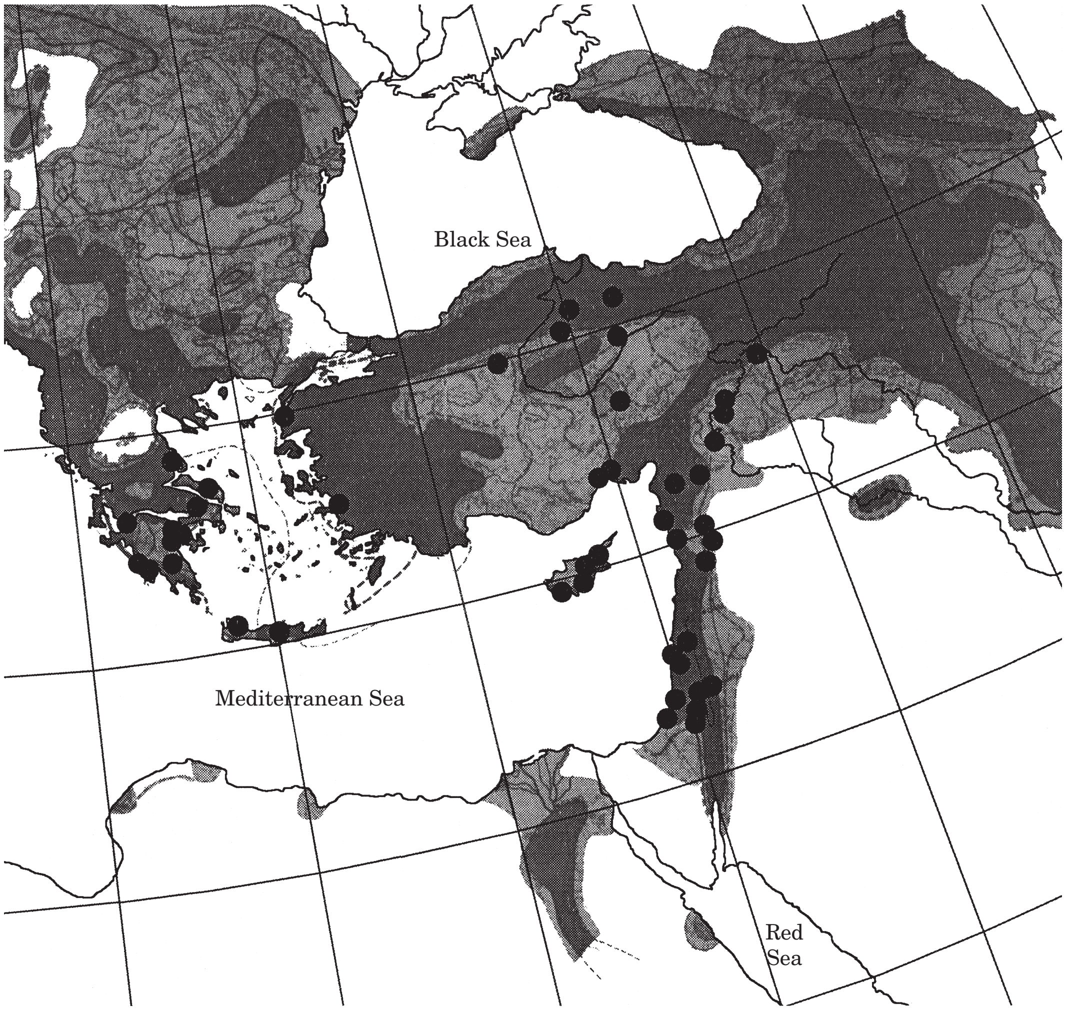

Figure 8. The Aegean and Eastern Mediterranean sites destroyed *c.* 1225–1175 BC (Figure 1) superimposed on the maximum intensity of seismic ground motion in the Aegean and the Eastern Mediterranean during *c.* 1900–1980, in which the intensity was greater than VII (Figure 4).

Panagia group—House III. In House III of the Panagia group, located at the same place and damaged at probably the same time as Houses I and II were destroyed (above), some of the walls had been buttressed and reinforced, a doorway was blocked, and new walls were inserted, which apparently allowed the occupants to continue inhabiting the house despite its weakened state (Mylonas-Shear, 1987: 154–155; Iakovidis, 1986: 250–251; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190).

House of the Oil Merchant. The House of the Oil Merchant, probably destroyed in late LH IIIB1 or early LH IIIB2, showed signs of destruction which Wace believed to be the result of "enemy action", but which Iakovidis thinks "portray the results of a strong earthquake followed by fire rather than the disarray caused by looting" (Wace, 1951: 254–255, 257, 1953: 13; Iakovidis, 1986: 252–253; Mylonas-Shear, 1987: 155; Tournavitou, 1995; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190; Shelmerdine, 1997: 542).

Other buildings. Other buildings at Mycenae which show possible earthquake damage include the Ramp House, the House of Sphinxes, the House of the Wine Merchant and Petsas' House (Mylonas, 1966: 221; Iakovidis, 1986: 242, 251, 254, 258–259, with further references; Mylonas-Shear, 1987: 155; Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: 190).

