Paleogeographical Surveys Around The Mound of Gözlükule (Tarsus)*

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Abstrackt

The Tarsus plains began to take shape when rivers flowing down the Bolkar Mountains caused an fan to form at its base. The sea level rose in front of this belt of fans for the last time during the Holocene, and in turn, created a jagged stretch of land at their base. The alluvial promontory extending in front of the Tarsus river connects to the Seyhan delta, which lies due east. In the west, however, a relatively low area was found between the Tarsus and Huzurkent alluvial fans. The present-day city of Tarsus was established and later flourished on the high, upper part of the old and large alluvial fan formed by the Tarsus river prior to the Holocene era. Rising sea during the early Holocene reached its highest level, namely its present position, during the Middle Holocene. The settlement mound of Gözlükule, situated within the Tarsus city area, also began at this time. However, the rising sea never reached Tarsus and the mound of Gözlükule located there; it did not even get close. From the Middle Holocene onwards (from approximately 6000 years ago to the present day) the delta plain of the Tarsus river advanced rapidly, and the coastline receded into the sea. Meanwhile, because not much alluvium was carried to the low area between the ancient Tarsus and Huzurkent alluvial fans, this area always remained as a depression area. Historical sources state that the wetlands that used to creep all the way into Karabucak provided harbor opportunities for Tarsus during Roman times. However, because these shallow water areas were rapidly filled with sands carried by the winds blowing especially from the coastal sand dunes developing in the south, they shortly thereafter could not be used as a harbor. We are of the opinion that descriptions found in historical resources stating that the Tarsus river used to flow into the Karabucak and Rhegma swamp does not correspond with geomorphologic realities.

Introduction

The mound of Gözlükule is located in the western part of Çukurova at Tarsus town center (in the state of Mersin), in an urban area (Figure 1). A delta plain in the Eastern Mediterranean second in size only to the Nile delta, Çukurova is situated on the skirts of the Bolkar-Aladağ mountain range – one of the highest sections of the Taurus Mountains that rise in southern Anatolia – and formed within a large geological depression stretching from the Mediterranean in a northeasterly direction. Çukurova is a delta plain with a complex structure, fashioned jointly by three large rivers. Its eastern part is formed by alluvium brought by the Ceyhan and Seyhan rivers, whereas its western part is the work of the Tarsus river, fed by the waters from the Bolkar mountains that stand over 3000 meters high, and is thus referred to as called the Tarsus plain.

* English translation by E. Gülşah Seral, M.A.

Due to its fertile soil and favorable climate, the Tarsus plain has been a preferred and important area for human settlement ever since ancient times. Without a doubt, its strategic position also played a significant role in the establishment of early settlements here. These settlements are located close to natural paths that follow the deep valleys formed by the rivers that also created Çukurova, and allowed interaction/communication between the Anatolian, and the Mesopotamian and Egyptian cultures.

Information gathered via archeological surveys and excavations conducted at the mounds of Yumuktepe at Mersin and Gözlükule at Tarsus have shown that the history of settlement in the Tarsus plain goes as far back as to the Neolithic era. The first archaeological excavations at Gözlükule, which may be considered the first place the city of Tarsus was built, were conducted by a team directed by Hetty Goldman between 1934-1939 and 1947-1949. After a rather lengthy intermission, in the year 2000, Bogazici University faculty member Assoc. Prof. Dr. Asli Ozyar initiated a multidisciplinary new archaeological research project, utilizing modern approaches, at this site. Prior to the excavations, it was deemed necessary to determine the features of the geographical landscape, the development and changes they underwent since prehistoric times, and their effects on the development of settlements and culture here. It was within such an approach that our team received an invitation to conduct geoarchaeological investigations around the mound of Gözlükule, thus during 2001 and 2002, our team worked in the Tarsus plain and around Gözlükule.

The work was conducted in three phases. First, and within a wide framework, the general morphology of the Tarsus plain and environs was focused on, and existing information was evaluated with landscape observation in order to examine geological structure and geomorphological development as required by the study. The second phase comprised an investigation of the alluvial geomorphology of the Tarsus plain. Because alluvium constitutes the final geological cover that fill the depressions on the surface of the Earth and because their topmost layers have developed parallel to the history of humankind, by examining the sedimentological characteristics of alluvium it is possible to discern changing natural environmental characteristics of the area through the time. With this aim in mind, core drilling was done in a total of 19 sites during the first phase of the study. Using a percussion drilling device, sediment samples taken from the ground at a depth of 15 meters on average (21 meters deepest) by a gouge corer tube 5 cm in diameter were assessed both at the survey site, and later by in-depth analyses in our laboratories, and information on sedimentary environments was thus gathered. Through these efforts, and via a three dimensional correlation of the determined sedimentation areas, an attempt was made to shed light on the distribution of the various sub-surface sedimentary environments, and the development of the plain especially during the history of humankind. Without a doubt, the higher the number of drills, the closer to the truth assessments made via this method will be, and at this point of time, the number of conducted drills can be said to be insufficient. However, this survey has nevertheless provided interesting new information and results that may be interpreted archaeologically. The third phase of our geoarchaeological surveys comprises the core drills conducted directly in relation to the mound Gözlükule. Of the 19 drills, five took place in the close vicinity of the mound. Here, the aim was to provide information on the stratigraphy of the general alluvial deposition, as well as determine the foundation, i.e. the initial settlement surface on which the mound rests, and thus define the paleogeography of the time when the first settlements occurred. For the time being, our knowledge on this issue is limited to the southern part of the mound. However, we were still able to determine that the base of the mound was 8 to 10 meters below the surface of the present-day mound and environs, that it rests on an old alluvial fan formation, and that the surrounding areas were later filled with fine-grained sediments carried by floods. A higher number of core drill samples taken from the vicinity of the mound would enable significant correlations to be established between the mound accumulation in its entirety and the deposited alluvium in its vicinity, and to relate natural environmental changes to cultural layers.

