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Geomorphic Reconstructions in the Environs of Ancient Troy

John C. Kraft, Ilhan Kayan, Oğuz Erol

The Greeks and Romans of Classical, Hellenistic, and Roman times located ancient Troy south of the mouth of the Dardanelles at the western end of the cuesta-like ridge at Hisarlik tell (Figs. 1 and 2).

Summary. Sea level rise, deltaic progradation, and floodplain aggradation have changed the landscape in the vicinity of ancient Troy during the past 10,000 years. With the waning of the last major world glaciation and resultant sea level rise and fluctuation, a marine embayment protruded nearly 10 kilometers south of the site of Troy at Hisarlik in the Troad of northwest Turkey. As the sea approached its present level approximately 6000 years ago, fluvial and marine deposition caused a northerly migration of the delta and floodplain of the Scamander and Simois Rivers past the site of Troy toward the present-day coast about 6 kilometers north of the site. In view of these major changes in morphology, interpretations of ancient geographies related to historical or historical-mythological settings must be changed. A number of paleogeographic maps have been reconstructed with the use of subsurface data that records the continuing landscape change since the first occupancy of the site at Troy 5000 years ago. These show that ancient Troy was located on an embayment of the sea. If the Trojan War occurred, then the axis of the battlefield and associated events must be relocated to the south and west of Troy.

Here they built a city, New Ilium. To these people, there never was a question of where Troy of the *Iliad* and the *Odyssey* was located. However, by the time of the Renaissance, scholars were uncertain as to the location of Troy. Indeed, by the 18th century many historians doubted that Troy had ever existed and considered the stories of the *Iliad* and *Odyssey* to be mythological. Yet, some scholars continued to insist on the historical fact of Troy (*1, 2*). Most notable was Heinrich Schliemann (*2*). In his excavations at Hisarlik, in the late 19th century, he identified a series of fortified sites approximately 5 kilometers south of the Dardanelles at the same site identified by the ancients as Troy and New Ilium. On the basis of his readings of Homer and other ancient Greeks and Romans such as Strabo (*3*), he correctly identified the location of Troy and made a series of major excavations (*2, 4, 5*). Schliemann identified up to 12 separate occupation layers in the tell at Hisarlik. With his absolute faith in the historic validity of the *Iliad*, he attempted to relate various strata of his excavations to ancient Troy of the *Iliad*. We now know that the site at Hisarlik was occupied from approximately 5000 years before the present to Roman times, when the relatively large city of New Ilium was constructed over the site of ancient Troy and the surrounding hill and plain.

Arguments as to the nature of the ancient geography of the region of Troy and the relation of this geography to features described in the *Iliad* are legion. Blegen (*6*) correlated Troy of the *Iliad* with layer VIIa. Even today, however, other archaeologists argue that layer VIh may in fact be the city of the Trojans of the *Iliad* (*7*). Further, some scholars insist that the stories told in the *Iliad* and the *Odyssey* are purely mythological and that there is no evidence that these stories have any definite relation to any known archaeological sites or to historic events (*8*). The arguments regarding the historicity of the *Iliad* and the *Odyssey* are in part emotional and in part empirical. Regardless, an archaeological site with occupation layers including a large

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number of settlements over a 3000-year period has been excavated and studied on the hill at Hisarlik and is generally regarded as the site of ancient Troy.

The geology of the Troad (the northwest portion of the Biga Peninsula) was intensively studied by Bilgin (*9*), who described in detail the deltaic processes that have led to the modern configuration of the combined Scamander-Simois delta over the past century. Bilgin also speculated that there may have been a deep marine embayment protruding southward along the Scamander River valley. Erol (*10*) mapped lineaments of the Scamander River plain and delta with the aid of aerial photography. Erol identified ancient shorelines and other fluvial features of the plain and made preliminary projections of the positions of shorelines in antiquity.

We initiated a drill hole study in order to determine the nature and depth of the sedimentary environments and their deposits in the Scamander and Simois River valleys. By study of the three-dimensional shapes of the sedimentary units deposited in each environment, we made precise paleogeomorphic reconstructions of the vicinity of Troy, covering the Holocene Epoch of geologic time (past 10,000 years). We were fortunate to have the cooperation of Maden Tetkik ve Arama Institüsü (the equivalent of the Turkish Geological Survey) in support of our efforts (*11*).

Geomorphology of the Vicinity of Troy

The northwest Troad near the mouth of the Dardanelles in Turkey is at a strategic position at the end of the straits between the Aegean Sea and the Sea of Marmara and the Black Sea. Thus, it is logical that this area was a focal point for commercial and military activities throughout historic and prehistoric times. The area is one of uplifted Neogene (late Tertiary) sediments with various erosional geomorphic features in large part produced by the great fluctuations of sea level throughout the Quaternary Period of geologic time and in particular the past 15,000 years (Fig. 2). Erosion by waves produced a line of retreating cliffs facing westward toward the Aegean Sea. Sited along this line of cliffs were several important Classical-Hellenistic cities. Most notable is that of Sigeum to the west-northwest of Troy, probably located on a slight promontory in the vicinity of modern Yenişehir. Further to the south of the area of study was located ancient Alexandria Troas. Continued erosion of these cliffs causes ongoing destruction of these archaeological sites. For instance, the precise site of the ancient city of Sigeum is not known, but is assumed to have been located on a promontory at Yenişehir (*12*). To the east of the coastal cliffs, located on low ridges lay several other ancient cities including Rhoeteum, New Ilium, and Aianteion (*12*).