Tiryns

Kilian, the late excavator of Tiryns, long argued that the site was destroyed at the end of LH IIIB2 by an earthquake which also affected several other sites in the Argolid such as Mycenae (cf. Kilian, 1980, 1981: 193, 1985, 1988; Shelmerdine, 1997: 543). Other archaeologists such as Iakovidis (1986: 259) have agreed with this assessment. Zangger (1991, 1993: 80,

1. Characteristic structural damage and failure of constructions, such as:
   a. Collapsed walls
   b. Patched walls
   c. Offset walls
   d. Opened vertical joints and horizontally slided parts of walls in dry masonry walls
   e. Diagonal cracks in rigid walls
   f. Triangular missing parts in corners of masonry buildings
   g. Inclined or subvertical cracks in the upper parts of rigid arches, vaults and domes, or their partial collapse along these cracks
   h. Slipped keystones in dry masonry arches and vaults
   i. Cracks at the base or top of masonry columns and piers
   j. Displaced drums of dry masonry columns
   k. Neat rows of parallel fallen columns, frequently with their drums in a domino-style arrangement
   l. Constructions deformed as if by horizontal forces (e.g. rectangles transformed to parallelograms)
2. Ancient constructions offset by seismic surface faults.
3. Skeletons of people killed and crushed or buried under the debris of fallen buildings.
4. Certain abrupt geomorphological changes, occasionally associated with destructions and/or abandonment of buildings and sites.
5. Pattern of regional destruction.
6. Destruction and quick reconstruction of sites, with the introduction of what can be regarded as "anti-seismic" building construction techniques, but with no change in their overall cultural character.
7. Well-dated destructions of buildings correlating with historical (including epigraphic) evidence of earthquakes.
8. Damage or destruction of isolated buildings or whole sites, for which an earthquake appears the only reasonable explanation.

Figure 9. Criteria for the identification of possible earthquake damage in antiquity (after Stiros, 1996: appendix 2 and Nur & Ron, 1997*a*, 1997*b*).

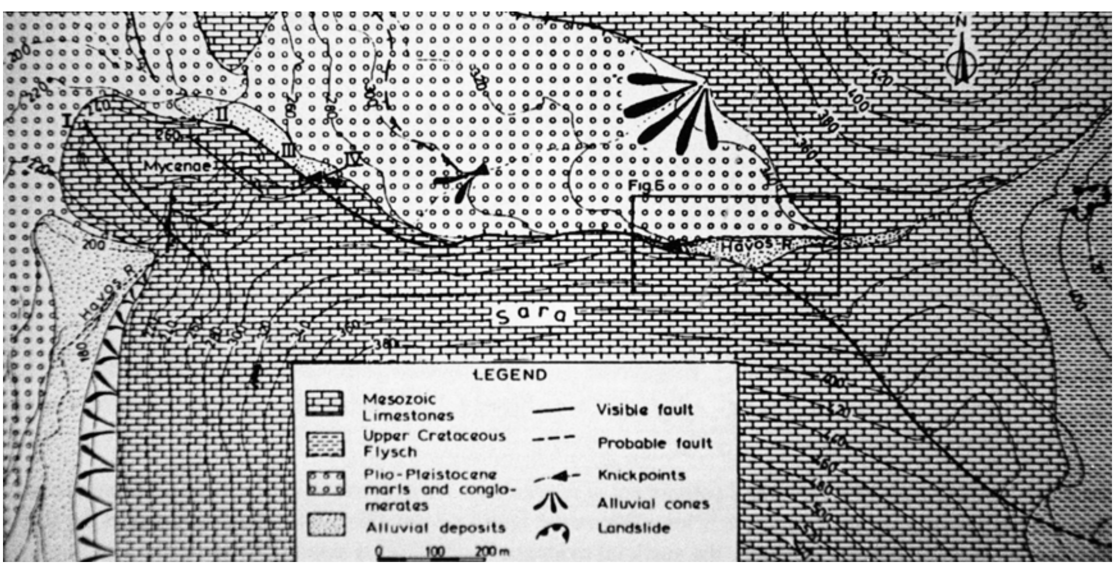

Figure 10. Active fault lines in the area of Mycenae (after Maroukian, Gaki-Papanastassiou & Papanastassiou, 1996: fig. 2).

1994: 192–193, 203, 207, 209–210) has recently suggested that a catastrophic flash flood which buried parts of the lower town of Tiryns (outside the Cyclopean walls), up to 5 m deep, may be related to this earthquake. In a posthumously published paper, Kilian (1996: 63) stated that "the evidence consists of building remains with tilted and curved walls and foundations, as well as skeletons of people killed and buried by the collapsed walls of houses" and continued (Kilian, 1996: 65) ". . . comparative study of buildings that have been affected by earthquakes in the last 100–200 years supports our conclusions that the observed deformation of excavated buildings are of seismic origin". Kilian (1978: 466; cf. Zangger, 1994: 207) also suggested that another earthquake had damaged Tiryns during the LH IIIC period.