The geological structure and geomorphologic formation of the Tarsus plain

Çukurova is a complex delta plain formed on the undulating Taurus Mountain range, situated on a large structural depression that stretches northeast from between Anatolia and Cyprus, on the part that edges toward Anatolia (Erol 1997). The Tarsus plain was formed on the western part of this area, with alluvium brought by the Tarsus river, which is fed by the Bolkar Mountains (Figure 1). In line with the main direction of the geological structure of the region, the Bolkar Mountains rise on the northwestern side of the Tarsus plain in a SW-NE direction and its peaks top 3000 meters (Medetsiz peak, 3529 m). The Bolkar Mountains are part of the Taurus Mountain system, and structurally consist of various lithological formations from the Paleozoic and Mesozoic eras. On higher levels, large areas are made up of ophiolithic components that have limestone sections within them. On descending to the Tarsus plain, the younger sections create a less higher but ragged morphology on the skirts of the elevation. Here, detritic (conglomerate, sandstone) and carbonated (marl, limestone) lithological formations dating to the Neogene cover wide areas. The plain stretching from the skirts of the Tarsus' northern side to the present-day coastline is covered with alluvium from the Tarsus river. Along the bed of the Tarsus river, the Tarsus plain stretches for nearly 30 kilometers. It narrows on its western side, and connects to and ends at the flatlands near Mersin, at the foot of mountains there. On the east of the Tarsus river extends the delta-floodplain of the Seyhan River, which developed parallel to the Tarsus plain.

According to general results of geological studies conducted in the region, during the rapid rise of the Taurus' and the Bolkar Mountains that are a part of this mountain system during the Neotectonic period, the wide structural depression that extends toward Çukurova from between the Taurus mountains and the island of Cyprus downfaulted even more, and while a part of it sunk deeper under the waters of Mediterranean, its NE section filled up with alluvium, creating the Çukurova plain (Erol 1997). However, this process continued through long geological periods, speeding up at times, and coming to a halt at others. During times of rapid rise, the materials that eroded off the Bolkar Mountains accumulated in the deepening basin at the foot of the mountain, and because the edge of the basin also rose during the next phase of rapid rise, the previous young sections were added onto the new erosion areas. Consequently, as one moves from the Bolkar Mountains toward the Tarsus plain the progressively younger sediment units stretch out in bands, and their faulted monoclinal blocks tilted down to the Mediterranean, form the main elements of the rugged geomorphology (Figure 1).

The sediment characteristics of the progressively younger units as one moves toward the plain also shed light on the paleogeography of the time they were formed. For instance, the fact that the gravelly Neogene formations at the foot of the mountain indicate rain-storms and flood regime that could transport these coarse sediments also played a role, in addition to rapid tectonic rise. These detritic formations later became erosional areas once they rose, and because they could be easily disaggregated, they caused more sediment to be transported to the basin that was increasingly deepening in the south. The fact that the Pliocene deposits contain a clayey matrix and concretions high in carbonate (caliche) reveals that during that time the climate here was semi-arid and its rainy and arid seasons were more distinct than when compared to the present (Erol 1988). These climactic features continued throughout the Pleistocene, when the present geographical environment developed, the Çukurova plain and the Tarsus plain on its western edge were formed. The Tarsus plain seems to have initially formed as great alluvial fans of the major rivers flowing downward from the mountains, particularly the Tarsus river. On

