Landscape Changes around Tiryns during the Bronze Age

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Abstract

Excavations and auger cores have revealed the Holocene stratigraphy in the vicinity of the Late Bronze Age citadel of Tiryns. During the Early Bronze Age, when the shoreline was only 300 m from the limestone hillock on which Tiryns rests, an expansive settlement covered the southern district of the lower town. Its remains are today buried by up to 6 m of sediment. Late in Early Helladic II a stream south of Tiryns accumulated several meters of gravel and floodplain deposits. In LH IIIB/C this stream abandoned its bed and shifted to the north of the Tiryns knoll. At the same time it deposited up to 4 m of coarse alluvium in the eastern parts of the palatial lower town. This depositional event may have coincided with a destruction phase in the archaeological record of Tiryns. To protect the lower town from future floods the inhabitants of Tiryns installed an artificial river diversion consisting of a 10-m-high dam and a 1.5-km-long canal.*

INTRODUCTION

In order better to understand ancient civilizations and their interrelation with the natural environment, field-oriented archaeologists are increasingly seeking support from natural scientists who are trained to employ physical methods to investigate past communities and their landscapes as a whole.[1] At the same time excavators are beginning to shift their attention away from the residences of the ruling classes to nonpalatial parts of settlements, such as lower towns and port installations.[2] The Argive Plain in the Peloponnese and the Late Bronze Age citadel of Tiryns are prime targets for such a regional investigation carried out jointly by archaeologists and natural scientists. Segregated from other fertile regions by mountains up to 1,700 m high that drop steeply to the coast on their Arcadian side, the plain is unusual among Greek valleys for its protected position, favorable orientation facing the Aegean, pleasant climate, and extensive arable soil. This valley has been a focal point of Greek culture during various times in the past, e.g., in the Early and Late Bronze Age, Geometric, Archaic, Classical, and Frankish periods; consequently, some of its ancient settlements rank among the best-known archaeological sites in Europe. Among them, Tiryns is especially suitable for a geoarchaeological investigation because of its location in a coastal plain consisting of recent, fine-grained, alluvial deposits. These sediments possess excellent preservational properties and contain buried ancient surfaces that record the evolution of the landscape.

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* This article is dedicated to the memory of Klaus Kilian, who initiated and kindly supported my research in the Argolid. I am indebted to Tjeerd van Andel, Ellik Adler, and Tina Niemi for their collaboration in the field. The cores were taken with the vigorous help of Stavros Zabetas and Theodoros Papakonstantinou. Eleni Paleologou and Christos Piteros of the Ephoria in Nauplion generously guided me through their excavations. Dimitris Bolis of the prison administration at Tiryns permitted the use of the drill truck on the prison ground. Ceramic fragments from the cores were dated by Klaus Kilian and Guntram Schönfeld. I am grateful to Rosemary Robertson, who produced the artwork for this article, except for figure 7, which was drawn by Roxana Portokali. Annie Jackson kindly edited my infelicitous prose. This paper benefited from the comments of the *AJA* anonymous reviewers and from those offered by John Bennet, Jack Davis, Elizabeth French, Jost Knauss, and Cynthia Shelmerdine. The Argive Plain Project and the Tiryns Project were funded by the Deutsches Archäologisches Institut (Berlin) and by private gifts to Stanford University.

The following special abbreviations are used:

Kilian 1978	K. Kilian, "Ausgrabungen in Tiryns 1976," *AA* 1978, 449–70.
Kilian 1983	K. Kilian, "Ausgrabungen in Tiryns 1981," *AA* 1983, 277–327.
Kilian 1988	K. Kilian, "Ausgrabungen in Tiryns 1982/83," *AA* 1988, 105–51.
Lehmann	H. Lehmann, *Argolis: Landeskunde der Ebene von Argos und ihrer Randgebiete* (Athens 1937).
Schliemann	H. Schliemann, *Mycenae* (New York 1878).
Zangger	E. Zangger, *The Geoarchaeology of the Argolid* (Berlin 1993).

[1] For some classic and more recent examples, see W.A. McDonald and G. Rapp eds., *The Minnesota Messenia Expedition* (Minneapolis 1972); G. Rapp, Jr., and J.A. Gifford eds., *Troy, the Archaeological Geology* (Supplementary monograph 4, Princeton 1982); T.H. van Andel and C. Runnels, *Beyond the Acropolis: A Rural Greek Past* (Stanford 1987); T.H. van Andel and S. Sutton, *Landscape and People of the Franchthi Region* (*Franchthi* 2, Bloomington 1987).

[2] E.g., J.C. Wright et al., "The Nemea Valley Archaeological Project—A Preliminary Report," *Hesperia* 59 (1990) 579–659.

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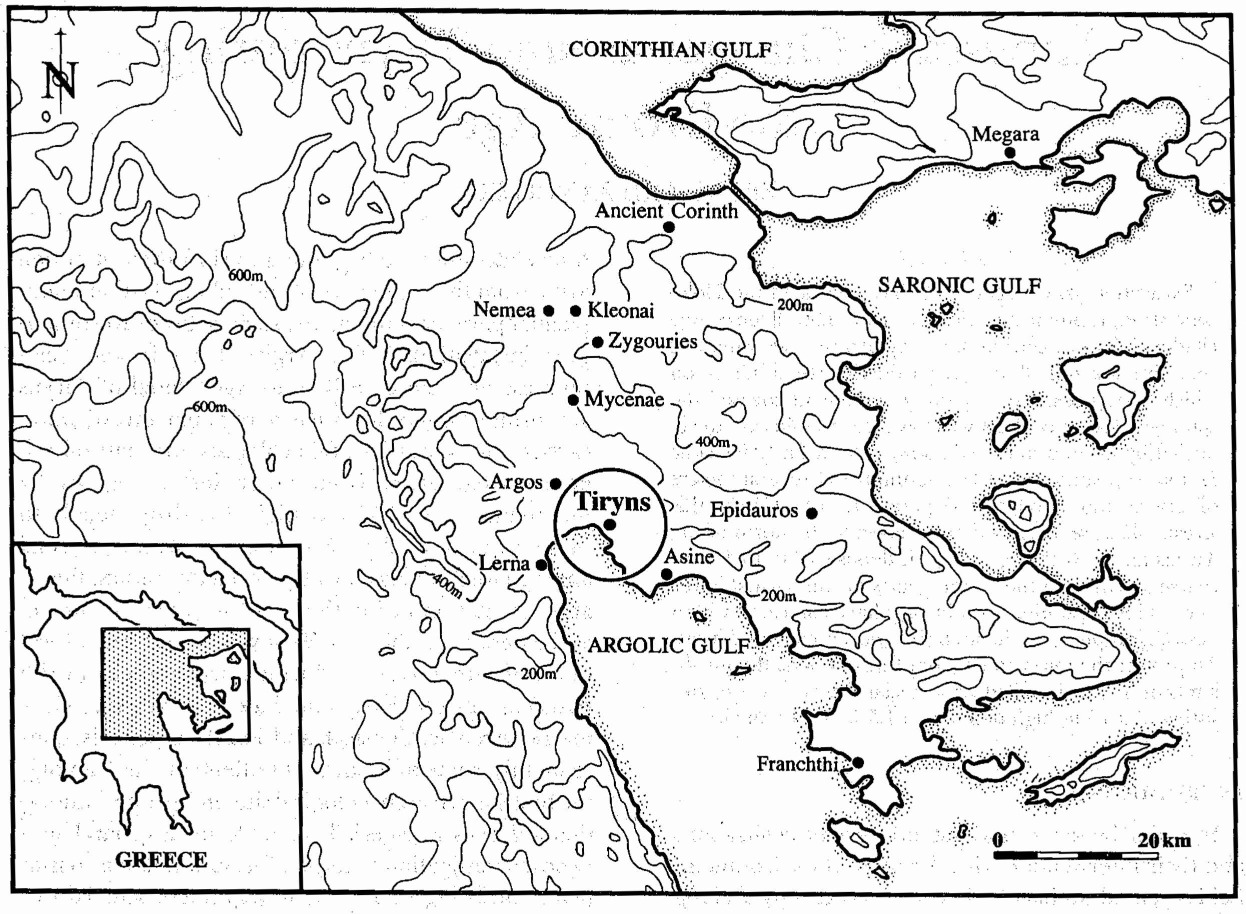

Fig. 1. Location of Tiryns in the Argive Plain. (R. Robertson)

In order to investigate the stratigraphy around Tiryns as well as the evolution of the landscape of the Argive Plain as a whole, I was invited by the Deutsches Archäologisches Institut to conduct a two-part geoarchaeological investigation of the Argolid: the first part (Argive Plain Project) was designed to reconstruct changes in landscape over the last 10,000 years and to determine the past setting of prominent archaeological sites such as Lerna, Mycenae, and Argos.[3] The second part (Tiryns Project) focused on the stratigraphy of the immediate surroundings of Bronze Age Tiryns. I also hoped to contribute to the discussion of possible environmental changes around 1200 B.C. that may or may not have had an impact on the demise of Mycenaean civilization.[4] The additional examination of the Holocene stratigraphy at Tiryns was intended to clarify three specific problems: the changing position of the coastline, the extent of the lower town, and the date and purpose of an artificial dam erected during the Late Bronze Age about 3.5 km east-northeast of Tiryns.

TIRYNS

The Late Bronze Age citadel of Tiryns is located in the shallowest part of the Argive Plain (fig. 1). It was erected on an isolated limestone knoll that lies 1.6 km from the coast and rises 26 masl (fig. 2). The citadel was placed near the fertile soils of the plain and the wide sandy beach, but was still protected and safely founded on its 300 × 55 m hillock.[5]

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[3] For the results of the Argive Plain Project, including geological descriptions of all cores and profiles, see Zangger.

[4] E.g., R. Carpenter, *Discontinuity in Greek Civilization* (Cambridge 1966), and H. Lamb's review of Carpenter in *Antiquity* 41 (1967) 233–34; R.A. Bryson et al., "Drought and the Decline of Mycenae," *Antiquity* 47 (1973) 46–50; H. Lamb, *Climate History and the Future* (Princeton 1977) 141; B. Weiss, "The Decline of the Late Bronze Age Civilization as a Possible Response to Climatic Change," *Climatic Change* 4 (1982) 173–98.

[5] The place name "Tiryns" appears first in the Catalogue of Ships in which Homer emphasized its great walls (*Il.* 2.559). Hesiod associated Tiryns with Herakles and cattle (*Th.* 292). Herodotos referred to Tiryns several times, mostly

Fig. 2. View from southeast of the LBA citadel of Tiryns on a 26-m-high limestone knoll in the coastal zone of the Argive Plain. The Cyclopean walls were partly reconstructed by the Greek Archaeological Service. The Larisa of Argos is in the background.

Travelers visiting the Argolid in the last century identified the site correctly and described the remains of the citadel in some detail half a century before the excavations by Heinrich Schliemann. Sir William Gell wrote extensively about the design of Tiryns and considered it the best specimen of military architecture of the heroic past.[6] He identified the ruins with the city mentioned by Homer and dated the site to the 14th century B.C. by reference to the Parian Marble. Gell also noticed that the general form of the citadel was that of a ship and that there still was a tower on the east side standing 43 ft high. A few years later Edward Dodwell complemented the description of the architecture.[7] Another visitor, J.A. Cramer, concluded that the massive fortifications still visible at Tiryns and Mycenae implied an advanced state of civilization or at least a considerable degree of opulence and power and observed that Mycenae and Orchomenos had been proverbially wealthy.[8] Hence, the notion of an advanced prehistoric society in the area existed long before Heinrich Schliemann worked there.[9]

in descriptions of struggles between Argives and Spartans (6.76, 6.77, 6.83, 7.137, 9.28, 9.31). On one occasion he remarked that Halieis in the southern Argolid was established as a Tirynthian colony (7.137). Roman authors including Virgil (*Aen.* 7.662–63) and Ovid (*Met.* 6.112, 7.410) knew of ancient Tiryns. Strabo claimed the Tirynthian walls were erected by workers from Lycia (Strab. 6.6.11, 8.6, 14.2.6). Elaborate descriptions of Tiryns in antiquity were produced by Pausanias (1.32.5, 2.16.2, 2.16.4, 2.17.5, 5.2.2, 5.23.2–3, 7.25.6, 8.14.2, 8.27.1, 8.33.3, 8.46.3, 9.11.1). He thought the impressive walls were built by the Cyclopes and compared them with the Seven Wonders of the World (9.36.3). For more ancient sources on Tiryns see: Hes. *Scut.* 81; Apollod. 2.4–5; Diod. Sic. 4.152; Eur. Frag. Tel. 1.; Pind. *Ol.* 7.49; Pliny *HN* 4.5, 7.56, 8.9.