Building X. In Building X, within a large complex inside the Acropolis dating to the period of the last palaces, the skeletons of a woman and a child were found "buried by the walls of Building X" (Figure 13). In addition, "the walls are not linear but curving, nor are they orthagonal where they meet" (Figure 14); that is, the walls are deformed "in various directions, especially at the corners" (Kilian, 1996: 63, 65, figs 4, 6).

Figure 11. The city wall of Mycenae includes in its lower part and as its foundation a natural fault scarp dipping here at 60 deg. or so. Even a very modest earthquake on this fault would cause the wall to tumble, and render it ineffective for defense against attack (after Mylonas, 1996: fig. 11).

Building VI. According to Kilian (1996: 64–65, fig. 5), within Building VI,

> "a high wall was transformed into a mass of rocks . . . S of the fallen rocks, the walls on the terrace and on the other side of the corridor are tilted downhill (westwards) and uphill (eastwards) respectively, that is in a direction opposite to that of a possible slope-movement . . . Such antithetical tilting of nearby walls is not the result of landslides but of seismic disturbances"

(Figure 15).

Early LH IIIB House. In an early LH IIIB (*c.* 1300–1260 BC) house, "a skeleton was found beneath the fallen walls" (Kilian, 1996: 65).

Upper Acropolis. According to Kilian (1996: 63, fig. 3), in the Upper Acropolis, the transverse wall closing the opening of the Main Gate on the Upper Acropolis was found to be curved rather than straight, as well as having collapsed (Figure 16).

Lower city room complex. In the excavation of a complex of rooms in an early LH IIIC (*c.* 1190–1150 BC) level in the lower city (Figure 17), some of the walls uncovered were curved rather than straight (Kilian, 1981: 192–193, 1996: 63, fig. 1; Dakoronia, 1996: 42); this is interpreted as an indication that they had somehow been pushed out of their original orientation, perhaps by an earthquake.

In the excavation of the same complex of rooms (Figure 18), but at a deeper level (i.e. perhaps dating to the late LH IIIB2 period), the walls were "also not rectilinear" (Kilian, 1996: 63, fig. 2); again, these may be interpreted as having been pushed out of alignment by some force.

Fortification wall. In 1956, Verdelis excavated fill by the fortification wall with "LH IIIB sherds, fragments of wall paintings, and remnants of burnt wooden beams". Here he discovered "two human skeletons, evidently not burned but killed and covered by the fallen debris" (Verdelis, 1956: 5–8; Mylonas, 1966: 49–50).

Midea

The excavators of Midea suggest that a destruction at the site in LH IIIB2 (*c.* 1190 BC) was caused by an earthquake. They cite in particular "collapsed, distorted, curved and tilting walls" as well as a skeleton found under collapsed debris (cf. Åström & Demakopoulou, 1996: 37, 39; Shelmerdine, 1997: 543; Demakopoulou, 1998: 227).

East Gate. In one of the rooms in the area of East Gate, in an LH IIIB2 context, "the skeleton of a young girl was found, whose skull and backbone were smashed under fallen stones" (Åström & Demakopoulou, 1996: 39; Demakopoulou, 1998: 227).

Acropolis. Buildings located inside the Acropolis to the left of the West Gate were destroyed by fire and

(a)

(b)

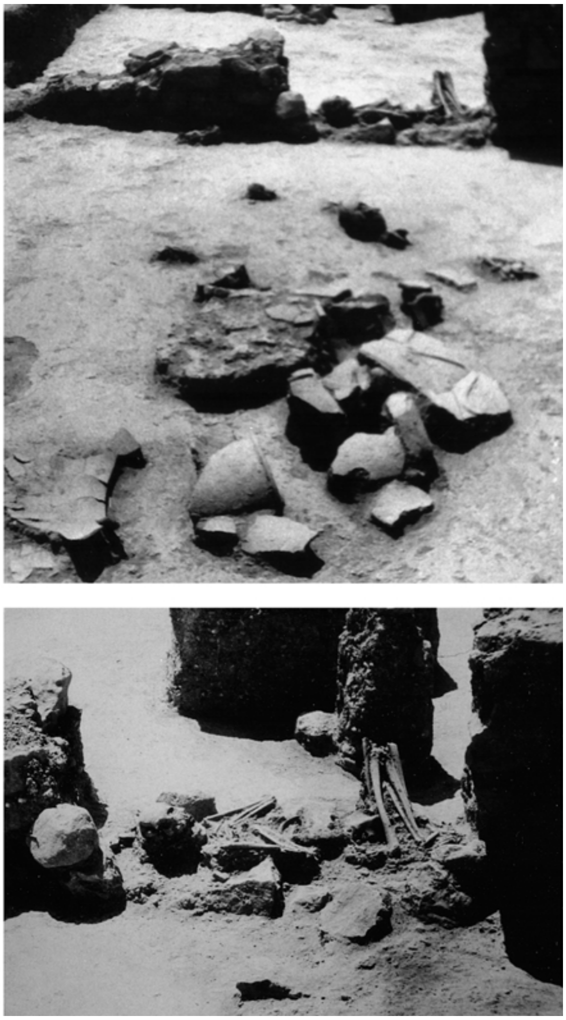

Figure 12. (a,b) House I of the Panagia group at Mycenae. (a) Destruction in Room 5 with skeleton in background; (b) close-up of skeleton in doorway of Room 5 (after Mylonas-Shear, 1987: plates 4b, 5b).