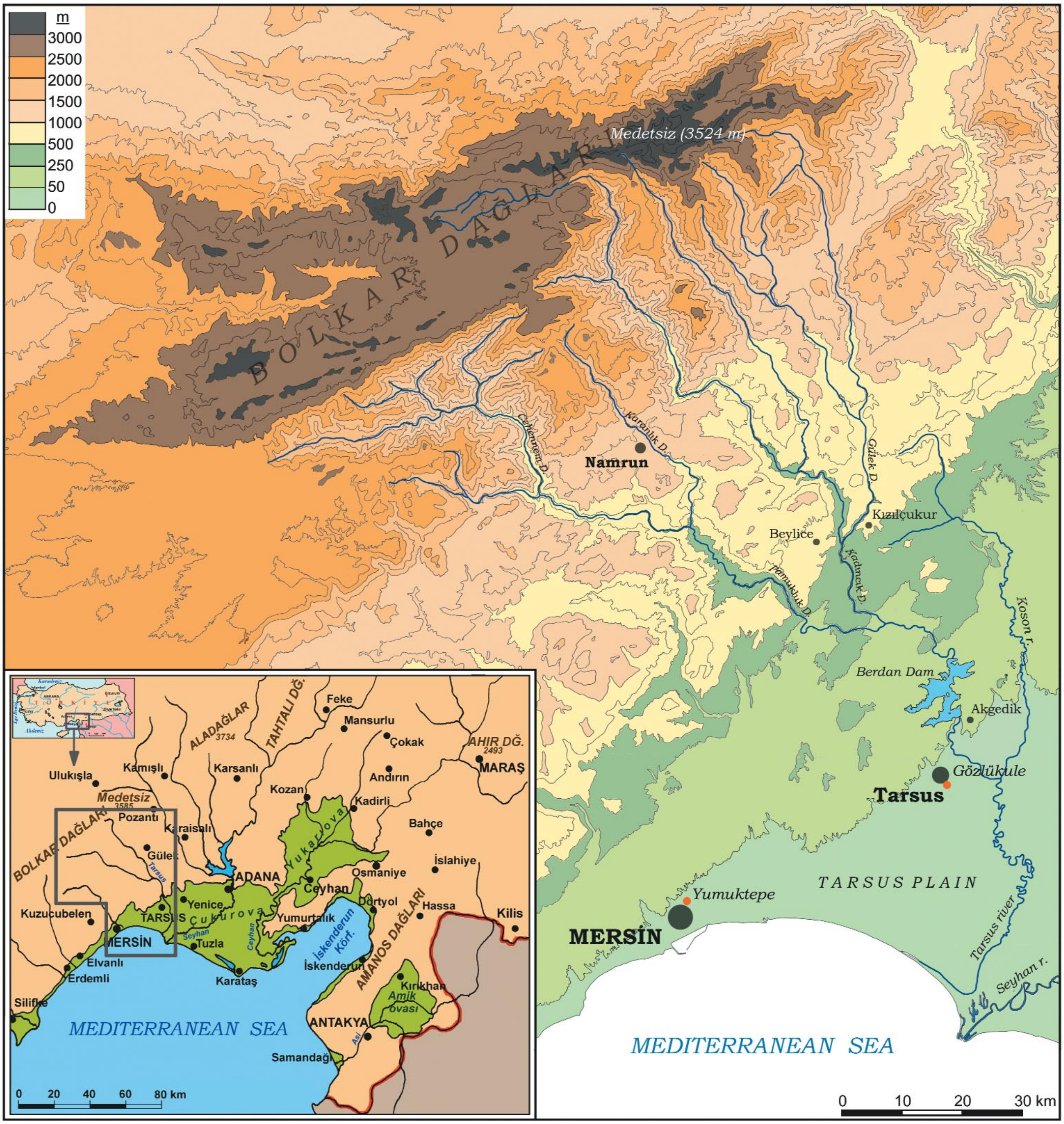

Figure 1: Topographical and oro-hydrographical map of the Tarsus river catchment area and location of the Tarsus plain.

the foothills beyond Tarsus, surfaces of these old deposits (or in the Tarsus case, the Tarsus alluvial fan) that contain a gravelly coarse elements within a reddish, clayey matrix and also are partially high in carbonate deposits (caliche) today form slightly-sloped, terrace-shaped flatlands on an elevation higher than the lower plain (Erinç 1953). Towards the plain, this old alluvial fan is covered with younger, fine grained flood sediments, which we could follow as the base of the new alluvium during our core drills near

Tarsus. Accordingly, it would appear that the shaping of the Tarsus plain in a more recent geological time (Quaternary), followed the earlier pattern where mountain ranges in the back continued to rise, and areas toward the Mediterranean continued to be downfaulted.

Alluvial geomorphology of the Tarsus delta plain

Deltas develop and are created through structural features linked to the movements of the earth's crust, as well as the accumulation of alluvium and factors that influence this process. Climactic characteristics constitute a large part of these factors. The amount of alluvium that rivers carry depends on the characteristics of the rocks in the region as much as the waterpower, namely rainfall, that erode them. Data provided by the Tarsus Weather Station states the average annual rainfall here to be 575 mm. However, this value varies significantly from one year to the next. In 25 years of observations here, annual rainfall has been measured at a maximum of 1262 mm, and a minimum of 320 mm. Daily maximum rainfall rates can be as high as 141 mm. In addition, because it rains mainly during the winter in a Mediterranean climate, rainfall increases during this season. Furthermore, Tarsus is situated at the foot of a mountain that abruptly rises on the coastline. Because there is not a weather station in the mountainous area, there is no information on the difference in the amount of rainfall that occurs in the highlands, the waters from which flow into the Tarsus river. Due to the elevation of this area, as well as orographical influences, it follows naturally that rainfall here will be higher than it is in Tarsus.

Another factor that plays a role in delta development is sea level changes that take place over long periods of time. There are two main reasons for this. One of them consists of relative changes that occur as a result of regional or local movements of the earth's crust. The fact that the highland area beyond the Tarsus plain rose as the Mediterranean depression became deeper resulted in exactly this kind of effect. This effect, however, did not reach such grand scales during for instance geologically recent Holocene (the last 15.000 years). Alternatively, changes in sea level (eustatic sea level change) that occur due to climate changes on a global level were experienced on a larger scale. During the nearly 15.000 years (the Holocene) that passed since the end of the last glacial period until the present, sea level have risen more than 100 meters. Accordingly, it is no surprise that the coastline of the Tarsus plain was off the current coastline during the last glacial period, when sea levels were lower. However, these coastlines are today under water and because they are covered with deposits from the delta, it is not possible to observe them directly.

During the Holocene while the sea level was on the rise, alluvial sediments which transported by the Tarsus river were accumulating on the coastal zone and worked by the waves to form various coastal features. Rising sea, which initially rose rapidly, covered the continuously changing coastline. This rise is known to have petered out about 6000 years ago (Kayan 1988). Although the sea level experienced small changes, no more than a few meters after that time, it is difficult to directly observe or determine these changes on the delta shores. In the last 6000 years, the sea level has remained more or less close to current level. Deltas, and in particular the Tarsus delta reached its present form during this last stage (the Middle to Late Holocene), which also bore witness to settlement in the vicinity. Due to the rapid development of the delta after the sea level ceased to rise, the coastline retreated into the sea, and the area of the alluvial plain that people could use, widened. The reason for going underneath the surface of alluvial areas here via core drills was to examine the sediment samples deposited here in the various sedimentary environments and determine their development.