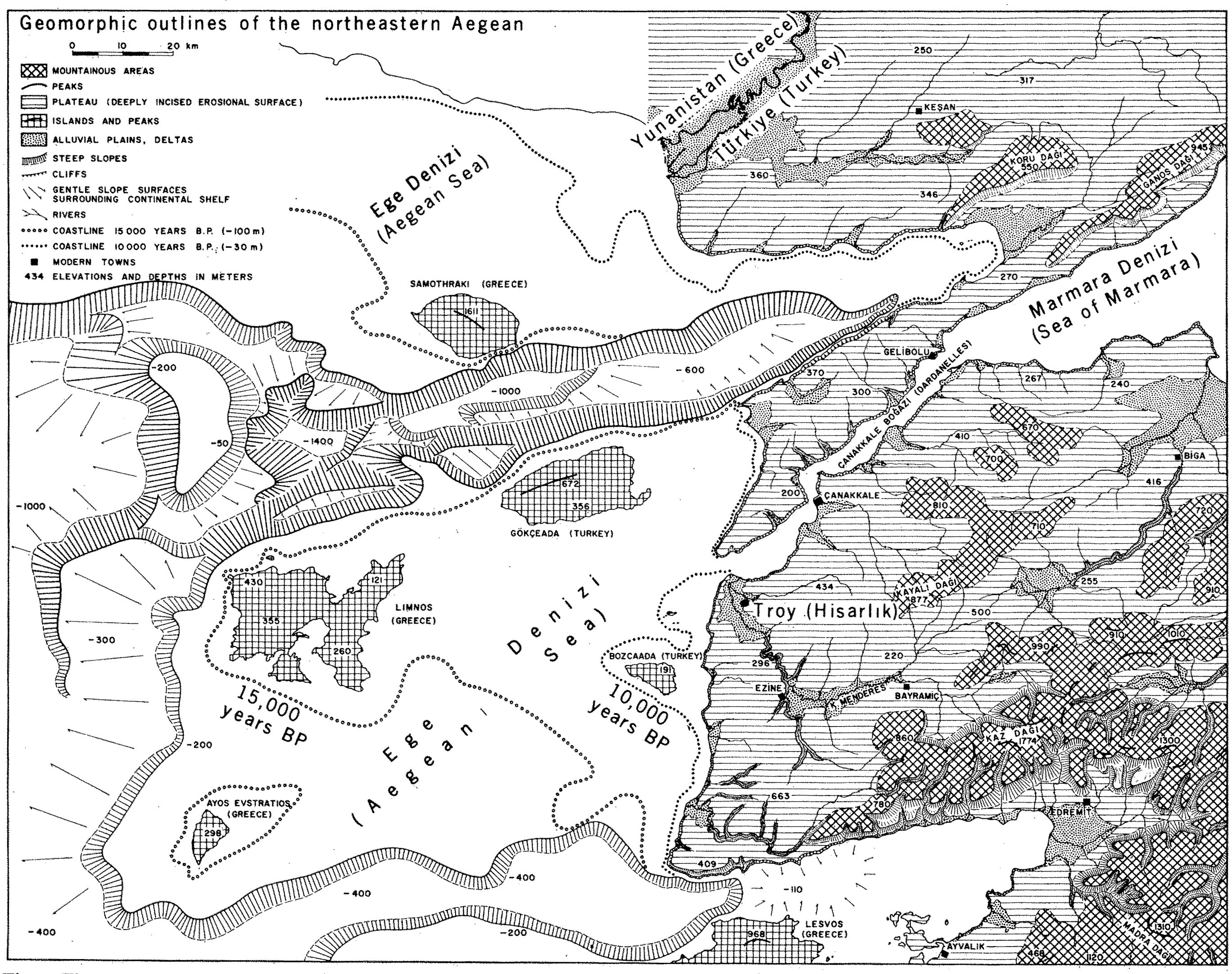

Fig. 1. The topography of the northeast Aegean Sea and the region of the Troad. The strategic nature of the mouth of the Dardanelles as a narrow strait between the Aegean Sea and the Sea of Mamara is evident. Shoreline positions at the time of the last peak Würm (Wisconsin) glaciation 15,000 years ago and the resultant sea level rise with the waning of the Würm glaciation at 10,000 years before the present (*BP*) are shown.

The area of the northwest Troad has been undergoing tectonic uplift during the past several million years. Concurrently, the soft Neogene silts, sands, and limestones have eroded at rates that probably varied because of changes in base level (relative sea level) and of changes in vegetation and rainfall. The result is a topography of ridges and valleys in a deeply incised plateau, 60 to 125 meters above the present sea level. Several cuesta-like ridges extend in an east-west direction along the south side of the Dardanelles and along the south side of the valley of the Dümrek Çayi (the Simois River). To the southeast of the low-lying, incised plateau lies a higher deeply incised plateau formed of older geologic units. This higher plateau reaches elevations of up to 300 m above present sea level within 10 km of Troy. The high plateau is deeply incised by the meandering river, the Kara Menderes Çayi (the Scamander River), which flows from its incised meander valley of the high plateau onto a 15 km long and approximately 3 km wide alluvial floodplain. The modern plains of the Scamander and Simois Rivers coalesce in the vicinity of Troy and form an alluvial-deltaic plain which extends toward the Dardanelles.