Figure 13. Skeleton of a woman and child buried by the fallen walls of Building X at Tiryns (after Kilian, 1996: fig. 6).

Figure 14. Building X at Tiryns, with undulating walls and non-orthagonal corners (after Kilian, 1996: fig. 4).

Figure 15. Tilted eastern and western walls within Building VI at Tiryns (after Kilian, 1996: fig. 5).

contained large stones and nearly complete mudbricks which had fallen from the walls of the rooms and from the collapsing fortification wall (Åström & Demakopoulou, 1996: 38–39).

Thebes

Excavations in 1980 yielded evidence of a destruction in late LH IIIB1, which the excavators have attributed to "a sudden earthquake succeeded by fire of long duration" (Sampson, 1996: 114). Previous excavations had also hinted at a destruction caused by an earlier earthquake in the LH IIIA2 period (Symeonoglou, 1987: 17–18).

Figure 16. Curved and collapsed transverse wall closing the Main Gate of the Upper Acropolis at Tiryns (after Kilian, 1996: fig. 3).

Figure 17. LH IIIC complex of rooms in Lower City at Tiryns, with curved walls (after Kilian, 1996: fig. 1).

Palatial workshop, Kadmeia. Part of a palatial workshop in the eastern wing of the Kadmeia yielded

> "a thick destruction layer . . . more than 1 m thick . . . Unbaked mudbricks coming from the fallen walls of the building were found in different levels; some of them were later baked by the fire. The destruction was immediate . . ."

(Sampson, 1996: 114). Within this general destruction, a human skeleton was found 0·70 m above the floor in Room I of the building:

> "The skeletal remains were within the destruction layer; since it was overlain by a much harder stratum of erosion . . . it cannot postdate the destruction layer. The remains were found well above the ground floor which suggests that the person was on the first floor at the dreadful moment of the destruction, could not escape and was finally trapped among the ruins. . . . A careful anthropological study suggests that the skeleton belongs to a young female of about 20 to 25 years old and 1·55 m in height. Injuries are evident on the skull, but what caused death was a fatal depressive detaching fracture in the middle of the cranium vault . . . very likely produced by a very violent blow from a sharp structural material—probably a roof beam—which hit the woman suddenly"

(Sampson, 1996: 114, fig. 1a–b).

Figure 18. Same complex of rooms in Lower City at Tiryns, but from lower, probable LH IIIB2, level, again with curved walls (after Kilian, 1996: fig. 2).

The Menelaion, Sparta

Terrace wall and lower terrace. While excavating at the Menelaion, Catling noted a monumental terrace wall which collapsed during the LH IIIB2 period. He stated:

> "When the terrace wall collapsed it did so suddenly and unexpectedly. This is implicit in the 1978 discovery of a human skeleton trapped in what is now seen to have been the terrace collapse".

There was also damage to a building on the lower terrace (Catling, 1978–79: 19–20, 1980–81: 18–19; Kilian, 1985: 74–75, 89 n. 33).

Kynos (Livanates, Central Greece)

Storerooms. Excavation of storerooms in this town identified as Homeric Kynos, dated to the early LH IIIC period, uncovered "mudbrick walls which had detached from their dry stone foundations and had

Figure 19. Destruction at Kynos (Livanates, Central Greece): mudbrick wall detached and shifted relative to its foundations (after Dakoronia, 1996: fig. 3a).

fallen into clay bins". In particular, the excavator describes "a destruction that can be recognized by a lateral shift of the walls relative to their foundations, by dislocation of certain mudbricks, and by mudbricks that fell into the clay bins" (Figure 19). The offset of the walls "testifies to a high acceleration event" (i.e. an earthquake), rather than deliberate destruction or a simple failure of the foundations (Dakoronia, 1996: 41–42, fig. 3a–b).

Other possible Aegean sites

Other sites in the Aegean with damage *c.* 1225–1175 BC possibly attributable to earthquakes include Pylos, Lefkandi, Korakou, Profitis Elias near Tiryns, Gla, Nichoria, Krisa in Phocis and Kastanas in Thessaly (cf. Hänsel, 1979: 186; Kilian, 1985: 74–75, 1988: 134, 151 n. 2, 1996: 65; Sampson, 1996: 115). At each of the above sites, the observable damage could be the result of seismic activity but cannot be conclusively attributed to earthquakes.

Troy VI

As Wood (1996: 225) and others have noted, Troy is situated "near the end of the major Anatolian fault; as a result there is a great deal of seismic activity". Schliemann, Blegen and other excavators at Troy noted evidence for earthquakes in the cities of Troy III, IV and V, and probably VI as well (Rapp, 1982: 43, 53, 55; Wood, 1996: 226). The idea of an earthquake having contributed to the destruction of Troy VI *c.* 1250 BC is a matter of some controversy, however, with scholars suggesting that some of the observed damage could have been caused by subsidence and settling rather than solely due to an earthquake (see most recently Rapp, 1982; Easton, 1985: 189–191, 195; Drews, 1993: 35, 41; Wood, 1996: 225–229).