When this development came to an end during the Early Holocene that dates back 6000 years and when the sea level was rapidly rising, the coastline intruded further inland than the present day coastline and reached the skirts of the old alluvial fans in the Tarsus-Mersin zone. In the following stage, alluvium brought this time by rivers, and in particular the

Tarsus river filled the coastal zone, and the rapidly advancing delta shore took its present-day shape, leaving behind various geomorphologic traces. The 19 core drills carried out within the framework and first phase of this survey were planned so as to be able to draw three cross-sections in a north-south direction (Figure 2). The cross-sections drawn were 1) on the eastern side, alongside the eastern bank of the Tarsus river, 2) in the middle, from southern Tarsus toward the coast, and 3) on the western side, from southern Huzurkent to the coastline. The core drills generally went as deep as 10 to 15 meters (21 meters at its deepest point), and those conducted near Tarsus revealed the pebbly, old alluvial fan underneath the new, fine-grain flood alluvium, while those near the coast depicted marine mud units beneath the flood alluvium that covers the present-day surface.

Utilizing cross-sections drawn based on surface morphology and data gathered through the drilling process, and the paleogeography map drawn based on these cross-sections, the development experienced at this section of the delta may be summarized as below:

The sea that rose rapidly during the Early Holocene inched in a northerly direction from the present day coastline, towards the south of Tarsus (Figure 2 and 3). The low area between the old alluvial fans on which Tarsus and Huzurkent rest, is where the sea advanced inland the most. Because less sediment reached this area in later times, it maintained its swampy features until recently. Known as the "Karabucak swamp", the area has been drained in the last half-century and trees planted. Although the Karabucak swampland area was always on a lower altitude than its surrounding area, it seems never to have been covered by the rising seawater. Drill number 05 conducted here did not bring up any marine sediment. The drill, which took place on a surface about 7 meters high and went 15 meters deep, came across filling that was at times swampy, and at others river flood sediments until about 13 meters, where we met the hardened filling of the old Tarsus alluvial fan deposits behind us. During this survey because no drills could be conducted to the south of the Karabucak swamp, it was not possible to pinpoint exactly how far the coastline had advanced. However, based on the information gathered from drills number 19 and 06, conducted further south, it appears that there was a wide and shallow depression between the Tarsus and Huzurkent alluvial fans and that the sea had advanced inwards toward this depression (Figure 3).

It is known as a general fact that the sea advanced inland the most about 7000 to 6000 years ago (Kayan 1988). One of the most frequently asked questions in archaeological assessments is whether or not the Karabucak swamp might be the harbor site of ancient Tarsus. For Neolithic-era Tarsus (the mound of Gözlükule), we are of the opinion that a coastal swamp that provides abundant seafood would be more important than a harbor. And in later times, although it always remained on a lower elevation because less alluvium reached this area, it would seem that there was never sufficient water here for a real harbor. This area has always been a swampland.

During the time the coastline advanced inland the most, it appears that especially the Tarsus alluvial fan formed a distinct promontory jutting out into the sea. The rising sea covered the skirts of the fan during its ascent. This fact is indicated by drills number 06, 11 and 15 that brought up marine sediments, and drills number 10, 07 and 04 that went directly into the hardened fill of the old alluvial fan formation (Figures 2 and 3).

Although organic materials that could be dated using the C14 method did come up during the core drills conducted in relation to the development of the Tarsus delta plain, it was not possible to conduct such a dating at this phase. Therefore, it is not possible at this time to connect geomorphologic development to absolute chronology. However, general information exists on sea level changes that occurred during the Holocene, and the delta stratigraphy of the Anatolian coastline during the Holocene (Kayan 1999). In light of this general information and the sedimentological data obtained from the core drills conducted at the Tarsus delta plain, it is, for the time being, possible to put forth an assessment in general terms. When the