About 5000 to 5200 years before present, a people entered the region and established the earliest known occupation sites at Kumtepe on the northwest side of the present plain of the Scamander River and Troy at the tell Hisarlik at the west end of the cuesta on the southern side of the Simois River valley (*6*, *13*). This occupation in Early Helladic times has been interpreted to have been along the edge of the fertile floodplain of the Scamander River (*5*, *6*, *13*, *14*). However, some have suggested a slightly different terrain at the time of the first occupation of Troy (*1*, *3*, *9*, *10*, *15*). Leake, following statements made by Strabo, suggested a shallow marine embayment extending approximately 3 km south of the present shoreline. He felt that this was the embayment that was occupied by the Achaean fleet at the time of the Trojan War. Indeed, Leake went so far as to locate the Greek camp on a map (*1*). Strabo, in contrast, provided a detailed description of the topography of the embayment at Troy and suggested that this was the topography of the time of the Trojan War. Strabo probably erred in

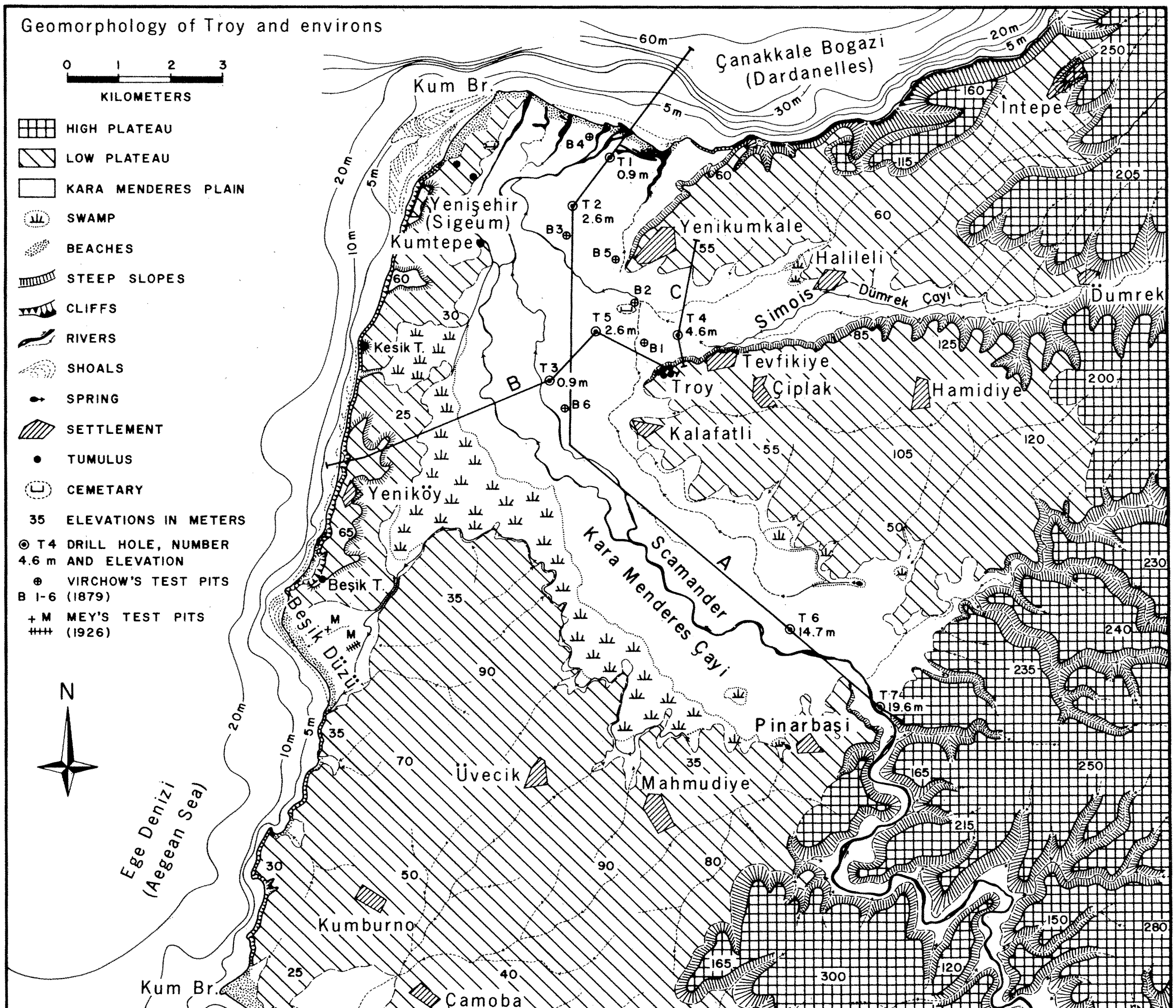

Fig. 2. Geomorphology of Troy and environs. The locations of Troy and Kumtepe are shown related to the plain of the Scamander and Simois Rivers. The high and low incised plateaus are identified. The cuesta-like topography of the ridge at Yenikumkale and Troy should be contrasted with the promontory of Sigeum, which is presently undergoing relatively rapid wave-cut cliff retreat. Lines of geological cross section interpretations (Figs. 3 to 5) and test pits by Virchow (*14*) and Mey (*18*) are shown.

that he described the embayment as it was in his time, approximately 2000 years ago. Strabo based his statements concerning the geography of the marine embayment at Troy on information provided by Demetrius and Hestaia of Alexandria Troas. The records of these two geographers are no longer extant. However, it does appear that at least the statements of Hestaia of Alexandria Troas are based on eyewitness accounts of the geography of the Troad of 2000 years ago.