On the other hand, the final report by the excavators (Blegen, Caskey & Rawson, 1953: 331; cf. Wood, 1996: 229) stated that "we feel confident in attributing the disaster to a severe earthquake": they believed that "a violent earthquake shock will account more convincingly than any probable human agency for the toppling of the city wall". A later re-examination by Rapp (1982), a geoarchaeologist, further concluded:

> "On the basis of the large quantity of loose material and the abundance of trimmed blocks in the debris from the major destruction of Troy VIh, I believe that the most tenable hypothesis for the cause of this destruction lies in foundation failures stemming from earthquake-induced earth movements in the underlying unconsolidated materials. Interpreted thus, the evidence supplied by the Cincinnati excavators . . . seems overwhelming".

Tower VIh. Blegen, Caskey & Rawson, 1953: 89–90 (cf. also 283, 331) say:

> "the great wall [of Troy VI] was founded on a cushion of earth some distance short of the native rock, whereas the substructure of the tower [VIh] was laid directly on the rock itself. It is this circumstance that provides an explanation for the conspicuous cracks to be seen in the south wall of the tower. The cracks occur near the western end of the structure, where it rests in part on the sloping face of the fortification wall: the latter has settled somewhat, probably as a result of the earthquake that brought to a close the last phase of the Sixth Settlement, and in its subsidence it has carried with it the portion of the tower which it partially supported"

(figs 28, 31, 174 left foreground, 493; cf. also Rapp, 1982: 55, 56; Easton, 1985: 190; Wood, 1996: 226).

Tower VIi. Blegen, Caskey & Rawson, 1953: 98 (cf. also 331) say:

> "The projecting west flank of Tower VIi corresponds almost exactly to the thickness of the south wall . . . The numerous cracks which mar the appearance of this side of the tower were caused by a slight settling of the foundations, perhaps induced by earthquakes"

(fig 44, 54; cf. also Rapp, 1982: 55). As Easton (1985: 190) notes: "Tower VIi, like Tower VIh, was founded on rock".

Figure 20. Fortification wall of Troy VI, tilted over sharply from vertical (after Blegen, Caskey & Rawson, 1953: fig. 36).

Inner face of the curtain. Blegen, Caskey & Rawson (1953: 92. cf. also 215, 331, figs 36, 58, 59) reported that:

> "The inner face of the curtain [i.e., the south wall in the area of the South Gate and Towers VIi and VIk], which was originally vertical, has been partially dislocated, and has tilted over sharply toward the north . . . A mass of stones fallen from the wall indicates that the destruction was just as great along the south side of the fortification as on the east"

(Figure 20; cf. also Rapp, 1982: 55; Easton, 1985: 190; Wood, 1996: 226).

House VIG. Concerning House VIG, Blegen, Caskey & Rawson (1953: 262; cf. also 257, 283, figs 174 right foreground, 175 right foreground, 476) said:

> "It was the easterly wall that suffered the greatest damage along with the eastern part of the crosswall. The effect . . . was most noticeable toward the northern end of the building, where characteristic flat stones from the wall fell in great numbers into the house and especially outside it toward the east. In this direction they extended out over the open area in masses until they almost met a similar fall of small bricklike stones from the rear wall of Tower VIh"

(cf. also Rapp, 1982: 55, 56; Wood, 1996: 226).

House VIE. Concerning House VIE and surrounding area, Blegen, Caskey & Rawson (1953: 330–332; cf. also figs 223–227) wrote:

> "the stones lay, as they had fallen, in utter disorder and confusion in a huge mass spreading across the whole space between the fortification wall and the terrace wall of House VIE. The heap was thickest along each side, where it rose against the citadel wall and the substructure of the house; toward the center of the area it sloped down gradually and thinned to a single 'course' of stones . . . The distribution of the material, as it was uncovered, indicates that it fell from the structures standing to the east and west of the area . . . When the east wall of House VIE was shaken down, a mass of stones piled up against the base of the terrace, while others rolled on down to the eastward in a diminishing cataract . . . we left the whole mass of fallen stones lying as they had settled against the base of the citadel wall and the terrace of House VIE, and scattered less thickly across the intervening space"

(figures 21–23; cf. also Rapp, 1982: 56; Wood, 1996: 226).

House VIF. Concerning House VIF, Blegen, Caskey & Robson (1953: 330–331) wrote:

> "In the southern part of Square J6, we observed several enormous rough boulders lying below the projecting corner of House VIF; there can be no doubt that they once formed part of the Cyclopean masonry in the massive eastern wall of that building".

Pillar House. Concerning the Pillar House, Blegen, Caskey & Robson (1953: 215; cf. figs 128–129) stated that:

> "The destruction was especially noteworthy on the terrace at the east end of the Pillar House, where some large pithoi of Troy VIIa were found to have been sunk deep into the heap of collapsed wreckage. The western part of the Pillar House also gave evidence of its untimely overthrow in a violent upheaval".