[6] W. Gell, *Argolis* (London 1810) 54.

[7] E. Dodwell, *A Classical Topographical Tour through Greece* (London 1819) 250.

[8] J.A. Cramer, *A Geographical and Historical Description of Ancient Greece* (London 1828) 250.

[9] For further elaborate descriptions by early travelers, see T.S. Hughes, *Travels in Sicily, Greece and Albania* (London 1820) 205; W.M. Leake, *Travels in the Morea* (London 1830) 350; E. Curtius, *Peloponnes* (Gotha 1851) 384; W.G.M.A. Clark, *Peloponnese—Notes of Studies and Travel* (1858).

EXCAVATIONS

The first documented trial excavation at Tiryns was conducted in September 1831 by A.R. Rangabe and Friedrich Thiersch; the handwritten notes of the latter are now stored in the Bayerische Staatsbibliothek, Munich.[10] During a sight-seeing journey to Greece in 1868 Schliemann briefly visited Tiryns, but since this trip predated his decision to embark on a new career in archaeology the notes in his diary are less informative than those of the average early traveler.[11] In August 1876, toward the end of his campaigns at Mycenae (1874–1876), Schliemann conducted 24 trial excavations at Tiryns.[12] Finally, beginning in March 1884, he excavated for five months in the upper citadel.[13] By this time he and his assistant Wilhelm Dörpfeld had gathered considerable field experience at Hisarlık and Mycenae, and their work at Tiryns was far less destructive than it had been elsewhere, with more archaeological deposits left intact for future excavations. From 1905 to 1929 further excavations were carried out intermittently by the Deutsches Archäologisches Institut. The Cyclopean walls of the citadel were partly reconstructed by the Greek government in 1957–1960. Another major excavation campaign by the DAI began in 1967 and ended in 1986.[14]

The present archaeological site of Tiryns is commonly divided into three main units: the southern upper citadel (Oberburg, palace); the northern lower citadel (Unterburg); and the so-called lower town, i.e., the area outside the Cyclopean walls. Most of the excavations were targeted at the palace itself, though the recent campaigns were dedicated to the lower citadel. Relatively little work has been done in the lower town. The excavations have shown that Tiryns experienced its cultural peak during the Bronze Age. Although some Neolithic finds were made, the earliest building remains date to Early Helladic II. At that time a circular building 28 m in diameter—interpreted as a granary[15]—was raised on top of the limestone knoll, but later during the same period it was destroyed by fire. Stratified EH II and EH III layers are known from the lower citadel and from some places south of the acropolis.[16] During the Middle Helladic a prosperous settlement with several large buildings covered the upper and lower citadels and parts of the lower town, where stratified MH layers were found to be over 2 m thick. Middle Helladic foundations are known from trenches F and H just south and southeast of the limestone knoll (see below, fig. 5).[17]

Very little could be traced of the earliest noble residence at Tiryns (LH II, I. Burg); better known is the palace of the LH IIIA period (ca. 1425–1300 B.C.; II. Burg). The present foundations of the palace (III. Burg) date to around 1250 B.C. (LH IIIB), when the rulers of Tiryns experienced the peak of their political and presumably economic power. This final palace was erected concurrently with the last expansion of Mycenae. At the transition from LH IIIB to LH IIIC around 1200 B.C. both Tiryns and Mycenae were destroyed,[18] and many contemporary settlements in the vicinity were abandoned, e.g., the Argive Heraion, Midea, Berbati, and Katsingri.[19] Later in LH IIIC Tiryns experienced a phase of recovery, when the settlement was thoroughly redesigned and rebuilt.[20] Finally, Mycenaean civilization collapsed at the end of LH IIIC and Tiryns, like other sites in the Argolid, deteriorated quickly. A Geometric temple and cemetery are known from the area, but the site itself was sparsely inhabited until its final desertion in A.D. 468.

Numerous questions remain to be answered about the evolution of landscape in the Argive Plain in general during the Bronze Age, and around Tiryns in particular. There is no comprehensive explanation for the rise and fall of Mycenaean culture and little is known about Tiryns' role in this process, although a century of excavation has provided an immense amount of piecemeal data. The precise position of the LBA coastline at Tiryns has never been determined,

[10] F. Thiersch, *Thiersch's Leben* (Leipzig 1866) 63.

[11] H. Schliemann, *Ithaka, der Peloponnes und Troja* (Leipzig 1869, repr. Darmstadt 1963) 106.

[12] Schliemann 9.

[13] H. Schliemann, *Tiryns, the Prehistoric Palace of the Kings of Tiryns* (London 1885).

[14] Kilian 1978, 1983, and 1988. See also K. Kilian, "Ausgrabungen in Tiryns 1977," *AA* 1979, 380–411; "Ausgrabungen in Tiryns 1978, 1979," *AA* 1981, 149–93; "Ausgrabungen in Tiryns 1980," *AA* 1982, 407–29; "Zum Ende der mykenischen Epoche in der Argolis," *JRGZM* 27 (1982) 166–95; and Kilian, "Mycenaeans Up to Date: Trends and Changes in Recent Research," in E.B. French and K.A. Wardle eds., *Problems in Greek Prehistory* (Bristol 1988) 115–52.

[15] K. Kilian, "The Circular Building at Tiryns," in R. Hägg and D. Konsola eds., *Early Helladic Architecture and Urbanization* (*SIMA* 76, Göteborg 1986) 65.

[16] U. Jantzen ed., *Führer durch Tiryns* (Athens 1975) 83; N. Verdelis, "Neue Geometrische Gräber in Tiryns," *AM* 78 (1963) 1–213.

[17] P. Gercke and G. Hiesel, "Grabungen in der Unterstadt von Tiryns von 1889 bis 1929," *Tiryns* V (Mainz 1971).

[18] Kilian 1988, 150.

[19] Kilian 1983.

[20] Kilian 1988, 150.

Fig. 3. View from the palace of Tiryns to the west, showing the coast of the Gulf of Argos ca. 1.6 km in the distance and the completely flat plain between Tiryns and today's coast. Photograph taken in conjunction with the excavations of the palace in 1910. (Courtesy Deutsches Archäologisches Institut, Athens, neg. TIRYNS 248)

although it has commonly been assumed that the coast used to be much nearer to the site (fig. 3). The results of the most recent excavations have suggested that Tiryns was damaged by one or several earthquakes, but the evidence for these earthquakes as well as their significance is disputable. Moreover, the size of the lower town has never been established; only a working hypothesis was introduced on the basis of trial trenches dug early in this century. According to this hypothesis Tiryns was once a port city right on the sea whose lower town grew in size from LH IIIB to LH IIIC.[21] Finally, there is a conspicuous artificial dam at Nea Tiryns 3.5 km east-northeast of the archaeological site, whose precise date and function have never been established.

ARGIVE PLAIN PROJECT

In order to shed more light on these problems a geoarchaeological investigation of the Argive Plain was conducted from 1984 to 1988, accompanied and succeeded by comparable studies in adjacent areas, such as Asine,[22] Berbati,[23] and Nemea.[24] One main objective of the Argive Plain Project was to determine the late Pleistocene and Holocene subsurface stratigraphy from drill holes, auger cores, and outcrops. Using aerial photographs, Landsat images, small-scale topographic maps, soil and sediment descriptions, and microfossil populations, it was possible to determine the quality of ancient soils, eustatic and tectonic changes, and the coastline development.[25]

[21] K. Kilian, "Neue historische Aspekte des Spätmykenischen. Ergebnisse der Grabungen in Tiryns," *Jahrbuch der Heidelberger Akademie der Wissenschaften* 1981, 82.

[22] E. Zangger, "The Island of Asine: A Palaeogeographic Reconstruction," *OpAth*, in press.

[23] E. Zangger, "Neolithic to Present Soil Erosion in Greece," in M. Bell and J. Boardman eds., *Past and Present Soil Erosion* (Oxford 1993) 133–47.

[24] Wright et al. (supra n. 2); J. Cherry et al., "Archaeological Survey in an Artifact-Rich Landscape: A Middle Neolithic Example from Nemea, Greece," *AJA* 92 (1988) 159–76.

[25] For preliminary reports see E. Zangger and H. Malz, "Late Pleistocene, Holocene and Recent Ostracodes from the Gulf of Argos," *Courier Forschungsinstitut Senckenberg* 113 (1989) 159–75; Zangger, "Tiryns Unterstadt," in E. Pernicka and G. Wagner eds., *Archaeometry '90* (Basel 1991) 831–40; T.H. van Andel, E. Zangger, and A. Demitrack, "Land Use and Soil Erosion in Prehistoric and Historic Greece," *JFA* 17 (1990) 379–96; Zangger, "Prehistoric and Historic Soils in Greece: Assessing the Natural Resources for Agriculture," in B. Wells ed., *Agriculture in Ancient Greece* (*SkrAth* 4, 42, Göteborg 1992) 13–19.

During the glacial maximum, 18,000 years ago, when the sea was 100–120 m below its present level, the coastline of the Argive Plain lay southwest of Tolon, i.e., 10 km south of its current position.[26] The landscape appears to have been in equilibrium as is indicated by a stable soil surface consisting of a well-consolidated red bed in the coastal plain; only limited deposition occurred along the shelf.[27] The eustatic sea level rise that commenced at the end of the latest ice age shifted the coastline to a maximum position 1.5 km inland from the present shore on the eastern side of the plain and 4.7 km on the western side. In this latter area a beach barrier isolated an extensive freshwater lagoon from the open sea. The transgression culminated ca. 2500 B.C. At about the same time a major phase of landscape instability resulted in the deposition of several meters of alluvium in the coastal plain thereby causing an early regression of the shoreline. Since the end of the Early Bronze Age the central and northern Argive Plain has essentially remained unchanged. The coastal zone, however, has experienced almost continuous changes. There was a phase of increased marshiness in post-Hellenistic times and occasionally Hellenistic houses have been found buried up to 1 m deep. The earliest artifacts found in cores taken in the alluvium of the plain date to the Neolithic.[28] The distribution of pottery and architectural remains across the coastal plain varies considerably. Some Neolithic sites in the floodplain are buried several meters below the present surface.[29] Throughout the plain as a whole EH II pottery fragments and building remains are most common; diagnostic LBA pottery was limited to the vicinity of the Mycenaean sites. Classical and Hellenistic pottery occurs especially around Argos, although simple Hellenistic buildings are also common in isolated places.

These results demonstrate that the Argive Plain's rich arable land was available in the Middle and Late Bronze Age,[30] a suggestion made earlier by Herbert Lehmann, who realized that the importance of the Argive Plain during the Late Bronze Age rested not only on its location, but also on the presence of much arable land.[31] Schliemann too emphasized that the plain of Argos was famed for its breed of horses in ancient times,[32] noting that Homer alluded to this fact seven times in the *Iliad*. J.M. Balcer concluded that "no one has ever denied the agricultural prosperity of the Argolid plain . . . during the fourteenth and thirteenth centuries B.C."[33]

SHORELINE

> Doubtless the sea-waves once washed the rocks of Tiryns, but this was probably at a time when our planet was not yet the home of man.[34]
>
> —H. Schliemann

The former position of the coastline at Tiryns appears to have intrigued scholars for a long time. In 1832 the Expédition scientifique de Morée used a coring method to demonstrate that marine sediments are buried below the present floodplain deposits.[35] A similar approach was followed by Kraft and his colleagues, who placed four power holes along a traverse between Tiryns and the sea and found buried marine deposits 1 km landward of the present shore.[36] Due to the flatness of the coastal plain (fig. 3) most scholars assumed the prehistoric coastline to have been landward of the present one.[37] During the latest excavation

[26] T.H. van Andel, E. Zangger, and C. Perissoratis, "Transgressive/Regressive Cycles in the Gulf of Argos, Greece," *Quaternary Research* 34 (1990) 317–29.

[27] van Andel et al. (supra n. 26).