The *Iliad* clearly notes that ancient Troy lay between the river valleys of the Scamander and the Simois Rivers. As there was no visible prehistoric archaeological site in this area, scholars from Renaissance time until the late 19th century were indefinite as to the identity of the Scamander and Simois Rivers and were therefore unable to locate the site of ancient Troy. Possibly many scholars believed the exercise to be futile because Troy and its legend were widely regarded as mythological. In addition, information regarding the location of several springs mentioned in the *Iliad* led to intensive efforts by numerous scholars to identify the Scamander and Simois Rivers as both lying on the southern plain of the Scamander River. Very large springs occur in a line near the modern town of Pinarbaşi at the foot of the high plateau. Therefore, many scholars attempted to locate ancient Troy in a position near the town of Pinarbaşi but were unable to locate the ruins. Schliemann, after several false starts including a search near Pinarbaşi, finally discovered the stratified fortification site at Hisarlik and identified the small stream (Dümrek Çayi) as the Simois River and the larger meandering stream on the major river plain of the Kara Menderes Çayi as the Scamander River. It now appears to be universally accepted that the site of ancient Troy is the archaeological site excavated on the tell at Hisarlik.

Depositional Sedimentary Environments

Clearly the topography of the environs of Troy in the northwest Troad has undergone rapid change. The previously mentioned wave-cut cliffs are obvious evidences. Changes in sea level and local climate during the Quaternary Period imply that major erosional and depositional events have occurred and continue to occur. Studies of floods that spread across the Scamander River plain in the past century indicate times of conversion of the area almost to a "lake." Today, however, an intensive drainage program to stabilize the channel of the Scamander River has been made. Present observers are less likely to understand the magnitude of the alluvial and deltaic depositional events that have occurred in the recent and more ancient past. The Scamander River, as it emerges from the gorge incised into the higher plateau to the southeast of Pinarbaşi continues to meander across the present plain. At present there are three channels, one dominant. However, in the past century, Spratt (*16*) identified up to six channels that were occupied in times of flood. In addition, the south and westerly side of the plain includes broad, low-lying swamps that are fed by the springs at Pinarbaşi. Spratt (*16*) and Schliemann (*2*) speak of frequent floods, particularly in the winter, in which waters of the Scamander spread across the floodplain and alluviation took place.

The present Scamander River meanders across a long, narrow floodplain with the highest elevations in the middle of the plain and along the levees of the river channels and the lowest elevations on the eastern and western flanks. The low elevations on the western flanks, together with the numerous springs of Pinarbaşi, led to swampy conditions reported even in antiquity. Repeated attempts to drain the swamps have met with only partial success. At present the Scamander and Simois River plains north and west of the swamps are well drained, flood controlled, and irrigated. Therefore, present alluvial processes cannot be used as indicators of past sedimentary events. As the natural levees of the Scamander River built up, the river episodically created new channels and