They also reported (Blegen, Caskey & Robson 1953: 220–221; cf. also 225) that:

> "Wall S curves perceptibly southward from about the midpoint of its length, diverging from the line of Wall N and increasing the inner width of the building by ca. 0·65 m. at its eastern end. This is perhaps not a remarkable discrepancy in so large a building, but it is scarcely to be accounted for as an error . . . The whole southeast corner of the building may have been destroyed . . . the inner face of the wall [Wall N] was originally vertical, but at some places it has been shaken out of plumb, probably by earthquake shocks. The north face . . . showed less dislocation . . .".

Figure 21. Fallen stones heaped against Troy VI fortification wall (after Blegen, Caskey & Rawson, 1953: fig. 223).

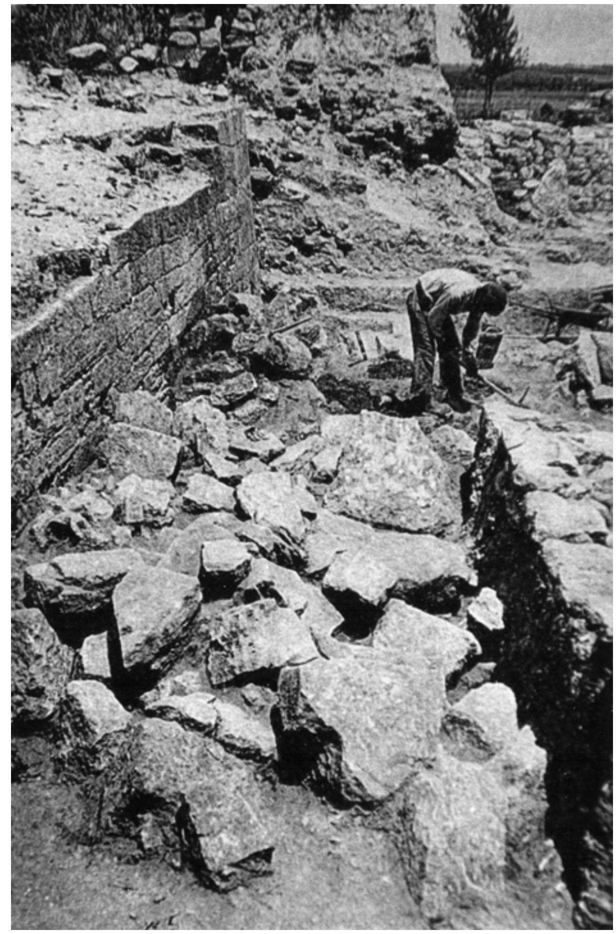

Figure 22. Fallen stones below East wall of House VIE in Troy VI (after Blegen, Caskey & Rawson, 1953: fig. 224).

Ugarit

In 1948, Schaeffer suggested that there had been an earthquake of at least Intensity VIII at Ugarit *c.* 1365 BC (Figure 24), which was documented by both archaeological and textual evidence (cf. Schaeffer, 1948: 2 and *passim*, fig. 1; Rapp, 1986, 371). In Schaeffer 1968, suggested again that the final destruction at the site, dated to shortly after 1200 BC, might also be the result of an earthquake; numerous scholars, including the current excavators of the site (e.g. Yon, 1992; cf. Drews, 1993; 33–34, 42–43), have taken issue with Schaeffer's hypothesis.

Although she attributes the final destruction to invaders, Yon (1992: 117) has recently written,

> "there is evidence of destruction and fire throughout the city. Visible traces within the *Palais Royal* include collapsed walls, burned *pisé* plaster, and heaps of ashes. In the residential quarters of the city, the ceilings and terraces were found collapsed, sometimes in the midst of intact walls. Elsewhere, walls were reduced to shapeless heaps of rubble, occasionally containing fallen bricks that had been hardened by fire"

(cf. also Schaeffer, 1948, 1968: 756, 761, 763–765, 766, 768). It is conceivable that this was instead all the result of an earthquake, as Schaeffer had hypothesized.

Megiddo

Megiddo is located on the active Carmel–Gilboa fault system, a branch of the more significant Dead Sea fault system, and has accordingly been prone to earthquakes throughout its history (Nur & Ron, 1997*a*: 533–535, 1997*b*: 50–51; cf. also Stewart, 1993). Several substantial destruction layers have been detected at Megiddo, including those marking the ends of Bronze Age Strata VIIB and VIIA, as well as Iron Age Stratum VIA although Ussishkin (1995) has recently suggested that the destructions noted at the end of VIIB and VIIA may in reality be a single destruction occurring at the end of Stratum VIIA).

End of Stratum VIIB. According to the University of Chicago excavators, at the end of Stratum VIIB, dating to *c.* 1250 BC at the earliest and possibly as late as *c.* 1200 BC, the palace in Area AA

Figure 23. Fallen stones in area between House VIE and fortification wall of Troy VI (after Blegen, Caskey & Rawson, 1953: fig. 226).