[28] Kefalari Cave, however, was inhabited since the late Middle Palaeolithic: see L. Reisch, *Pleistozän und Urgeschichte der Peloponnes* (Habilitationsschrift, Erlangen 1980); and summary in C. Perlès, *Les industries lithiques taillées de Franchthi (Argolide, Grèce)* I: *Présentation générale et industries paléolithiques* (*Franchthi* 3, Bloomington 1987) 204.

[29] T.H. van Andel and E. Zangger, "Landscape Stability and Destabilisation in the Prehistory of Greece," in S. Bottema, G. Entjes-Nieborg, and W. van Zeist eds., *Man's Role in the Shaping of the Eastern Mediterranean Landscape* (Rotterdam 1990) 139–57.

[30] Contra J. Bintliff, *Natural Environment and Human Settlement in Prehistoric Greece* (*BAR* Suppl. 28, 1977) 336.

[31] Lehmann 112.

[32] Schliemann (supra n. 13) 14.

[33] J.M. Balcer, "The Mycenaean Dam at Tiryns," *AJA* 78 (1974) 145.

[34] Schliemann (supra n. 13) 29.

[35] E.P. Boblaye and T. Virlet, *Expédition scientifique de Morée* (Paris 1883).

[36] J.C. Kraft, S.E. Aschenbrenner, and G. Rapp, "Paleogeographic Reconstructions of Coastal Aegean Archaeological Sites," *Science* 195 (1977) 941–47.

[37] Schliemann (supra n. 13) 11: "The plain of Argos was apparently in early prehistoric times a bay running far inland; this was gradually filled up by the deposit of the numerous streams descending from the surrounding hills, which, though now bare and barren, were then covered with forest." See also Gell (supra n. 6) 54; A. Philippson, *Die griechischen Landschaften* (Frankfurt 1892) 61; O. Maull, *Beiträge zur Morphologie des Peloponnes und des südlichen Mittelgriechenlands* (Leipzig 1921) 64; H. Lehmann, "Zur Kulturgeographie der Ebene von Argos," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (1931) 42; J.C. Kraft, *A Reconnaissance of the Geology of the Sandy Coastal Areas of Eastern Greece and the Peloponnese* (Newark 1972) 113; Bintliff (supra n. 30) 339.

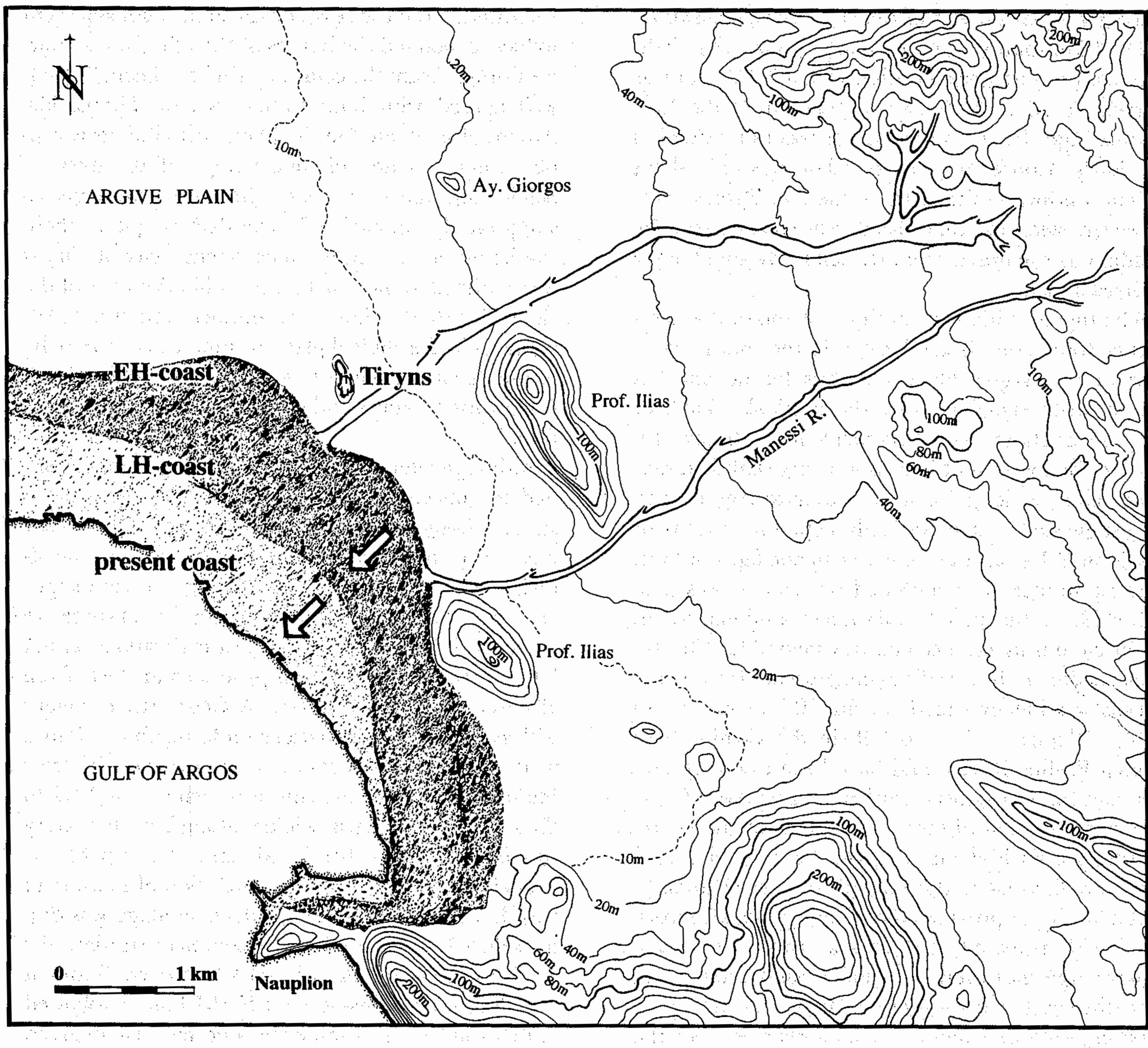

Fig. 4. Coastline changes in the eastern part of the Argive Plain. (R. Robertson)

campaigns at Tiryns Kilian inspected a construction trench 200 m north of the Tiryns citadel that contained dark subaqueous sediments, Hellenistic graves, and modern pottery.[38] He interpreted the sequence as an indication of a Late Bronze Age coast near the citadel and subsequently used this hypothesis as a basis for the reconstruction of the settlement at Tiryns.[39] Consequently, Kilian assumed Tiryns to have been a harbor town right on the coast whose port would have been about 200 m west of the acropolis.[40]

The stratigraphy found in cores taken during the Argive Plain Project showed that the coastline used to be further inland during the Bronze Age (fig. 4) and substantiated the conclusions presented by Kraft, Aschenbrenner, and Rapp in 1977.[41] Around 2500 B.C., during the maximum transgression, the sea stretched up to 1,500 m landward of its current position. It eroded the western parts of the small Profitis Ilias hill north of Nauplion and extended from there north along a steep sickle-shaped beach that was as close as 300 m to the site of Tiryns. From there the shore continued westward to the mouth of the Inakhos stream. Still during the Early Bronze Age a phase of landscape instability resulted in the deposition of extensive alluvia, especially in those areas of the coastal plain where streams exited into the sea. Two rivers south of Tiryns deposited sufficient sediment to force a rapid regression of the

[38] Kilian 1978, 468.
[39] For coastline, see Kilian 1978, 469; Kilian 1983, 172.
[40] Kilian 1983, 171.
[41] Kraft et al. (supra n. 36).

coast (fig. 4). By the end of EH II the coast had shifted about 1 km southwest of Tiryns, i.e., more than halfway between its peak position at 2500 B.C. and its current location. It remained there until the Late Bronze Age. Hence, when Tiryns was first settled in the Early Bronze Age, the coastline was only about 300 m southwest of the site. In the Late Bronze Age, however, when the final palace was constructed, the citadel was separated from the shore by about 1 km of coastal plain.

The topographic map in figure 4 shows that altogether four mounds are located in the southeastern part of the Argive Plain and thus far no one has satisfactorily explained why the particular knoll of Tiryns was chosen as a settlement site. Lehmann regarded the location of Tiryns as being slightly disadvantageous, at least for a Late Bronze Age citadel, and suggested that it was only kept for reasons of tradition.[42] His argument is unconvincing, however, because numerous abandoned settlement sites provide evidence that people will vacate traditional homes when circumstances become less favorable. The reconstruction of the coastline changes would argue that Tiryns was ideally suited for an EBA as well as an LBA settlement. The two hills in the vicinity, both named Profitis Ilias, would have been too steep and too high for an extensive settlement and Ayios Georgios was, at 3 km distance, too far from the shore. During the Early Bronze Age in the Argolid coastal sites were favored, as the example of Lerna shows. At that time Tiryns provided the advantages of a bedrock knoll with proximity to the sea. During the Late Bronze Age, however, the citadel was located 1 km from the coast, which may have been an advantage in avoiding surprise attacks. The floodplain between the city and the sea was probably useful for beaching boats and presumably served to separate the elite of the palace from the fishermen.

THE LOST SUBURB

The first speculations about the location of the lower town that must have belonged to the citadel at Tiryns date to the times of the early travelers. Gell argued quite convincingly that "the city of course surrounded the fortress, for the area is not sufficient to have contained the houses of the inhabitants, however insignificant the colony might have been."[43] Dodwell agreed with him: "The town of Tiryns, like Athens, was situated in the plain encircling its acropolis. Time has not left one vestige of the town."[44] Schliemann, however, made the same erroneous assumption that he had at Troy,[45] declaring that "there can be no doubt that the most ancient city of Tiryns was confined to the small space within the walls of the citadel."[46] He did, however, conduct some trial investigations in the alluvial plain around Tiryns where he found "Hellenic pottery" at the surface and painted prehistoric ceramics and obsidian tools in the subsurface.[47]

Although later archaeological investigations continued to concentrate on the citadel, the idea that a suburb should have existed somewhere in the vicinity was never abandoned. Several excavations in the alluvial plain were conducted during the campaigns between 1907 and 1929 though very few of these are recorded in detail (fig. 5).[48] Most excavations within 50 m of the Cyclopean wall produced artifacts from all three Bronze Age phases. A Geometric cemetery with no Late Helladic pottery underneath was found in trenches A and B south of the citadel. The later phases of LH were missing in trenches F and G1 to the southeast of Tiryns, while nothing but LH pottery was found in trenches L, M, and N north of the citadel. In 1929, toward the conclusion of more than two decades of excavation, a deep sondage was dug in trench F to determine the complete stratigraphy down to bedrock.[49] An LH IIIA house was found at 1 m depth; two consecutive LH I/II houses followed at 1.6 m and 2.1 m; Middle Helladic material occurred below 2.5 m; EH II and EH III levels were separated by a burnt layer at 4.2 m. Further down the soil turned more reddish and contained only Neolithic pottery. The bedrock base was reached at a depth of 7 m. Georg Karo reports from another excavation to the north of the citadel where he found what is now interpreted as LH IIIC pottery at the surface and "basically nothing" below to a depth of 3 m.[50] These unsystematic investigations led to the belief that the

[42] Lehmann 69.

[43] Gell (supra n. 6) 54.

[44] Dodwell (supra n. 7) 249.

[45] H. Schliemann, *Trojanische Alterthümer* (Leipzig 1874, repr. Munich 1990) 5.

[46] Schliemann 15.

[47] Schliemann 15.

[48] Gercke and Hiesel (supra n. 17) restudied some of the material from the pre-war excavations and suggested LH IIIC dates. I am grateful to Elizabeth French for pointing out that the LH IIIC phase, except for the Granary Class, was not known before the 1960s. Tiryns was thought to be unoccupied after LH IIIB until the Syringes were cleared.

[49] See Gercke and Hiesel (supra n. 17).

[50] G. Karo, "Archäologische Funde," *AA* 1930, 111: "Nach Norden ergab sich bis zu einer Tiefe von gegen 3 m unter der modernen Oberfläche so gut wie gar nichts."