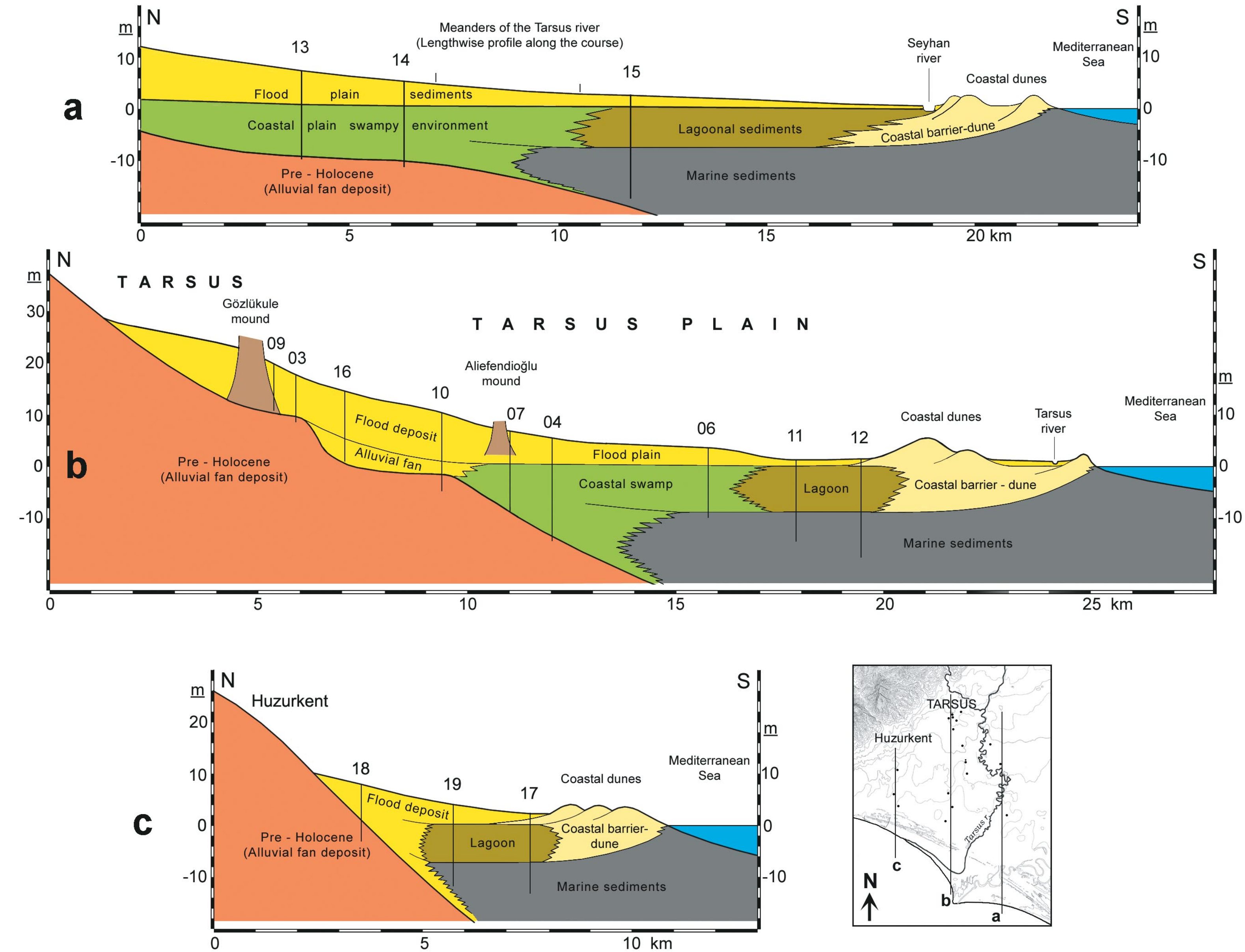

Figure 2: The North-South cross-sections of the Tarsus plain showing alluvial stratigraphy on the pre-Holocene alluvial fan deposits. Vertical lines and corresponding numbers indicate core drillings. Small map shows locations and lines of the cross-sections. Vertical scale is much exaggerated to reflect the complete geometry of the subsurface sedimentary units.