Figure 24. Misaligned wall at Ugarit, attributed to the earthquake of 1365 BC (after Schaeffer, 1948: fig. 1).

"suffered violent destruction so extensive that the Stratum VIIA builders deemed it more expedient to level off the resulting debris and build over it than to remove it all as was the procedure in previous rebuilding undertakings. When excavated court 2041 and room 3091 . . . were filled with fallen stone to a height of about a meter and a half . . . charred horizontal lines found here and there on the walls of the rooms to the north of the court . . . supply a general floor level throughout the palace".

As a result, the floor of the ensuing palace of Stratum VIIA was almost 2 m above that of Stratum VIIB and

"the half-burnt bricks which . . . were used in the construction, probably originate from the burned debris of stratum VIIB"

(Loud, 1948: 29, figs 70–71; cf. also Gonen, 1987: 94–96; Singer, 1988–89: 101; Kempinski, 1989: 10, 76–77, 160; Finkelstein & Ussishkin, 1994: 40; Finkelstein, 1996: 171–172; Nur & Ron, 1997*a*: 537–539; Leonard & Cline, 1998: 7–8).

End of Stratum VIIA. According to the University of Chicago excavators, at the end of Stratum VIIA, dating to *c.* 1170 BC at the earliest and possibly as late as *c.* 1135 BC, "the destruction was enormous, the city being . . . set on fire" and with the ensuing debris, including fallen walls, "as much as 4 feet deep" (Loud, 1948: 6; cf. also Shipton, 1939: 4; Davies, 1986: 64; Gonen, 1987: 96; Kempinski, 1989: 10, 72, 76–77; Finkelstein & Ussishkin, 1994: 40; Ussishkin, 1995; Finkelstein, 1996: 171–172; Nur & Ron, 1997*a*: 538–539, 1997*b*: 51, 54; Leonard & Cline, 1998: 7–8).

Ashdod, Akko and other sites in Syria–Palestine

Drews (1993: 38–39), in discussing the possible earthquake damage at Ugarit, Knossos, Troy, Mycenae, Tiryns and Midea claims:

"It appears in fact that the destruction levels at the six problematic sites are very similar to destruction levels at sites outside the seismic zone. For the Palestinian coast, for example, Moshe Dothan has reported destruction levels ranging from one to two meters at Ashdod and Akko. Here too, the destruction level consisted mainly of collapsed buildings, ash (from site-wide fires), pottery, and very few artifacts or valuables. The archaeological novice would therefore assume that the cities of Palestine must have suffered the same fate as did those in the seismic zone to the north."

In actuality, a mere glance at Figure 8 shows that the sites on the Palestinian coast are also within, not "outside the seismic zone" as Drews says.

Overview

In all, sites in the Aegean reporting such possible earthquake damage *c.* 1225–1175 BC include Mycenae, Tiryns, Midea, Thebes, the Menelaion and Kynos, and possibly Pylos, Lefkandi, Kastanas, Korakou, Krisa, Nichoria, Profitis Elias and Gla as well; there are most probably more sites which could be added to this list. Sites in the Eastern Mediterranean may include Troy, Karaoglun, Ugarit, Alalakh, Megiddo, Ashdod, Akko and numerous others among the cities listed by Drews and Bittel as having been destroyed *c.* 1225–1175 BC, including possibly Hattusas (Figure 1; cf. also Bittel, 1983: abb. 2).

No fewer than 16 skeletons have been found in collapsed debris dating to *c.* 1225–1175 BC at seven different sites in the Aegean and the Eastern Mediterranean: six skeletons at Mycenae, five at Tiryns and one each at Midea, Thebes, the Menelaion in Sparta, Troy and Karaoglun in Anatolia (cf. also Bittel, 1983: 31, abb. 2; Drews, 1993: 8). *Contra* Drews (1993: 39) who states that "none of the . . . quakes . . . resulted in casualties", the destructions, whatever may have caused them, obviously did result in fatalities.

A Study in Contrasts: Evidence of Bronze Age Destructions by Invaders

By way of a brief contrast, several examples of sites which present evidence of destruction caused by invaders/warfare rather than by earthquake are presented below. The differences between these and destructions found at the sites presented above are readily apparent.

Aphek

Concerning the destruction of Stratum X-12, dating to the end of the 13th century BC, Beck & Kochavi (1993: 68) report:

"The governor's residence . . . was destroyed in a violent conflagration.; its debris rises to a height of 2 m. This palace was destroyed in battle, as indicated by the arrowheads found in its debris and the conflagration that consumed it. The archaeological finds contain no data revealing the identity of its destroyers".