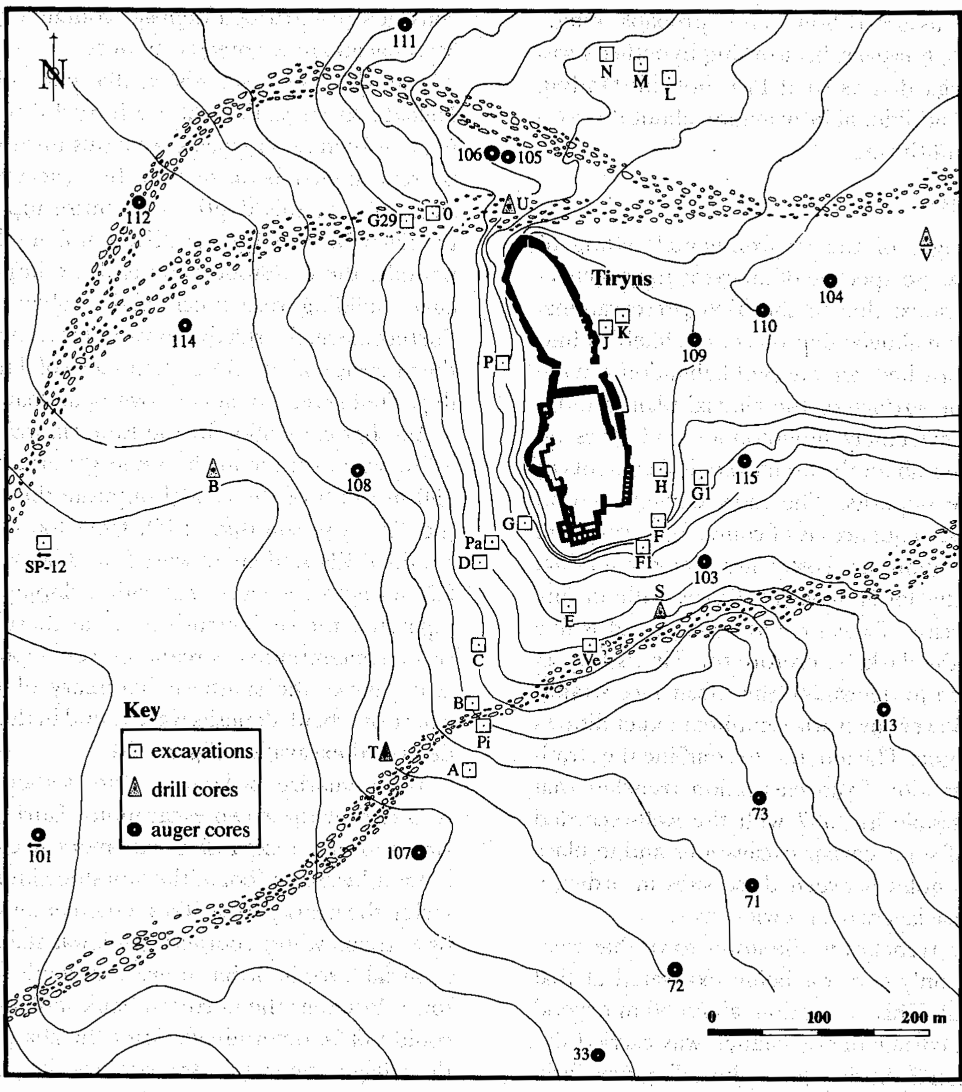

Fig. 5. Field area of the Tiryns Project showing the locations of excavations, auger cores, and drill holes in the lower town. Positions of the streams south of Tiryns (Neolithic–LH IIIB2) and north of Tiryns (LH IIIB2/LH IIIC) are only schematically indicated. (R. Robertson)

excavational record of the lower town at Tiryns is fragmentary and confusing.[51] Jantzen concluded that the whole settlement stretched over an area of 20,000 m^2,[52] but that neither the Early Helladic[53] nor the Middle and early Late Helladic[54] lower town was sufficiently well known, although they must have existed judging by the large amount of pottery from these periods found on the citadel. LH IIIC building remains, however, were frequently found within the uppermost meter of the floodplain. In summarizing the erratic information of the earlier trial excavations in the lower town,[55] Kilian concluded that the suburb reached its maximum size (24.5 ha) during the LH IIIC period.[56] Since there was much less evidence for an extensive LH IIIB town, he assumed the settlement to have been considerably smaller during the palatial period. When Kilian introduced this idea of a relatively small LH IIIB city and a much more extensive LH IIIC city in his first preliminary report, he cautiously qualified the suggested extent of the cities with

[51] E.g., Jantzen (supra n. 16) 6, 10, 59; Gercke and Hiesel (supra n. 17); Balcer (supra n. 33) 142.
[52] Jantzen (supra n. 16) 10.
[53] Jantzen (supra n. 16) 83.
[54] Jantzen (supra n. 16) 6.
[55] Kilian 1978, 468.
[56] Kilian 1983, 171.

terms such as "assumed limit" and "probable limit." In future years, however, his working hypothesis was increasingly regarded as solid fact, notwithstanding the lack of any additional information about the stratigraphy around the citadel.

STRATIGRAPHY

The advantages of the environmental setting of Tiryns from the perspective of an excavating archaeologist are obvious: due to the high preservational properties of the alluvial deposits one is likely to find relatively undisturbed sequences of habitation. On the other hand, the surface of the alluvial plain around the citadel is extremely monotonous and gives no hints whatsoever about the archaeological contents of the subsurface deposits. The most obvious way to determine these sequences is of course by excavation, but since excavations are costly and time-consuming, digging into the lower town at Tiryns without any notion or forecast of what could be expected is like shooting into the dark. Therefore the Tiryns Project was undertaken to determine the subsurface stratigraphy of the lower town with minimal expenditures of funds and time. The aim was to combine the stratigraphic information from excavation trenches that were still accessible in 1987 with the well-recorded stratigraphy of some earlier excavations and to place auger or drill holes between these sites in order to trace subsurface layers over a wide area.

Of the three trenches in the lower town that were open in 1987 only one was being excavated at that time (fig. 5: Pa). This excavation, about 50 m beyond the southwest corner of the citadel, was carried out by the Nauplion Ephoria prior to installing new facilities for visitors to Tiryns. Since the excavator continued this trench as long as pottery fragments occurred in otherwise perfectly natural deposits, we now possess an excellent record of the geological and archaeological stratigraphy of the lower town. At the bottom of this trench an EH II site was found at 5.45–6.00 m, resting on the surface of a red Pleistocene paleosol at 6.0–6.8 m. The upper surface of this site consisted of a soil A horizon (at 5.20–5.45 m) reflecting strong human activity. From 3.95–5.20 m natural alluvial deposits were found interspersed with EBA pottery fragments. Undisturbed, interlayered stream and floodplain deposits followed higher up in the stratigraphy between 2.80 and 3.95 m. The upper 2.8 m consisted of disturbed deposits containing abundant Mycenaean and Geometric pottery.

The whole sequence shows that parts of the Early Helladic lower settlement are buried 6 m below the present surface. How extensive this town was cannot be determined because very few excavations were conducted to this depth. The entire topography in the Early Bronze Age was different from that of later periods: the limestone knoll and the impressive circular building rose much higher above the plain. Furthermore, the stratigraphy in this trench indicates the presence of an EBA stream south of Tiryns, which deposited several meters of overbank loam.

Another excavation by the Ephoria was conducted a few years earlier in the same general area, about 150 m south of the citadel opposite the entrance to the Tiryns prison (fig. 5: Pi). Here too remains of a stratified EH settlement were found between 0.7 and 2.5 m depths. A levee wall with a sloping outer side separated the settlement on its northern perimeter from contemporary stream gravel deposits.[57] The levee marks the southern boundary of the stream whose overbank deposits were found in the previously described excavation (fig. 5: Pa).

To summarize the landscape and settlement history recorded by these two excavations: During the Early Bronze Age an expansive settlement stretched along the southwestern foot of the limestone knoll at Tiryns facing the nearby coast. This settlement was traversed by a stream whose southern bank was stabilized by an artificial levee in order to prevent floods in the lower town. Whether the northern bank was contained too could not be determined. After the abandonment of the village, the stream transgressed its previous bed and in some areas deposited several meters of overbank loam on top of the EBA settlement remains.

The third excavation still accessible in 1987 was a trench northwest of the citadel (fig. 5: G29), dug by Kilian in March and April of 1976.[58] Here, three building horizons from an early phase of LH IIIC were found directly under the turf.[59] Below these buildings were up to 1.8 m of undisturbed sand and gravel deposits interspersed with LH IIIB pottery. At one place within the excavation a Late Geometric well was followed to a depth of 6.5 m. In 1987 this trench was still exposed to a depth of 4.35 m. The lowest unit of the stratigraphic sequence was a Pleistocene paleosol at 3.25–4.35 m with two consecutive A ho-

[57] D.N. Konsola, Η πρώιμη αστικοποιήση στους πρωτοελλαδικούς οικισμούς (Athens 1984) fig. 28.

[58] Kilian 1978.

[59] All dates based on ceramics were provided by K. Kilian and his coworkers.

rizons containing Neolithic pottery at its former surface. The next unit consisted of alluvium at 2.80–3.25 m, again with an A horizon at its top, this time containing LH IIIB1 sherds (2.65–2.80 m). Kilian reported architectural remains at this level that were exposed in a construction trench just outside his excavation (personal communication). Another thinner alluvial unit followed in the stratigraphy at 2.25–2.65 m, again containing LH IIIB1 sherds. The uppermost part of the sequence consisted of gravel/sand deposits and the foundations of the early LH IIIC buildings. Poor sorting and rounding as well as cross bedding point to a deposition of the gravel and sand by moving water. The whole sequence indicates the presence of a Late Helladic stream north of the citadel. Either the river that once ran south of Tiryns had shifted north during the Late Bronze Age or two streams were active at the same time. The deposition of sand and gravel layers 1.8 m thick at the transition between LH IIIB and LH IIIC also points to some sort of rapid landscape change.[60]

In addition to these accessible trenches, a number of earlier excavations in the lower town provided some information on the stratigraphy, despite the lack of stratigraphic profiles for these trenches. Between 1907 and 1909 trenches A, B, C, D, J, K, L, M, N, and P were excavated in the lower town. The little stratigraphic information that survived from these trenches was collected by Gercke and Hiesel.[61] A large Geometric necropolis was found in A and B but no LH strata were detected below it. Trenches C, D, K, and P, on the other hand, contained Early, Middle, and Late Helladic strata. Trenches J, L, M, N, and O (the last dug in 1916) revealed LBA walls immediately below the surface but no EH or MH remains.

From 1926 to 1929 trenches E, F, F1, G, G1, and H were dug in the lower town. All Bronze Age periods were represented in E, including LH IIIC walls. G1 only contained LH IIIC architectural remains. The location of trench G, excavated in 1926, is only approximately known, but LH IIIC walls were found there too. Trench H revealed LH IIIC buildings just below the surface outside the citadel. In 1929 a deep sondage was dug in trench F to determine the entire sequence down to bedrock at a depth of 7 m. The lowest 2 m consisted of the red bed that seems to have contained Neolithic pottery near its surface. As in trench Pa, EH material was found on top of the red soil. Middle Bronze Age deposits continued from there to 2.5 m below the surface, where a burnt horizon separated it from LH I/II houses at 1.6 m and 2.1 m depths. The uppermost unit contained an LH IIIA house.

In 1957, Nikolas Verdelis conducted an emergency excavation about 150 m south of the citadel (fig. 5: Ve).[62] The lowest unit in his trenches was at 2.8–4.8 m and consisted of coarse sand and stream gravel deposits. EH remains including a wall were discovered at 2.4–2.8 m. MH pottery occurred between 2.0 and 2.4 m followed by stratified LH material at 1.3–2.0 m. The uppermost unit was evidently disturbed. Verdelis assumed that the coarse sand in his excavation provided the dry land that enabled the first habitation in the lower town of Tiryns. Balcer, however, suggested that the sand was the result of the bleaching of alluvial deposits and their reworking by sea water.[63] Bintliff argues that the same flood horizons ("Überschwemmungshorizonte") are rather recent and that they disturb prehistoric layers.[64] Knowing the stratigraphy, however, one can attribute this sand to the same stream whose deposits are exposed in trenches Pa and Pi. The main conclusions to be drawn after the trial and emergency excavations in the lower town are that 1) much LH IIIC material, including architectural structures, can be found in a wide area within 1 m below the surface; and 2) remains of all Bronze Age periods occur at various places, but there does not seem to be a simple stratigraphic pattern.