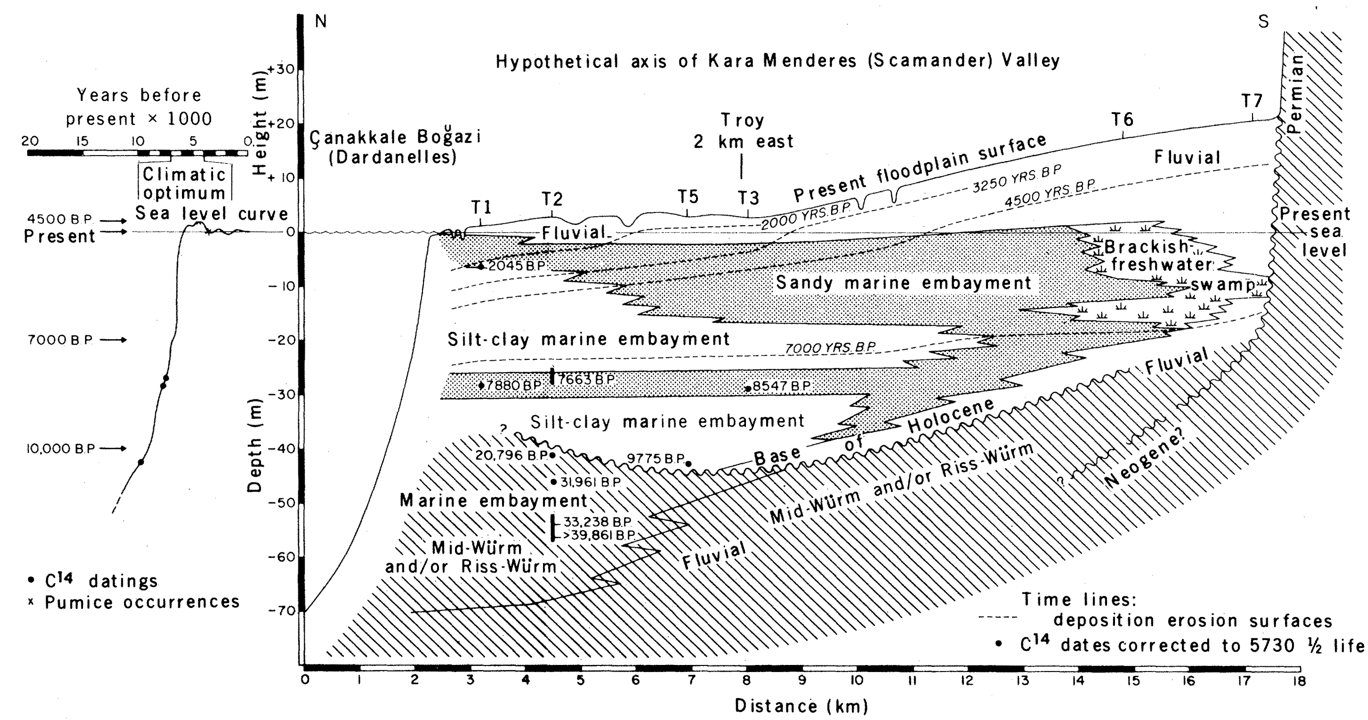

Fig. 3. A geological cross section of subsurface stratigraphic units along the axis of the Scamander River valley. Time lines based on the lithologies encountered by the drill holes of this project and on radiocarbon dates are shown. A sea level curve for the northwest Turkey region is shown on the left (*17*). The sea level curve is related to the sediment distribution shown in the cross section of the sandy marine embayment, prograding delta, and aggrading floodplain surface.

sought new, lower elevation paths to sea. Accordingly, the valley between the Sigeum promontory to the west and the cuestas of the ridge at Troy and the ridge at Yenikumkale (Fig. 2) is one of deposition of stream bed sand and gravel, low-lying natural levees of silt and sand, and backswamp mud (mainly silt). Similar depositional environments occur in the Simois River valley. In some areas, sand from the dry river beds has blown into low-lying dune fields, particularly to the northwest of Troy. These low-lying dune fields are presently vegetated and inactive.

As the Scamander and Simois Rivers prograded seaward, deposition in floodplain backswamps and in the many asmaks or separate channels occurred, leading to a complex sequence of deltaic sands, silts, and clays. Evidence based on drill studies (Fig. 3) shows that both the entire lower valleys of the Simois and Scamander Rivers were occupied by a marine embayment approximately 7000 years before present. These embayments were progressively infilled by progradation of the deltas and aggradation of the alluvial plains of the two rivers to the present coastline near the mouth of the Dardanelles. At present the combined delta of the Scamander and Simois Rivers protrudes northward to the Neogene sediment ridges of the Sigeum promontory and the cuesta at Yenikumkale. The relatively strong current and countercurrents flowing from the Sea of Marmara through the Dardanelles into the Aegean Sea have probably produced a condition of relative stability of position of the delta. Some of the delta sands are removed by currents flowing out of the Dardanelles around the tip at Kum Burnu to a submarine fan to the southwest. These sands enter the littoral transport stream along the foot of the eroding cliffs in a southerly direction. Thus the delta might not advance further into the Dardanelles. This is probably also true in view of the fact that the Scamander River plain is now undergoing irrigation and much water is diverted up stream for irrigation. Therefore, the amount of sediment transported to the delta has probably been reduced during the past 100 years.

Geological cross sections aid in delineating the sedimentary depositional environments that have caused the infill of the pre-Holocene (10,000 years before present) valleys of the Simois and Scamander Rivers (Figs. 3 to 5). Cross sections A and B (Figs. 3 and 4, respectively) provide a paleoecologic interpretation of sediment deposited along the axis of the Scamander River valley from Troy to the Sigeum promontory and Aegean Sea. Cross section C (Fig. 5) provides such an interpretation for the lower Simois River valley from Troy to the cuesta at Yenikumkale. A number of sedimentary environmental lithosomes have been identified. The alluvial sand and silt of the rivers themselves now cover the valley surfaces. Freshwater backswamp environments such as those found now on the western and southwestern side of the Scamander valley include organic mud. The marine embayment along the axis of the valley of the Scamander River is identified by a stratigraphic unit consisting of marine silt and clay which include a macrofauna of pelecypods and gastropods and a microfauna of foraminifers, ostracods, and microgastropods. The shallow fringe of the sandy marine embayment depositional environmental unit includes a larger number of mollusks, particularly oysters and the clam *Cardium edule*. In addition, marine microfossils are present. A brackish-freshwater fluvial-swamp environment, possibly the same as the flank-