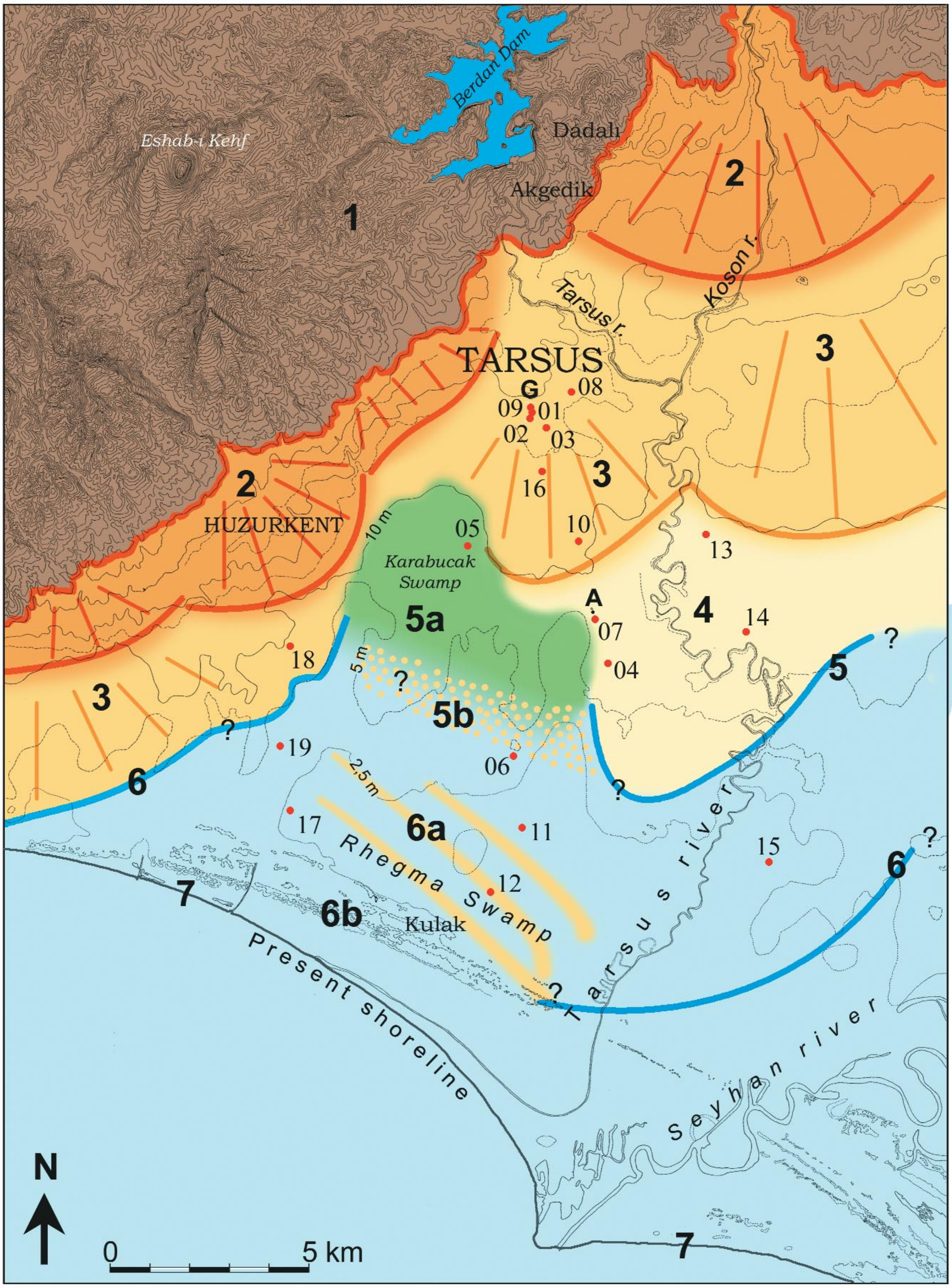

Figure 3: Paleogeographical map of the Tarsus plain.
1) Rough mountainous area. 2 and 3) Old (Pre-Holocene) alluvial fans. 4) Early Holocene delta-floodplain of the Tarsus river. 5) Middle Holocene shoreline (Maximum extension of the Holocene marine transgression). 5a) Coastal swamp or partly lagoonal pond during the Middle Holocene. 5b) Coastal barrier or spit formation along the entrance of the Middle Holocene coastal embayment. 6) The mid-late Holocene progradational delta coast of the Tarsus river and 6a) corresponding coastal barrier-dune formation (Partly subrecent dune). 6b) Subrecent coastal barrier-dune formation. 7) Present-day shoreline. Red dots and corresponding figures indicate core drillings. G: Gözlükule mound. A: Aliefendioğlu mound. Contour lines with 10 m interval (5 and 2,5 m only on the plain).

sediment units that deposited in different subsurface sedimentary environments are assessed in a stratigraphical order, from the bottom up, geomorphological development may be parsed into the below components (Figure 2 and 3):

Pre-Holocene alluvial fan deposits

In the Tarsus plain, there exist extensions of the pre-Holocene alluvial fans deep beneath the present-day surface, under the Holocene sediments, and visible on the surface of the distant foot of mountain slopes. These are deposits brought by high-energy flood-like flows from the mountains and consist of large pebbles and coarse sand within a reddish brown, clayey matrix. Within the fill, there are various kinds of limy concressions, which reflect humid seasons followed by hot and arid ones where heavy evaporation occurs. It would seem that along the foot-slope of the mountain, the larger alluvial fans extend in front of bigger rivers such as the Tarsus river. Therefore, the pre-Holocene mountain skirts may be defined as a belt of alluvial fans, the surfaces of which undulate slightly, boast jagged edges in accordance with their size, and face the sea which then was about 100 meters below its present level.

The Early Holocene transgression and marine sediments

The sea that rose during the Early Holocene covered the skirts of the alluvial fans and moved inwards from the present-day coastline. Because the surfaces of the fans incline toward the sea, despite numerous attempts, efforts to drill this surface, which rapidly grows deeper, proved futile (Figure 2). Nonetheless, while the sea was rising and advancing on this surface, it seems that a narrow coastal plain was formed beyond the coast, which is mostly covered with coastal swamps, whereas marine mud is generally gray to dark gray in color and silty-fine sandy. The sediments that are partially sandy and the layers including plenty of marine shells represent the variety of environments in front of the delta. It seems that when the rate at which the sea level was rising increasingly slowed down, the coastal plain beyond the shoreline grew wider. This is an indicator that in time, the advancement of the delta began to dominate over transgression.

Development of the Middle Holocene delta plain

In the time that followed the end of rising sea levels (about 6000 years ago), river deposits on the coast began to dominate even more, and the delta plain of the Tarsus river rapidly advanced toward the sea. It would appear that the sandy barriers formed by the sands deposited at the coastal zone played an important role in this development (Figure 2 and 3). Because traces of these features, which formed at a time closer to the present day, have not yet been erased, they are still visible on the surface and thus, aerial photographs are very useful in their assessment. It would appear from these photographs that the sands formed from the alluvium brought by the Seyhan to the east, and even the Ceyhan rivers in addition to the Tarsus river were transported by littoral drift all along the coastline westward. These sands formed the coastal spits and barriers that extend from the delta lobe that advances toward the sea from the mouth of the old Tarsus river to the west, toward the depression that lies due south of the Karabucak swampland area. During this process, which took place in several phases, the low areas beyond the coastal barriers were initially lagoonal ponds. Although there exists no information on C14 dating regarding this development, it appears that these lagoons were viewed as suitable water routes to access ancient Tarsus (late 1000 BC) by sea, and information is available on this topic in historical sources. However, when evaluating these lagoons as harbors, one must keep in mind that they were in fact rather shallow, and their use as "harbors" should not be overestimated.

This Middle Holocene formation, which represents the change from marine environments to present day terrestrial plain surface, offers a rich variety of environments made up of different sediment deposits. The sediments that accumulated in the lagoons are distinguishable in that they are partially rich in organic materials and their fine silty-clayey laminated structures, whereas the plains beyond the lagoons are covered with fine sandy-silty alluvium brought by low-energy river floods. As they advanced, first the lagoons were filled, then mostly fine-grained alluvial deposits accumulated on top of this fill from even lower-energy floods, and the delta plain continued on its path toward the sea.