AUGER CORES

To complement the rather erratic information from these excavations in the lower town a sequence of auger cores (101–114) was taken in 1987 that allowed the stratigraphy between the archaeological trenches to be traced (table 1). Since the Holocene sediments often turned out to be too consolidated or too coarse to be penetrated with a hand-coring device, an engine-driven bailer rig was used five times (B, S, T, U, V) to enter the ground at crucial places. The cores provided sufficient information to determine the stratigraphy on all sides of the citadel and to develop a comprehensive reconstruction of the environmental history of the lower town at Tiryns.

The excavations and the coring conducted during the Argive Plain Project provided several important facts for the reconstruction of the landscape history

[60] Kilian 1978, 450.

[61] Gercke and Hiesel (supra n. 17).

[62] This trench was opened during construction work at the Tiryns prison, Verdelis (supra n. 16).

[63] Balcer (supra n. 33) 146.

[64] Bintliff (supra n. 30) 281.

Table 1. Tiryns Excavation Coordinates for Auger Cores, Drill Holes, and Archaeological Trenches in the Lower Town

Core/Trench	Coordinates
103	LXXI 75
105	LXXI 29
106	LXX 28
107	XXXVI 80
108	XLV 49
109	LXXIV 49
110	LXXX 48
111	LX 12
112	XXXIII 21/22
S	LXXIII 64
T	XXXVI 74
U	LXIII 30
G29	LIV 30
Pa	LI/LII 59/60
Ve	LVI 72
Pi	XLIV 77

at Tiryns: 1) during the last 20,000 years the sea never extended into the field area shown in figure 5; 2) closest to the sea was core 33, which marked the beach during parts of the Early Bronze Age; 3) the LBA coast was about 1 km southwest of Tiryns; 4) a stream used to run south of the citadel at least during the Early Bronze Age; and 5) a stream passed north of the citadel at least temporarily at the transition from LH IIIB to LH IIIC.

Determining the development of the stream at Tiryns was one of the primary aims of the coring campaign. The area south of the citadel, however, is virtually impossible to auger due to gravel deposits in the subsurface. Aerial photographs show how the gravel forms a large alluvial cone that is also recognizable in the contour pattern (fig. 5). One of the hand auger cores (107) terminated at a depth of 1.5 m in the gravel, which appeared to be well sorted with pebble sizes of about 5 cm. A drill hole (T) near the old Tiryns railway station penetrated 2.5 m of overbank loam and sand at the surface, reached the gravel layer between 2.5 and 5.5 m, and the Pleistocene substrate at 5.5–7.0 m. Auger core 103 produced an unclear stratigraphy of several disturbed soils with LH IIIB pottery. The Pleistocene base was reached at 4.5–5.0 m. The stratigraphy of these cores and the information from excavations south of the citadel are aligned in a block diagram (fig. 6) to demonstrate how the stream gravel deposits and the EBA site excavated in trench Pa rest directly on the Pleistocene base. The sediment accumulation southwest of the citadel must have occurred after the habitation of the EH II site in Pa but before the end of the Early Bronze Age. The stream appears to have used the bed south of Tiryns from the Neolithic to the Late Bronze Age,

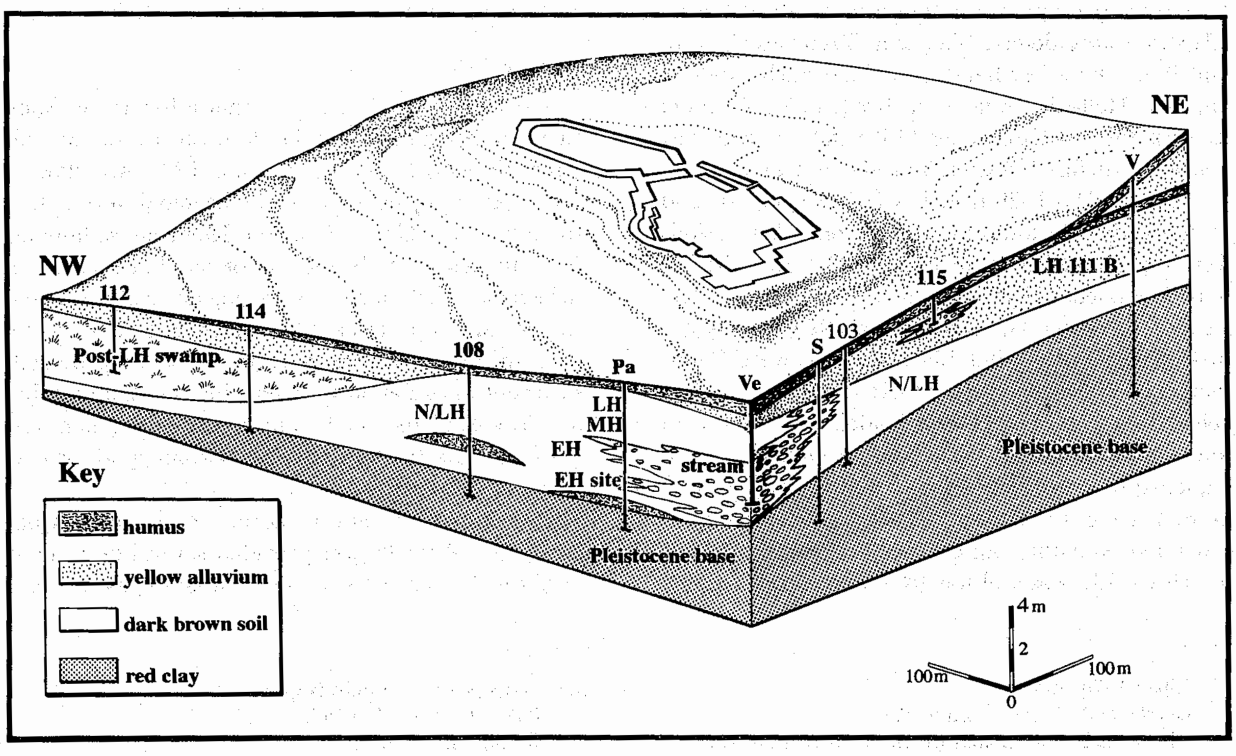

Fig. 6. Block diagram showing the Holocene stratigraphy west and south of Tiryns. (R. Robertson)

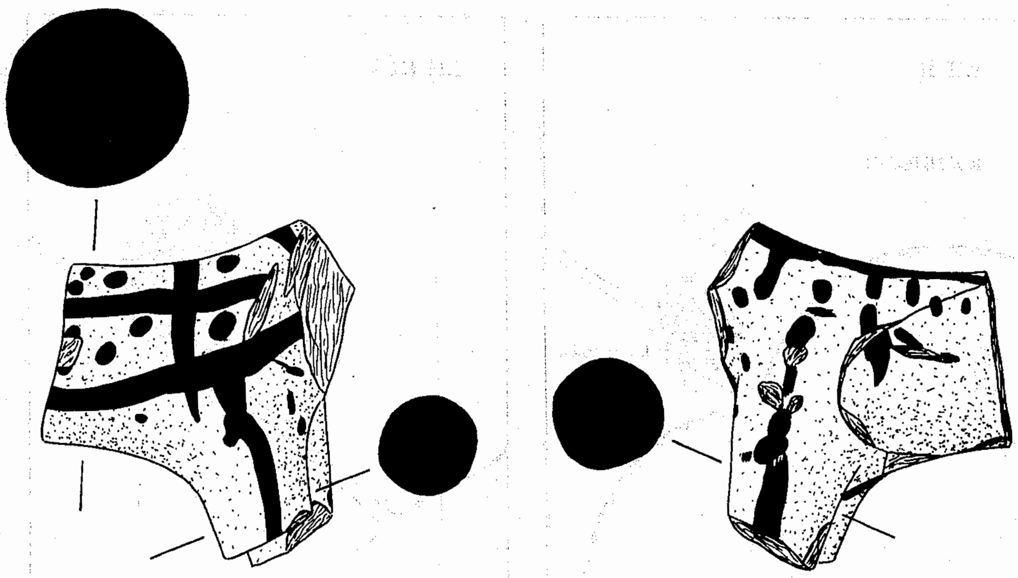

Fig. 7. Mycenaean animal figurine found in auger core 104 at a depth of 1.9 m. (R. Portokali)

but most of the sediment in this area accumulated during or shortly after EH II. Such a phase of soil instability late in EH was already detected in the Argive Plain and elsewhere in the Argolid.[65] Despite the threat of torrential floods, habitation southwest of the Tiryns knoll persisted throughout most of the Early Bronze Age, although thick and undisturbed stream and floodplain deposits below 2.8 m in trench Pa show that habitation was restricted spatially by the inundations during EH II, for either part or all of the period.

North of the citadel, trial trenches L, M, N, and O had produced LH IIIC houses just under the turf. The excavation in Tiryns NW (G29) showed that these buildings were partly placed on top of a 1.8 m stream gravel deposit. The existence of these deposits—dating to a relatively short period between LH IIIB and LH IIIC—argues strongly for landscape instability, while the presence of LH IIIC houses in the former streambed indicates almost total landscape stability very shortly after the deposition of the gravel.

To the north of the Tiryns citadel, only core 106 penetrated the entire Holocene sequence and reached the Pleistocene base at a depth of 6.4–7.3 m. On top of the red bed a post-Pleistocene soil, including its preserved A horizon, was found. The floodplain deposits between 1.9 and 5.1 m can be correlated with the sand and gravel deposits in G29. The uppermost 1.9 m in core 106 consisted of a disturbed topsoil containing much Mycenaean pottery, which may represent some of the dump from Schliemann's excavations. The same disturbed material was found in the upper 2.5 m of drill hole U just 20 m beyond the northernmost tip of the limestone knoll. More stream gravel deposits occurred between 2.8 and 5.0 m, where the limestone bedrock was struck. Combining the stratigraphic information from the area north of the citadel provides more evidence for the existence of an active stream before LH IIIC, which stands in sharp contrast to the almost total lack of deposition thereafter.

East of the citadel, coarse and poorly sorted alluvium prevented auger cores 109 and 110 from reaching a significant depth. Only core 104 penetrated the entire Holocene sequence and hit the Pleistocene red bed at 6.8 m. The glacial paleosol was found to be covered by a 1-m-thick early Holocene soil (4.9–5.9 m) and stratified layers with abundant EH and LH III pottery (4.2–4.9 m). The next unit (0.3–4.2 m) consisted of an unstratified, homogeneous, coarse alluvium with abundant Bronze Age pottery fragments including a Mycenaean animal figurine at 1.9 m depth (fig. 7). The figurine was dated to "LH IIIB2/C early" by Kilian and "LH IIIC early or middle" by E. French. The lack of stratification and the large amount of pottery from one archaeological period (LH IIIB/C) argue in favor of a deposition during a short period, possibly even in one single event. Considering the

[65] Zangger (supra n. 23); Zangger 1992 (supra n. 25); K.O. Pope and T.H. van Andel, "Late Quaternary Alluviations and Soil Formation in the Southern Argolid: Its History, Causes, and Archaeological Implications," *JAS* 11 (1984) 281–306.