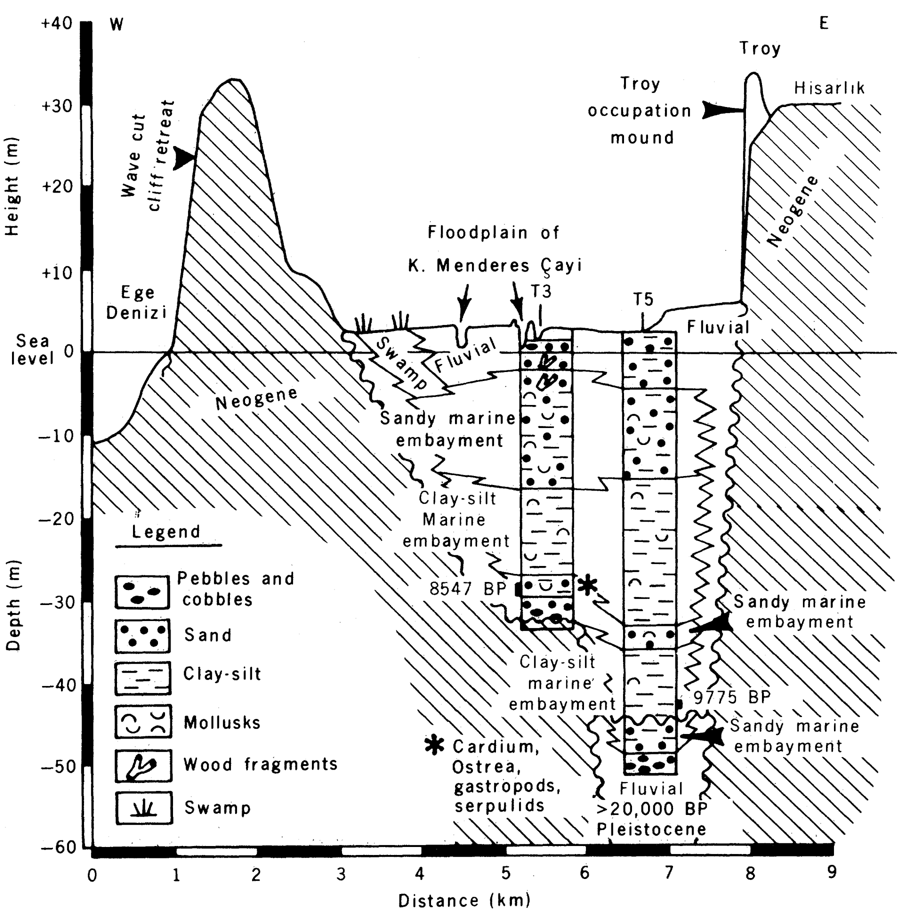

Fig. 4. A geologic cross section from the cliffs of the Sigeum promontory by the Aegean Sea, across the floodplain of the Scamander River valley to the promontory at Troy showing sedimentary environmental stratigraphic unit distributions related to several early Holocene radiocarbon dates.

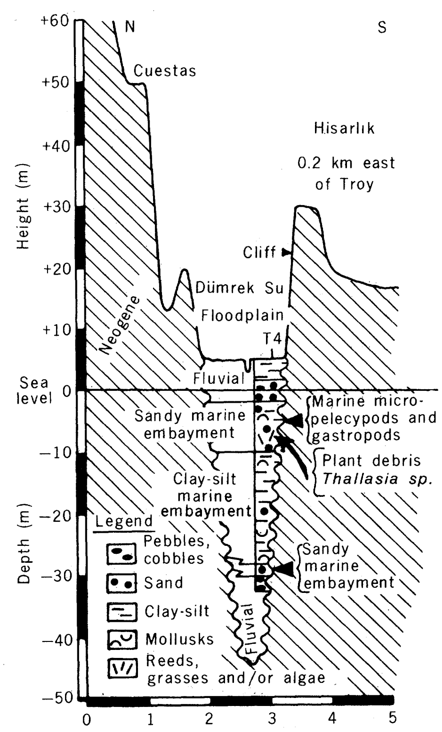

Fig. 5. A geologic cross section across the lower Simois River valley from the cuesta-like cliff at Troy to the southern flank of the cuesta at Yenikumkale showing sedimentary environmental stratigraphic unit distributions of the marine embayment and fluvial sediments.

ing swamp environment, is identified on the basis of the occurrence of freshwater ostracods and charophytes. At the head of the marine embayment in the vicinity of test hole 7, freshwater, brackish, and marine sedimentary environments interfingered as the shoreline rapidly shifted position and seasonal variation in fluvial discharge occurred.

Radiocarbon dates on organic materials, including shell and organic mud, provide information for interpretation of positions of relative sea level and of depositional environments in time and space during the Holocene Epoch (Fig. 3). The marine intrusion in the Holocene Epoch extended at least 15 km south of the present shoreline of the Dardanelles. As sediment flowed into the head of the marine embayment of the Scamander River and of the Simois River, the sandy sediment was redistributed, and delta progradation and aggradation or sediment buildup of the river plains occurred. This accompanied a rise in relative sea level (Fig. 3, left).