Delta-floodplain development in the Late Holocene

During the final phase of the development of the Tarsus plain, the surface of the plain beyond the coast, especially in places close to the Tarsus river bed, was filled with silty-fine sandy alluvium spreaded by new floods, and rose higher. Conversely, the wide area due south of the Karabucak swamp, which lies to the west, and where less sediment was deposited, always remained on relatively lower ground and maintained its swampy characteristics. It would appear that the sands carried by the wind blowing from the coast had more of an influence in filling this area than did the alluvium that came from behind. The sands carried westward by a littoral drift along the coast first accumulated as coastal barriers in the coastal zone because of waves, then were carried inland by the southerly winds prominent especially in the summer (Hocaoglu, 2003). These sands formed wide areas of sand dunes beyond the coast. To prevent the sand dunes from expanding toward agricultural areas gained from draining the more inland swamps, treess were planted here with the aim of bringing an end to the movement of the sand.

During the final phase of delta development, because the coastline kept on advancing toward the sea, marine effects such as sea depth and wave strength are on the rise, whereas delta development has increasingly slowed down. It would appear that the present day delta projection also has different effects on sand movement along the coast when compared to the past. For instance, new coastal barriers, lagoons and swamps have not been forming on the coast. In addition, large dams (such as the Berdan dam built on the Tarsus river) constructed on inland rivers diminish and organize the amount of water and alluvium they carry to the shore. Thus, the influence of flooding, which plays the most vital role in delta plain development, has been greatly reduced. This is why it may be said that a new era has begun in the Tarsus plain and its coastal zone where geomorphologic development will from now on continue at a very slow rate.

A geoarchaeological assessment of the core drills conducted in the vicinity of the mound of Gözlükule

As the main aim of this survey was to contribute to the archeological research to be conducted on the mound Gözlükule situated within the present-day urban Tarsus area via the utilization of a paleogeographical approach, core drills were concentrated near the vicinity of the hoyuk and 6 drills were conducted here first (Figure 3 and 4). However, due to difficulties of working in an urban area, drilling had to be restricted to the southern and eastern side of the hoyuk during the first phase (Öner et al. 2003a and 2003b). Although the drill points were not aligned, a general assessment was done and the cross-section in Figure 4 compiled. In the light of the available information on the vicinity of the mound, it is possible to make the below appraisals for the time being:

The present-day upper surface of the mound of Gözlükule is about 40 meters above sea level. Due to the incline of the base, the visible part of the mound is 15 meters in the north and about 20 meters in the south. Within the stratified cultural layers that form the mound, a continuous settlement dating from the Neolithic until the present day had been discovered in the earlier excavations directed by Hetty Goldman (Goldman 1956; Özyar et al. 2003). However, excavations did not reach below the levels where obsidian tools were found. Digging did not go down to sterile base on which the mound deposit rests. The base of the mound was never reached. The geoarchaeological work we conducted in this area focused firstly on the ancient surface on which the base of the mound rests, and on its characteristics.