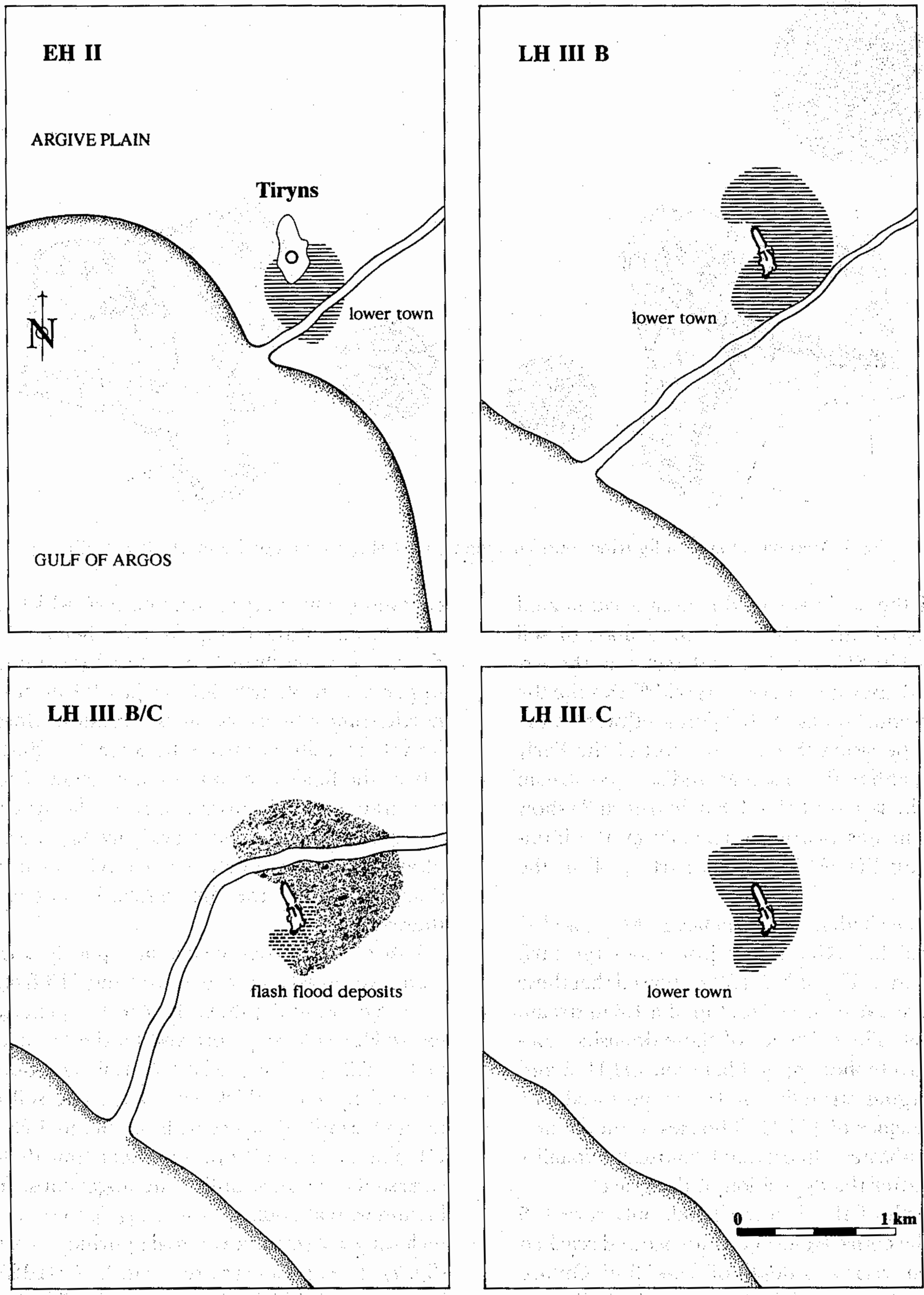

Fig. 8. Hypothetical reconstruction of the development of the lower town at Tiryns and its relation to the coastline and stream development. (R. Robertson)

geological and archaeological evidence, the alluvium should have formed within a period of no more than a century, although providing an absolute date is hazardous, because 1) ceramic fragments from auger cores are tiny and difficult to identify; 2) earlier pottery frequently occurs in more recent layers; 3) mixing of artifacts during the augering is all too common (pottery on the edge of the hole may fall down into older units); 4) many of the LH III ceramic types occur over periods of several decades; 5) classifying

LH IIIB/C pottery is very difficult and a disputed subject; and 6) the LH IIIC surface found just under the turf in the lower town may well have been concealed somewhere within the upper 2 m of core 104.[66] If the pottery assemblage at 0.3–4.2 m is dated as a whole and compared with the ceramic evidence from the citadel, it would postdate the construction of the final palace at Tiryns by a few decades.[67] A drill hole (V) 100 m east of core 104 produced a similar stratigraphy, including a Hellenistic site and an additional 0.9-m-thick stream and floodplain deposit at the top of the sequence.

West of the acropolis, cores 112, 114, and 108 revealed the subsurface transition between the alluvial cone in the south and a lowland swamp or marsh west-northwest of the citadel. Closer to the limestone knoll a relatively undisturbed stratigraphic record can be found, dominated by continuous deposition at a low rate and by strong human impact. Such a sequence was indeed exposed in the upper part of trench Pa and in the form of stratified anthropogenic horizons with building remains in Tiryns West.[68] Further west, however, cores and exposures are dominated by reduced marsh or subaqueous deposits that are interrupted at places by alluvium (fig. 5: 101, 112, 114, SP-12, B). In one area the alluvium contained foundations and rooftiles of a Hellenistic house.[69] The bluish marsh deposits had been noticed by Kilian who interpreted them as marine sediments from the Late Bronze Age.[70] Microfossil analysis, however, has shown that these sediments originated in a freshwater environment.[71] Furthermore, the remains of a Hellenistic house in the alluvium below the reduced marsh deposits indicate a post-Hellenistic date for their formation.

In summary, the postglacial stratigraphy of the lower town of Tiryns begins with a highly consolidated red bed of Pleistocene age that forms an easily identifiable substrate about 6 m below the present surface. Near the limestone knoll this paleosol emerges at the surface. Neolithic pottery was found at several places in a thin unit that covers the Pleistocene surface, but no evidence for a major Neolithic depositional phase was detected. The first extensive Holocene alluvia date to EH II (fig. 8). At that time a large settlement existed to the south and southwest of Tiryns. The village was traversed by a stream that appears to have used its bed south of the limestone knoll during all ceramic periods until LH IIIB. Further evidence for the existence of such a perennial stream came from the discovery of a fish otter bone (*Lutra lutra*) in an LH IIIB2 deposit.[72] In some places the stream accumulated 2.4 m of levee and overbank deposits during EH II, at a time when the Argolid experienced a phase of general landscape instability. Nevertheless, habitation of the area continued during the Early Bronze Age. No evidence was found for any significant deposits from EH III, MH, LH I, or LH II. Pottery from these periods was also rare in auger cores (table 2).

Rapid and far-reaching landscape changes must have occurred in LH IIIB2–LH IIIC (fig. 8). At that time parts of the lower town appear to have extended to the north and east of the limestone knoll. During the latter half of LH IIIB or the early part of LH IIIC, the stream that used to run south of the citadel shifted its bed to go around the hillock on its northern side. At the same time it deposited up to 4 m of coarse alluvium in the area east and north of the citadel, thereby destroying and burying a significant part of the lower town. After this major depositional event, sediment accumulation at Tiryns came to a sudden end. Less than 1 m of material was deposited in the area of the lower town after the end of the Bronze Age. The lower town west of Tiryns was sheltered from torrential floods by the limestone knoll itself; hence the record of human occupation there is more continuous and less disturbed than at most other places around the acropolis.

The Tiryns knoll lies on the distal edge of a large alluvial fan (see above, fig. 4) and thus in an environment characterized by intermittent, high-volume sediment accumulation. From a geological point of view the depositional events during EH II and LH IIIB/C are not unusual, but they both happen to fall into a time of intensive occupation. Most remarkable is the deposition of several meters of alluvium in LH IIIB/C and the almost total lack of sedimentation thereafter, when LH IIIC houses were built in the former streambed.

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[66] Klaus Kilian's untimely death added more uncertainty to the dating, since illustrations of the pottery found in the auger cores could not be published.

[67] Guntram Schönfeld, personal communication.

[68] Kilian 1988.

[69] Zangger 43.

[70] Kilian 1978, 450.

[71] E. Finke and H. Malz, "Der Lernäische See: Auswertung von Satellitenbildern und Ostracodenfaunen zur Rekonstruktion eines vergangenen Lebensraumes," *Natur und Museum* 118:7 (1988) 213–22.

[72] A. von den Driesch and J. Boessneck, "Die Tierreste von der mykenischen Burg Tiryns bei Nauplion/Peloponnes," *Tiryns* XI (Mainz 1990) 109.

Table 2. Diagnostic Potsherds from Auger Cores near Tiryns

Core	Depth (m)	Archaeological Period	Pottery
AP-103	0.7	LH III	Mycenaean skyphos (?)
		EH II	EH saucer
AP-103	1.0	LH IIIB/C early	skyphos, linear banded, open vessel
AP-103	1.2	LH IIIB/C	fineware, base fragment, fragment of large vessel
		LH III	coarse and cooking ware
AP-103	1.8	LH IIIB/C	fragment of pithos
AP-103	3.7	LH IIIB/C	pithos with nail impressions
AP-103	4.5	LH I–IIIB early	goblet, unpainted handle
AP-104	1.6	LH IIIB/C	jug/hydria/amphora, banded
		LH I/II	fragment of closed vessel
		EH	fragment
AP-104	1.9	LH IIIB2/C early	animal figurine
AP-104	2.5	EH III	dark burnished
AP-104	2.7	LH IIIA/B1	open vessel, goblet (?), unpainted fragment
AP-104	3.2	LH IIIA/B early	unpainted fragment
AP-104	3.4	LH IIIB	closed vessel, banded
		EH	fragment of pithos
AP-104	3.8	LH IIIB	closed vessel, neck fragment, fineware
		older Mycenaean	closed vessel, greenish clay
		EH	fragment
AP-104	3.9	LH IIIA/B1	unpainted, open vessel, flat bottom
		MH	brown Minyan fragment
AP-104	4.0	MH/LH I	unpainted neck of jug
		EH III	smearware
AP-104	4.3	LH IIIB/C	neck of closed vessel, matt painted
AP-104	4.5	LH IIIB/(C)	closed vessel (jug?)
AP-104	4.6	LH III	handle unpainted, neck fragment plain
		LH IIIA/C	cooking pot
		LH IIIB/C	base of kylix
		EH	coarse ware
AP-104	4.7	LH IIIA/B (early)	stand of goblet
AP-104	4.8	LH IIIB/C	rim fragment of amphora, etc.
		LH III	fineware, plain goblet, smearware
		EH III	smearware on orange clay
AP-104	4.9	EH III	smearware on orange clay, rim of jar
AP-105	0.3	LH	coarseware
AP-105	0.5	LH	coarseware
AP-105	0.9	LH IIIA (late)–?	open vessel, goblet or kylix, plainware
		LH IIIB	closed vessel, plainware
AP-105	1.2	LH III	open vessel, unpainted
AP-106	1.2	LH IIIB/C	neck of jug, banded

THE MYCENAEAN DAM

In 1930 Georg Karo first described an artificial dam, about 10 m high and 100 m long, across a riverbed 3.5 km east-northeast of Tiryns (figs. 9–10).[73] Ever since the dam was erected it has diverted the Manessi stream into an artificial canal that extended over a distance of 1.5 km to an adjacent natural streambed further south (figs. 11–13).[74] Before the diversion the river exited into the sea near Tiryns;

[73] Karo (supra n. 50) 112; see also Karo, "Die Perseia von Mykenai," *AJA* 38 (1934) 126; M.P. Nilsson, *The Mycenaean Origin of Greek Mythology* (Cambridge 1932) 37.

[74] See also Philippson (supra n. 37) I 485; Verdelis (supra n. 16) 5; Balcer (supra n. 33); Bintliff (supra n. 30) 280–82.

Table 2. (continued)

Core	Depth (m)	Archaeological Period	Pottery
AP-106	1.6	LH IIIA late/B	handle, stirrup jar
AP-106	1.7	LH IIIA/B	stirrup jar (?)
AP-106	1.9	LH IIIB/C early	goblet
AP-106	2.2	LH IIIA/B	cooking ware
AP-106	2.4	LH IIIA/B	fine cooking ware, closed vessel
AP-106	2.5	LH IIIB	open vessel, base of bowl
AP-106	2.9	LH IIIA/B	coarseware, bowl
AP-106	5.7	LH I/IIIB	goblet
AP-107	1.3	EH (?)	base, red urfirnis
AP-108	1.0	LH IIIB/C early	closed vessel, motif on shoulder
AP-109	1.1	LH IIIB/C early	hydria/amphora
		LH IIIB/C early	goblet, monochrome inside, kylix
		LH III	plainware
AP-109	1.2	LH IIIB	open vessel, banded fragment
AP-109	1.7	LH IIIA/B	jug (?), banded fragment
AP-109	2.0	LH IIIA/B	fragments of closed vessel, fine, plainware
AP-109	2.2	LH IIIB/C	carinated vessel, kylix, plain
		LH IIIA/B	monochrome painted
AP-109	2.5	LH IIIB	stirrup jar, banded
		LH IIIA	goblet
		LH IIIB/C	rim, closed vessel, coarse ware
AP-109	2.7	MG/LG	cup, monochrome inside, outside banded
		LH IIIB	base of unpainted kylix
		LH IIIA/B	import (?)
		MH/LH I	rim, matt painted
AP-109	2.8	LH III	jug/hydria, amphora, hard-fired
AP-109	2.9	LH III(A)/B	fine plainware (goblet/dipper)
		LH III	coarseware stirrup jar (?)
		LH II/IIIA early	painted
		LH I/IIIA	none noted
		EH	closed vessel
AP-110	0.4	LH IIIB/C early	high stemmed goblet, monochrome inside
AP-110	0.7	Byzantine	fine- and coarseware
		LH IIIA/B early	cup or bowl with triton motif (?)
AP-114	1.8	Late Roman/Byzantine	horizontally grooved
AP-114	2.6	older Mycenaean	banded
AP-114	2.8	LH III	banded goblet, monochrome inside
		LH III	monochrome inside
		EH	coarse vessel
AP-115	0.5	LH IIIA/B early	base of goblet
AP-V	1.5	Hellenistic	Corinthian rooftile

in other words this was the stream that passed south of the citadel during the Early Bronze Age and changed its course to the north of the citadel in LH IIIB2/C. Cyclopean walls at the bottom of both sides of the dam (fig. 10) indicated to Karo that the artificial river diversion dated to the Late Bronze Age. He assumed the purpose of the dam was to protect the lower town of Tiryns from ephemeral floods. Jantzen suggested a date in the 14th to 13th century B.C. for the construction of the dam[75] and emphasized that the stream could have passed either south or north of the citadel. He concluded that this kind of stream redirection is unique, but reminiscent of the hydrologic control of Lake Kopais.[76]

[75] Jantzen (supra n. 16) 70.