Kochavi (1977: 8) reported more extensively:

"Excavation of the Canaanite palace on the acropolis (Area X) of Aphek is proceeding year by year, so far revealing two wings of this monumental structure . . . A four-meter wide passage separates the two wings, apparently serving as the main entryway to the palace complex. A Hittite seal impression and an Egyptian signet ring were found on the floor of this passageway, as well as arrowheads stuck in the walls, eloquent testimony to the bitter fighting that raged over the storming of the palace. Additional evidence as to the nature of this catastrophe is seen in the mud-brick-and-ash debris of the palace walls and roof, which accumulated on the floor to a height of two meters or more, burned to an orange-red and cinder-grey in the consuming conflagration"

(cf. also Kochavi, 1990: XII, XX)

Lachish

Regarding the destruction of Stratum VI *c.* 1150 BC, Ussishkin (1993: 904) writes:

"Level VI was totally destroyed in a fire and the inhabitants were killed or deported. The city was abandoned and not resettled until the tenth century BCE . . . striking evidence was found in the ruins of the public building in Area S. Human skeletal remains uncovered there included bones of an adult and a child, as well as of a child and an infant, who were trapped in the destruction debris".

Previously, Ussishkin (1983: 168, 170) had stated:

"The city of Level VI came to a sudden end accompanied by a terrible fire . . . It was razed by a violent destruction that . . . came very suddenly. This event—obviously the result of attack by a strong enemy force—probably occurred about the middle of the 12th century BCE. The destruction was total, the population was wiped out or exiled and the site was abandoned and left desolate for a very long time".

Troy VIIa

Blegen *et al.* (1958: 11–12) stated that:

". . . the Sixth Settlement came to its end in the phase we have called VIh, when a severe earthquake overthrew the great houses inside the citadel and shook down considerable parts of the superstructure of the fortification walls. The ruins were found to show no traces of fire, no signs of the handiwork of man. The layer comprising the remains of Troy VIIa, on the other hand, was everywhere marked by the ravages of fire. Among the heaps of dislodged material from the razed buildings many stones were partly calcined from the heat of the conflagration. They were invariably accompanied by abundant debris of half baked crude brick, charred wood and other burnt matter, and the general effect was one of utter desolation.
On the doorway of House 700 were recovered some bones of a human skeleton and fragments of an adult male skull came to light in the street outside the house. Remnants of another skull were found farther to the west in Street 711.

The burned rubbish covering House 741 outside the eastern wall of the citadel likewise yielded a broken mandible, probably of an adult male. A human skeleton, most probably attributable to Troy VIIa, was also unearthed far down the western slope of the hill in Square A 3: it lay in an awkward position, as if the body had not been properly buried, but had been struck down and left to lie as it fell. These scattered remnants of human bones discovered in the fire-scarred ruins of Settlement VIIA surely indicate that its destruction was accompanied by violence. Little imagination is required to see reflected here the fate of an ancient town captured and sacked by implacable foes. One may wonder if the arrowhead found in Street 710—a point of a type known in the contemporary Mycenaean world on the Greek mainland—was not perhaps a missile discharged by an invading Achaean''.

Conclusions

Ever since Schaeffer's original suggestion in 1948 (elaborated upon in 1968), a continuing major obstacle to accepting an earthquake hypothesis has been the fact that the physical evidence of destruction at the end of the Late Bronze Age covers a span of approximately 50 years, *c.* 1225–1175 BC. This obstacle disappears, however, if one recognizes that earthquakes can occur not only as a single catastrophic event but also as related multiple events over both time and space. As Shakespeare said: ''When sorrows come, they come not single spies, But in battalions'' (*Hamlet* IV, scene 5).

Therefore, we offer the hypothesis that a number of the sites were partly or totally destroyed in a 50-year period at the end of the Late Bronze Age as a result of seismic events occurring as an ''earthquake storm'' along the geological faults of the Aegean and the Eastern Mediterranean (cf. also Kilian, 1996: 65). We further suggest that Schaeffer's original hypothesis that an earthquake caused the destruction at Ugarit and other sites in the Aegean and the Eastern Mediterranean near the end of the Late Bronze Age should be modified to encompass the concept of an ''earthquake storm'' rather than the occurrence of a single seismic event.

We are not suggesting that *all* sites in the Aegean and the Eastern Mediterranean with evidence of damage dating to *c.* 1225–1175 BC were directly destroyed as a result of earthquakes. We would simply point out that there is a reasonable statistical possibility that an ''earthquake storm'' could have been in part responsible for at least some of the damage seen at a number of these sites in the Aegean and the Eastern Mediterranean at the end of the Late Bronze Age.

Nor would we suggest that earthquakes destroyed entire societies. Indeed, there is good evidence that earthquakes alone did not bring the Late Bronze Age to an end, as shown by the rebuilding and reoccupations at Mycenae, Tiryns, Midea, Kynos and elsewhere in the later LH IIIB2 and LH IIIC periods (cf. Mylonas, 1966: 222, 225; Iakovidis, 1986: 242, 247, 260; Kilian, 1988: 150; Zangger, 1994: 192; Åström & Demakopoulou, 1996: 38; Dakoronia, 1996: 41; Shelmerdine, 1997: 580, 582–583; French, 1998: 4).

In sum, we would simply like to suggest that an ''earthquake storm'' may have occurred near the end of the Late Bronze Age, and that archaeologists might wish to reconsider how such an event may fit with the other forces at work in the Aegean and Eastern Mediterranean *c.* 1200 BC.

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