Changes in sea level relative to land for the region of northwestern Turkey (*17*) support our interpretation of the deposition of sedimentary environmental units and the paleogeographic variants of these environments. Although some may argue that the sea level curve (Fig. 3) is not a truly eustatic curve, it certainly is valid as a local, relative, sea level curve for the Biga Peninsula. Our drill core evidence and radiocarbon dates substantiate the validity of the curve as established by Erol (*17*). The marine embayment underwent several fluctuations of increases in marine sands deposited there. These may reflect fluctuations in sea level as it rose rapidly from 10,000 years ago to and above its present position. The slight "shoulders" shown on the curve on Fig. 3 may support this hypothesis. Regardless, ultimately, sediments flowing out of the higher southern plateau across the Scamander and Simois Rivers filled the embayment by deltaic progradation and alluvial aggradation to the present geomorphic configuration. Time-depositional surface lines are interpreted for 7000 years, 4500 years, 3250 years, and 2000 years ago in Fig. 3. These interpretations are based on radiocarbon dates from the drill hole program, fluctuations in the sea level curve established for the Biga Peninsula region and the occurrence, in the area, of the marine and alluvial sedimentary deposits. The ancient time-depositional surfaces are equivalent in concept to the present shallow marine-floodplain depositional surface, which might be viewed as the 1980 time-depositional surface.

Paleogeographic Reconstructions

With an understanding of ongoing alluvial, deltaic and coastal erosional, transportation, and depositional processes, and subsurface distribution of sediments deposited in various environments, it is possible to make paleogeographic reconstructions over the past 10,000 years. With a knowledge of time-depositional surfaces, depositional environments and their geometry, the geographic recon-

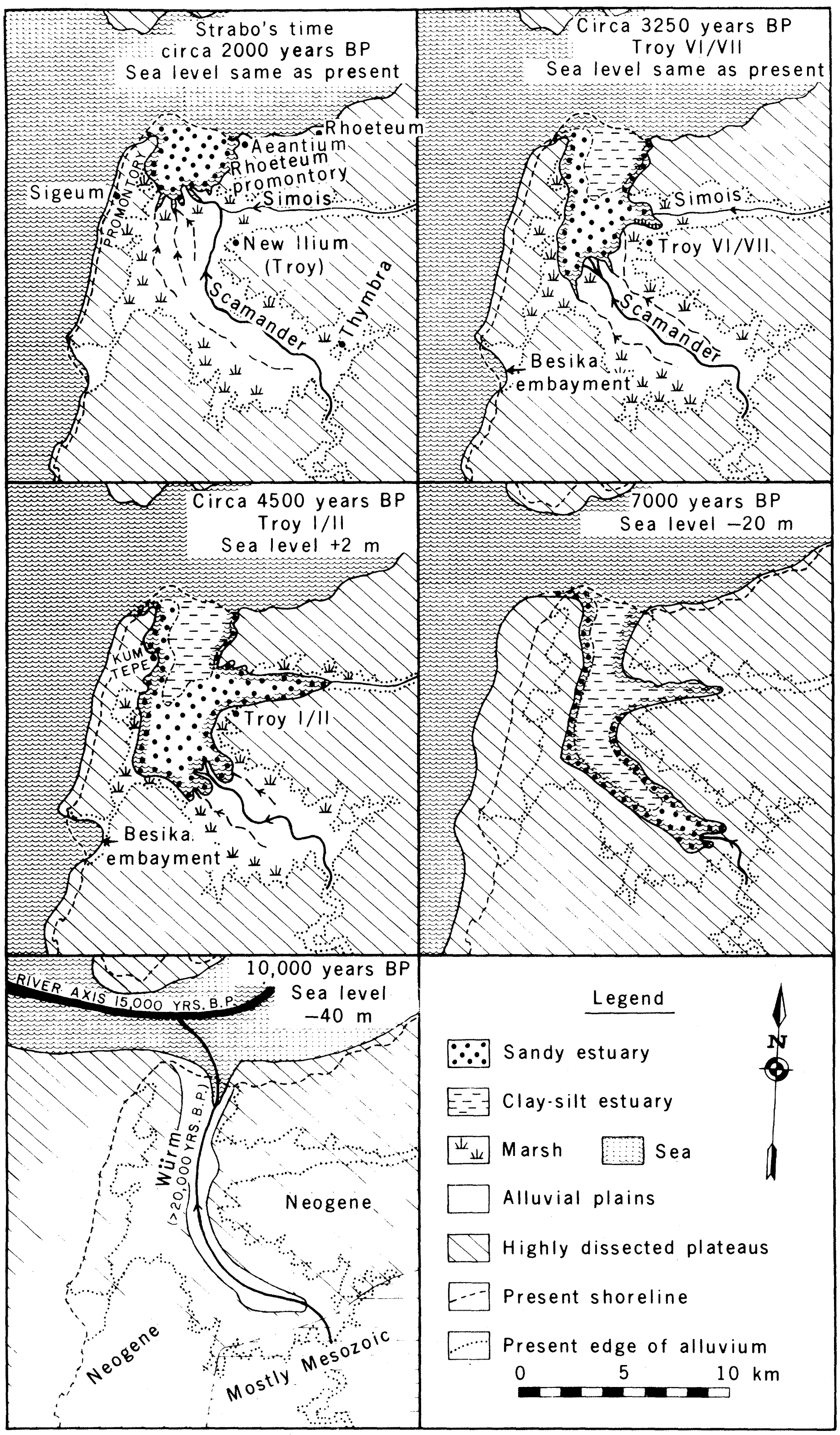

Fig. 6. Paleogeographic reconstructions of the vicinity of Troy throughout the Holocene Epoch of geologic time. The maps shown indicate wave-cut cliff retreat along the Sigeum promontory to the west and delta-floodplain progradation and alluviation northward to the present coast at the Dardanelles. The marine embayments are shown in terms of bottom sediment types including a clay-silt (muddy) marine environment and a sandy marine environment.

structions may be made with precision. Figure 6 presents five reconstructions of the geography of the northwest Troad 10,000, 7,000, 4,500, 3,250, and 2,000 years before the present. These interpretations are derived from information provided in the cross sections in Figs. 3 to 5 and the map in Fig. 2.