[76] J. Knauss, *Kopais* 3 (Munich 1990).

Fig. 9. Crown of the Mycenaean dam east of Nea Tiryns. The stream originally ran from the lower left to the upper right in the photograph. Since the diversion was carried out, the stream has run from the lower left through an artificial canal to the upper left.

Fig. 10. Part of the east face of the Mycenaean dam. The dam was ca. 10 m high and protected by Mycenaean walls still visible below the tree and in the center of the photograph. (Courtesy Deutsches Archäologisches Institut, Athens, neg. TIR 68/326)

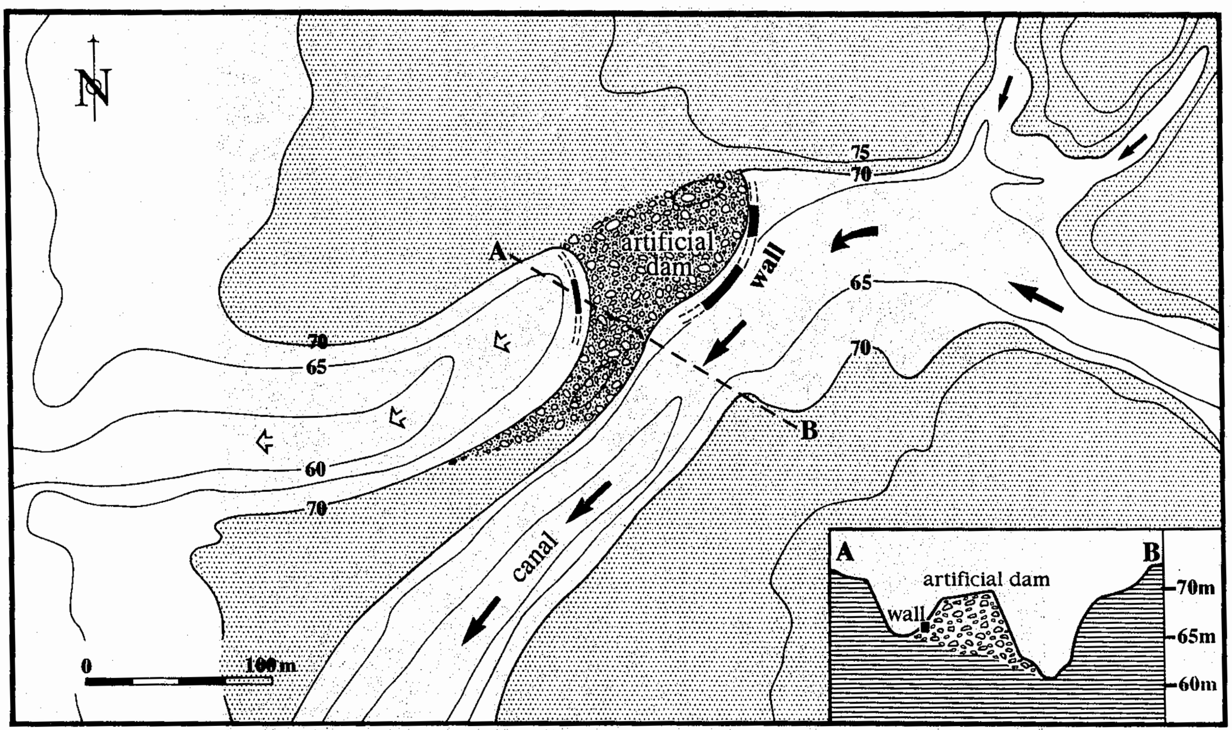

Fig. 11. Map showing the detailed topography in the vicinity of the Mycenaean dam. The river was blocked just behind the junction with two more tributaries to include as much drainage area as possible. (R. Robertson)

The stratigraphic analysis of the Holocene deposits around the Tiryns hillock sheds more light on the date and cause of the dam construction. The massive alluvial deposits east of the citadel must predate the erection of the dam, because the deposition of roughly 500,000 m^3 of sediment would not have been possible with the dam in place. On the other hand, the LH IIIC houses in or near the bed of a formerly active river only make sense if they postdate the construction of the dam. Hence the river must have been diverted at some point in LH IIIB2 or LH IIIC, evidently as a reaction to the massive deposition of alluvium in the lower town of Tiryns. Additional support for a date at the end of the Bronze Age was discovered in the area to which the Manessi stream was diverted. An auger core cross section taken during the Argive Plain Project revealed a phase of enhanced alluviation commencing at the end of the Bronze Age.[77] In one of the cores a Mycenaean LH IIIB figurine was found at the bottom of the sediments. The deposition of this unit was clearly triggered by the artificial river redirection.

EARTHQUAKES

In 1978, during the excavation on the lower citadel, Kilian noticed for the first time a destruction phase, the cause of which he could not initially determine with certainty.[78] After further excavation, however, he became convinced that this particular destruction was caused by an earthquake.[79] According to Kilian, the catastrophe occurred at the end of LH IIIB, causing the collapse of all known buildings on the lower citadel. It also brought serious damage to the Cyclopean walls and prompted the abandonment of most casemates.[80] Subsequently simple makeshift buildings were erected and extensive leveling was conducted on the lower citadel before the surviving inhabitants started a totally new rebuilding program for their city.[81] During LH IIIC another earthquake seems to have occurred. Kilian argued that the undulating floor surfaces associated with this phase of devastation indicate earthquake damage rather than human destruction.[82] In addition, he discovered the crushed bodies of a woman and child beneath the rubble of a collapsed building.[83]

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[77] Zangger 34.
[78] Kilian 1981 (supra n. 14) 159.
[79] Kilian 1981 (supra n. 14) 192.
[80] Kilian 1983, 177.
[81] C. Podzuweit, "Die mykenische Welt und Troja," in B. Hänsel ed., *Südosteuropa zwischen 1600 und 1000 v. Chr.* (Berlin 1982) 68–70.
[82] Kilian 1978, 466.
[83] Kilian 1983, 408: Bau X, LH IIIC.

Fig. 12. Aerial photograph showing 1) the location of Tiryns; 2) the natural streambed of the Manessi River; 3) the Mycenaean dam; and 4) the artificial canal. North is to the left. (Courtesy K. Kilian)

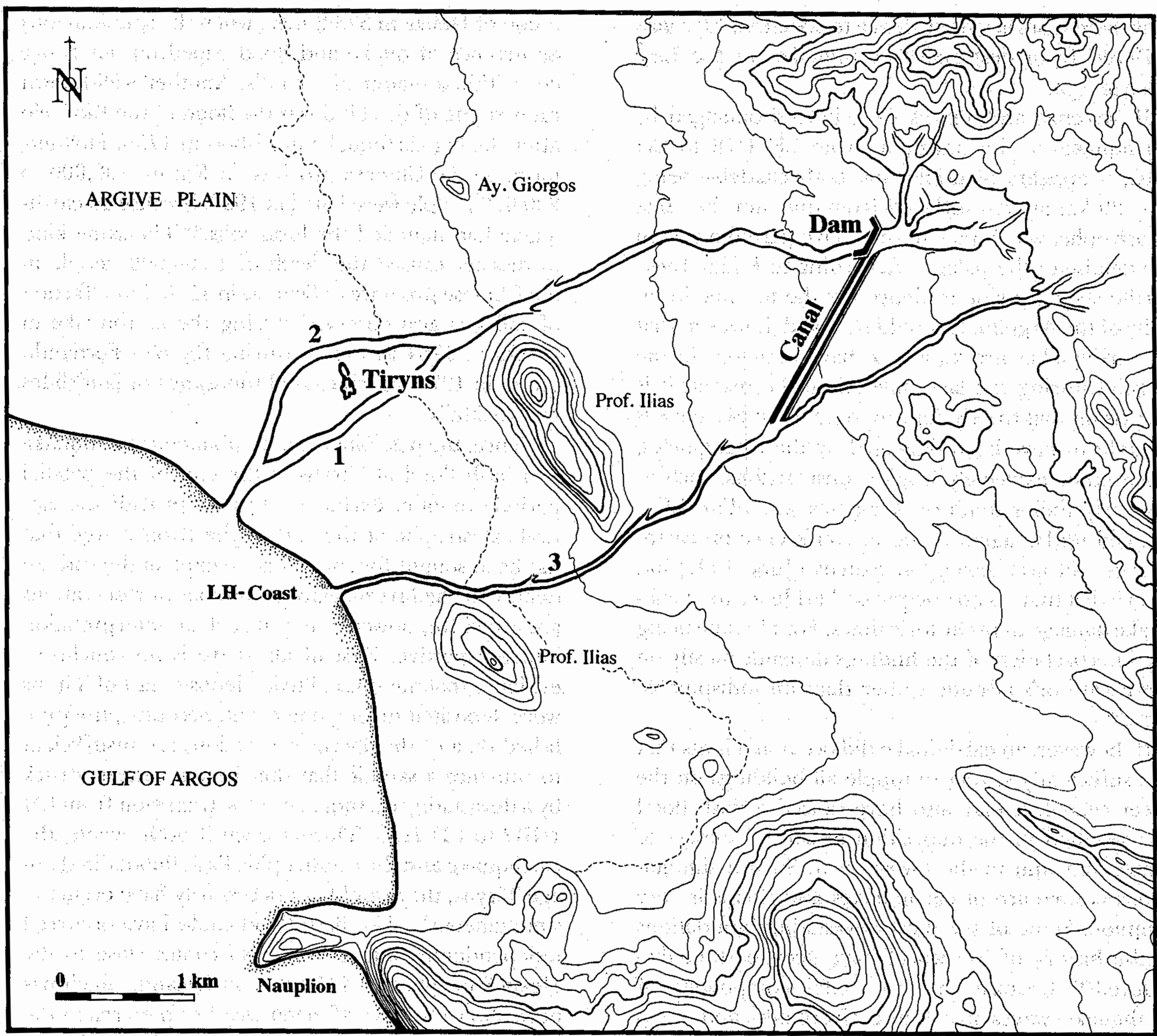

Fig. 13. Map showing the course of the Manessi River 1) from the Neolithic to LH IIIB2; 2) during the natural diversion in LH IIIB2/C; and 3) after the artificial redirection. (R. Robertson)

Both earthquakes at Tiryns, the one at the end of LH IIIB (often described by Kilian as the "big quake"[84]) and the one during LH IIIC, might be correlated with destructions at Mycenae,[85] although some of the strongest indications for earthquake damage at Mycenae seem to predate the catastrophe at Tiryns. Two building periods at Mycenae's cult center were found to be separated by a destruction that occurred shortly after the middle of LH IIIB.[86] At the same time widespread fires occurred in various parts of the settlement and a few houses collapsed, crushing at least one occupant in a doorway.[87] Iakovidis concludes that the character of the havoc definitely argues for earthquake damage rather than a general conflagration or an enemy attack.[88] Later, at the end of LH IIIB, further scattered, more or less simultaneous fires occurred at Mycenae. These destructions have also been interpreted as the result of an earthquake.[89] The interpretation of these findings remains controversial, however, because not all experts agree

[84] Kilian 1983, 327; Kilian 1988, 150.
[85] Kilian 1983, 184, fig. 7.
[86] S.E. Iakovidis, *Late Helladic Citadels on Mainland Greece* (Leiden 1983) 48.
[87] I.M. Shear, *The Panagia Houses at Mycenae* (Philadelphia 1987) 154.
[88] Iakovidis (supra n. 86) 48.
[89] Iakovidis (supra n. 86) 50.

that there is sufficient evidence to state that Mycenae suffered from destructive earthquakes in the Late Bronze Age.

If Mycenae and Tiryns were indeed damaged by earthquakes at the transition from LH IIIB to LH IIIC, it appears plausible that both citadels—being only 20 km apart—suffered from one and the same catastrophe, which may in turn have played a role in the demise of the palaces. According to Kilian, these earthquakes provide evidence for the tectonic instability of the Argolid. It should be noted, however, that no earthquakes are known to have occurred in the Argolid during the last millennium. Moreover, it is surprising that the Cyclopean masonry at Mycenae is thought to have been damaged by the earthquakes, while other extremely fragile constructions, such as the early tholos tomb of Aegisthus (ca. 1450 B.C.), escaped undamaged. A recent conference on earthquakes and archaeology in Athens (June 1991) has shown that there is no unequivocal evidence for earthquake damage in prehistoric times. For the time being the interpretation of the findings depends mostly on the excavator's attitude rather than on indisputable facts.[90]

If, however, an earthquake did occur at Tiryns that was sufficiently strong to topple all buildings on the lower citadel, it may also have caused a flash flood that resulted in the deposition of several meters of coarse alluvium in the lower town. Such a simultaneous occurrence of earthquakes and floods is very common. Some of the most devastating inundations in the history of the world have been earthquake-induced,[91] because the horizontal component of earthquake waves may cause riverbanks and steep slopes to collapse. The resulting debris flows and mudslides frequently block riverbeds and therefore cause torrential inundations. Moreover, during earthquakes porewater pressure in the soil may reach extremes so that the quake may even liquefy the ground. The coincidence of earthquakes and inundations was also known in Greek antiquity. Aristotle refers to the "earthquake in Achaea,"[92] probably the great devastation of Helike in 373/2 B.C., when the simultaneous occurrence of quake and flood wiped out an entire city within a matter of seconds. Another well-known catastrophe of this kind was the flood of the Rio Tejo after the big earthquake in Lisbon in 1755. Furthermore, in the Chinese province of Kansu, 100,000 to 200,000 people were killed in 1920, because an earthquake had liquefied the loess soils.[93] The same kind of disaster caused the death of 1,000,000 people in the Chinese province of Schensi in 1556. Liquefaction of soil was also observed during the earthquake in Alaska in 1964 as well as during the San Fernando quake in 1971, which caused thousands of landslides and rockfalls.

Hence, the possibility of a simultaneous earthquake and flash flood at Tiryns at the end of the palatial period cannot be excluded. It would provide the natural catastrophe at the end of the Bronze Age that has been sought for some time to explain the sudden demise of the Mycenaeans. A number of reservations are called for, however, to put such an interpretation into perspective. First of all, there is no conclusive evidence that the thick alluvial deposits east of Tiryns were deposited during one event. Secondly, the published data of the Tiryns excavations are insufficient to convince a skeptic that the site was indeed struck by a devastating earthquake at the transition from LH IIIB2 to LH IIIC. Thirdly, even if both events, the earthquake and the catastrophic flash flood, did damage Tiryns, they would not necessarily have occurred simultaneously. The flash flood could have occurred independently, but its date also comes close to the Hekla 3 eruption in 1159 B.C. in Iceland, which has been shown to have affected weather patterns in the Mediterranean.[94] Unusually strong rainfall during the climatic disturbance following the eruption of Hekla would also provide a plausible trigger for the flash flood. Finally, the events at Tiryns were of strictly local character and are unlikely to have played a major role in the collapse of the Mycenaean palatial system.[95] The archaeological excavations have shown that a centrally planned rebuilding program commenced

[90] S. Stiros and R. Jones eds., *Archaeoseismology* (BSA Fitch Laboratory occasional paper 7, Oxford, forthcoming). R. Drews, *The End of the Bronze Age* (Princeton 1993) 33–47 reexamines the evidence for devastating earthquakes at the end of the Bronze Age and arrives at the conclusion that "it is about as clear as such things can be that the cities destroyed in the Catastrophe were destroyed by human hand" (p. 47).

[91] I am grateful to George (Rip) Rapp for pointing this out to me.

[92] Arist. *Mete.* 1.6.343b.3, 2.8.368b.7.

[93] M.A. Koenig, *Geologische Katastrophen und ihre Auswirkungen auf die Umwelt* (Thun 1984) 222.

[94] M. Baillie and M.A.R. Munro, "Irish Tree Rings, Santorini and Volcanic Dust Veils," *Nature* 332 (1988) 344–46; Baillie, "Irish Oaks Record Volcanic Dust Veils Drama!" *Archaeology Ireland* 2:2 (1988) 71–74; Baillie, "Marker Dates—Turning Prehistory into History," *Archaeology Ireland* 2:4 (1988) 154–55; P.I. Kuniholm, "Archaeological Evidence and Non-evidence for Climatic Change," *Philosophical Transactions of the Royal Society of London* A 330 (1990) 645–55.

[95] I could not find any historical examples of earthquakes that aggravated a politically fragile situation. Natural catastrophes tend to bring people together rather than to divide them. The Armenia quake in 1990, for instance, prompted a ceasefire in the fighting with Azerbaijan.

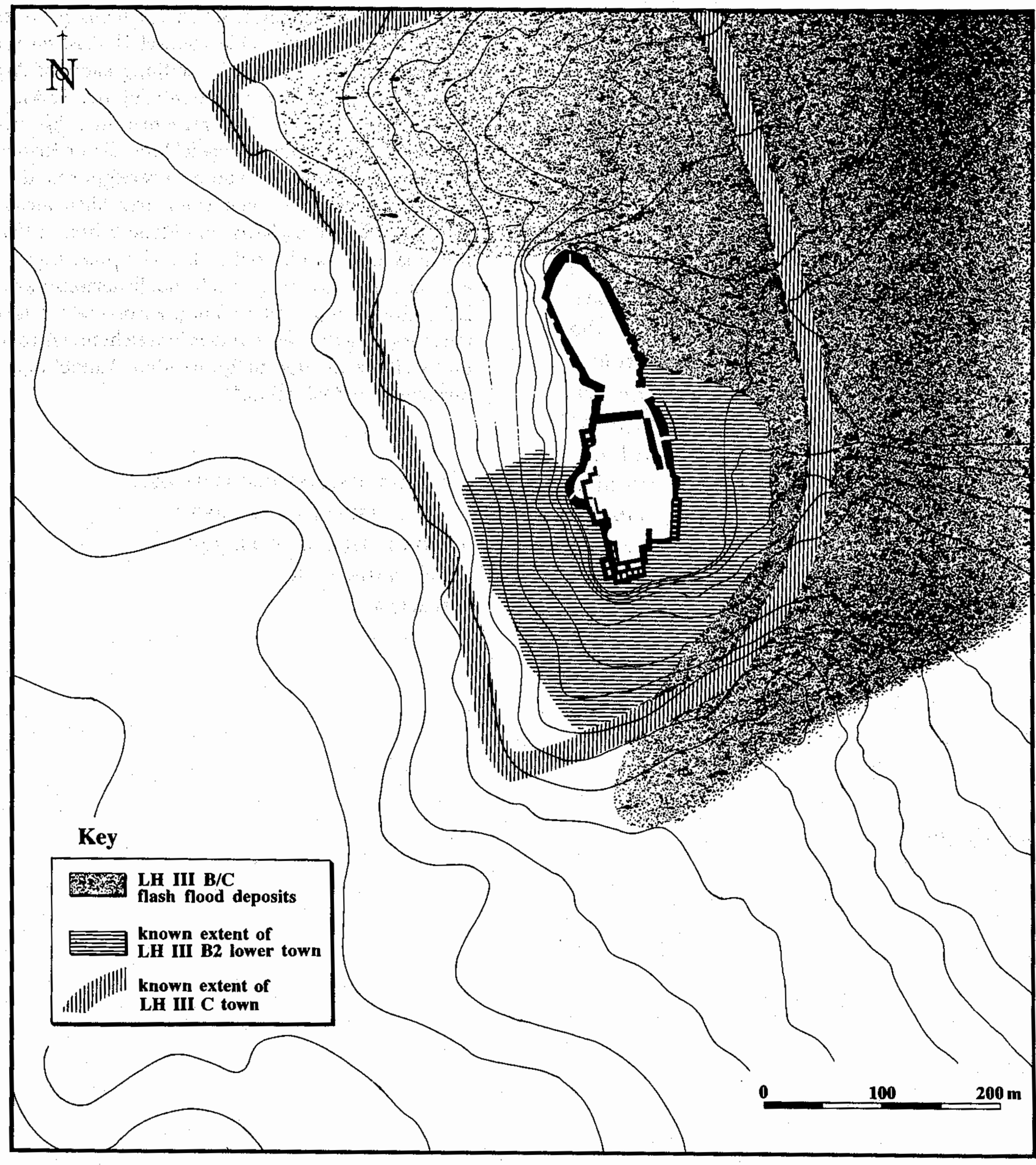

Fig. 14. Map of Tiryns area showing extent of flash flood deposits and of the LH IIIB2 and LH IIIC towns below the citadel. (R. Robertson)

soon after the destruction had occurred.[96] At the same time there was still sufficient manpower and engineering skill to construct the remarkable dam and the artificial canal.

LH IIIB TIRYNS

With respect to the size of the lower town of Tiryns, the discovery of extensive LH IIIB2/C sediments east, north, and south of the acropolis might explain the apparent absence of an extensive suburb during the palatial period (fig. 14). Parts of this suburb were probably buried so deeply under sediment that they were not discovered in the trial excavations. Karo's description of his sondage north of Tiryns, where he found LH III houses at the surface and "basically nothing" for 3 m below,[97] is characteristic of the stratigraphic and settlement record in that area. If Karo had continued to excavate 2 m deeper, he might have found more LBA, EH, and Neolithic habitation layers.

Kilian's suggestion that Tiryns increased in size from LH IIIB to LH IIIC,[98] because it served as a

[96] Kilian 1978, 178.
[97] Karo (supra n. 50) 111.
[98] Kilian 1978, 470.

refuge at a time when many settlements in the Argolid were abandoned, rests only on negative evidence: the absence of LH IIIB remains in trial trenches that were poorly excavated early in this century. The results of the Tiryns Project indicate that there are not sufficient grounds to assume that the LH IIIB city was smaller than the LH IIIC city. It is rather more likely that the palatial suburb exceeded the postpalatial one in size, but is now buried under flash flood deposits (fig. 14). Accordingly, Tiryns would have assumed no special role during the collapse of the Mycenaean society. In conclusion, the Tiryns Project, initiated and enthusiastically supported by Klaus Kilian, may have rectified some of his early ideas about the position of the coastline and the size of the lower LH IIIB town, but at the same time it has provided some additional support for his most important deduction: the political collapse of the Mycenaean palatial culture was most likely accompanied by natural catastrophes in the Argolid.

Aus den gewohnten historischen Vorstellungen über die Palastkatastrophe am Ende von SH IIIB ist nach dem archäologischen Befund die Siedlungskammer Argolis auszusondern, da hier die Zerstörung der Paläste und Burganlagen auf ein Naturereignis zurückgeht. Die oben skizzierte Siedlungsentwicklung dieser Region erfolgte unter einer Reihe von Naturereignissen, die eine Serie von Veränderungen wohl ursächlich auslösten. Offensichtlich landschaftsgebundene Wirtschaftsfaktoren und ein Wandel politischer Gruppierungen sind ebenso wie Zerstörung durch möglicherweise kriegerische Einwirkung—Pylos (?) und Paros—oder allgemeiner Rückgang des Fernhandels hinreichende Anzeichen und Gründe für den tiefgreifenden Wandel der spätmykenischen Zivilisation.[99]

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[99] Kilian 1983, 193.