One might first consider the geomorphology of the area at the peak of the last Würm (Wisconsin) glaciation approximately 15,000 years ago. At that time, sea level was approximately 100 m below its present level. Accordingly, the areas of the Scamander and Simois River plains were freshwater tributary valleys to a river flowing through the Dardanelles into the Aegean Sea. As sea level began to rise, the marine waters began to encroach the deeply incised topography, and by 10,000 years ago the Dardanelles became an open strait to the Sea of Marmara (Fig. 1). At this time, the Scamander valley was a broad low-lying erosional plain with a river flowing into the marine waters of the Dardanelles. With continuing rise in sea level, by approximately 7000 years ago, a peak marine transgression or inundation of the lower valley of the present Scamander River area occurred (Fig. 6). At this time, marine waters with both muddy and sandy bottom sediments extended approximately 15 km south of the present shoreline of the Dardanelles.

By the time of first known occupancy of the area, when the peoples of Kumtepe and Troy I settled in the region, a low-lying deltaic and fluvial plain had formed in the southern part of the present Scamander River valley. A paleogeographic interpretation of the muddy and sandy marine embayment positions about 4500 years ago (the breakpoint between Troy I and II) is presented in Fig. 6. Troy I and II and Kumtepe were seashore sites. An abundant shellfish and fish fauna was available for use by the people occupying these sites. Evidence of this has been determined by excavations at Kumtepe and Troy (*6, 13*). Fortification Troy was surrounded on three sides by a marine embayment. By 3250 years ago (Troy VI/VII), the supposed time of the "Trojan War," the delta prograded to the vicinity of Troy and lay to the southwest of Troy. Fortification Troy VI and VII lay on a projection or promontory at the edge of a marine embayment. It is possible that low-lying swamps occurred around the base of Troy at this time, although further drilling would be required to verify this. By approximately 2000 years ago the sandy marine embayment lay approximately 3 km south of the present shoreline, or northwest of Troy. Strabo's statements regarding the geography of his time may now be used to make a fairly precise map and description of the region (*3*). Strabo's descriptions of asmaks or blind mouths of the delta and their marshy protrusions and directions are very specific. The data determined from our study suggest that Strabo's statements are extremely accurate despite their secondhand source.

From then until now, delta progradation and alluvial aggradation on the floodplain have continued. In view of the floodplain aggradation, it is unlikely that we will discover the many ancient occupation sites that must exist on the modern floodplain. They are deeply buried as indicated by the time-depositional surfaces shown in cross section in Fig. 3. At the same time that these depositional events were occurring along the valleys of the Scamander and Simois Rivers, the cliffs of the Sigeum promontory were undergoing erosion. An attempt at interpreting this erosion is also shown in the paleogeographic projections in Fig. 6. The precise rates of cliff retreat are little known. However, we do know that the ancient city of Sigeum is undiscovered and that only a small part of its ruins may occur under the ruins of Medieval time at the site of Yenişehir (*12*).

The Beşika embayment of 4000 to 5000 years ago (Figs. 2 and 6) was possibly an indentation approximately 2 km inland. Thus, a sheltered embayment existed in this location about the time of the Trojan War. Mey (with Dörpfeld and Schede) (*18, 19*) made several small excavations in the 1920's on the Beşika plain. They identified shoreline sediments overlying Early Helladic artifacts several kilometers inland, slightly above present sea level. Mey hypothesized that the Beşika embayment was probably the place where the Achaean fleet anchored. Artifacts associated with Troy I were found in coastal sedimentary deposits slightly above present sea level (*18, 19*). Mey's and Schede's hypotheses about the Beşika embayment have tended to remain in limbo over the past half century. The Biga Peninsula is tectonically active and therefore minor coastal uplift is likely. Therefore, these hypotheses now merit reevaluation.

Conclusions

It is now time to reexamine various hypotheses regarding the "Trojan War." Surface and subsurface stratigraphic studies show major paleogeographic changes over the past 10,000 years. Any consideration of historic events over the past 5000 years in the vicinity of Troy must take into account that the geographies of the various times were very different from the present. Should there be a historic basis to the Trojan War, then the axis of the battlefield lay to the south of Troy and to the east of the Beşika embayment. Thus one might suggest that the Beşika embayment was indeed the site of the Achaean camp, and the events described in the *Iliad* and *Odyssey* occurred in a dramatically different geographic and geomorphologic setting from that described heretofore by archaeologists. There are no apparent contradictions between the stories of the *Iliad* and the *Odyssey* and the geographical concepts described in this article. We recommend that scholars of the *Iliad* and the *Odyssey* might find it of interest to reconsider some of their interpretations in the light of the geological and geographical analyses presented here (*20*).

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