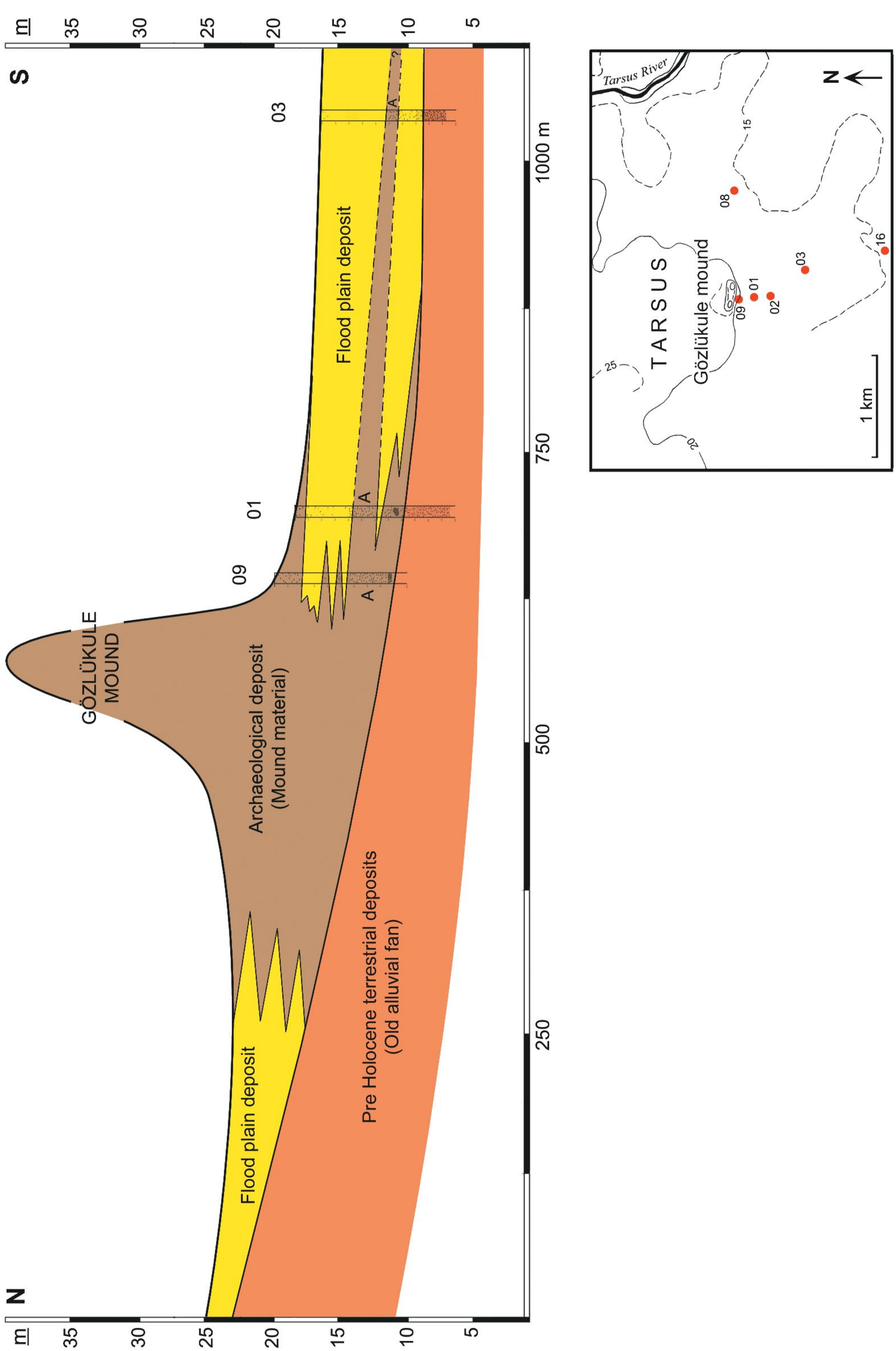

Figure 4: Stratigraphical position of the Gözlükule mound.
09, 01 and 03 indicate core drillings. A: Archaeological material (Pot-sherds, fire remains like ash, charcoal, burned bones). Small map shows topographical position of the mound and core drillings (Red dots). Vertical scale is much exaggerated to reflect complete geometry of the mound.

The core drills conducted south of the mound entered its base about 8 meters below the present-day surface of the plain. This base is the surface of the pre-Holocene alluvial fan formed by the Tarsus river (Figure 4). Drill number 09 and 01 revealed that fill containing archaeological material distinctly begins on this level. The archaeological materials discovered via the core drill are of pottery sherds, large stones, fire remnants such as ashes and coal, burnt bones, and seashells. However, when considering that the drill holes are 6 cm in diameter, these objects are very small and not suitable for archaeological dating. It can be said with absolute certainty that the sea never advanced as far inland to the surface on which the hoyuk rests. The seashells found here are remnants of marine gastropods generally consumed as food (especially Cerastoderma edule), often found on all archaeological sites near a coast. Because the sea never got very close to this area, sediment diversity resulting from a variety of environments is not evidenced here, as is the case in coastal areas.

The fill beneath the base of the mound is part of the alluvial fan that the Tarsus river has been accumulating since ancient times, dating back to well before the Holocene. It comprises pebbles and sands found within a reddish brown, clayey-fine grain matrix related to a semi-arid climate. Since the fill surface was offshore during the beginning of the Holocene and was washed by low-energy surface waters, and because fine grains are easily carried, large pebbles remained on the surface. During the drilling process, these pebbles act as clues toward defining this surface. The first settlement site of the Gözlükule hoyuk was here, on this surface. It is possible to distinguish this surface from the pottery sherds and fire remains in the matrix of the mound.

While the settlement layers of the mound were accumulating on top of one another and rising, in the south, due to rising sea levels and the decrease in the slope of the Tarsus river bed leading to a loss of some of its carrying power, the old alluvial fan surface that had eroded prior to the Middle-Holocene began to be covered by fine-grained-silty alluvium as a result of the low-energy floods of the Tarsus river from the Middle-Holocene onwards. The timing of this morphodynamic change is in significant accordance with archaeological finds dating back to the Neolithic era.

In line with this assessment, the Gözlükule settlement area and environs must have at times experienced flooding. However, it would seem that these floods did not prevent settling here. One fact that arises frequently concerns archaeological materials spreading out from the cultural layers of the mound to the surrounding area. Perhaps the mound expanded at times, and was used less intensely during others, and thus during the latter, remnant relics were washed by surface waters and dispersed within the area, may be a viable interpretation of this fact. The intensity of archaeological materials found at 5 to 6 meters of depth via drill number 03, conducted about 300 meters south of the mound, is interesting in this regard. Without a doubt, only through archaeological excavation to be undertaken here will it be possible to shed light on the expansion of mound fill and its archaeological stratigraphy.

Results and geoarchaeological assessments in the light of historical resources

The city of Tarsus experienced its golden age during the Roman era (Ramsay 2000). Strabon, Xenophon and Dion Chrysostomos all mention a lagoon situated due south of the city of Tarsus during this time. Strabon also writes about a lagoon that existed during the time of Christ, which was called Rhegma, due south of Tarsus, and which connected to the sea. Dion Chrysostomos, who visited Tarsus around the same time, also stated that the city's wealth came from a harbor built on the shore of the lagoon, into which the Tarsus River flowed. Furthermore, he also mentioned that the Tarsus river passed through the city before flowing into a pond due southwest of the *höyük* (the presently-drained Karabucak swampland area), and that this pond was connected via an outlet to a lagoon (the Rhegma lagoon). According to historical sources, the city of Tarsus experienced large floods during the 6th century AD, upon which the bed of the Tarsus river was moved to an ancient riverbed further east of the city via a canal dug due north of the city.

Neither the alluvial geomorphology of the current surface, nor the data obtained by core drilling completely fit these definitions or comments made on this issue up to the present. The locations of the Karabucak and Rhegma lagoons can be still be seen on aerial photographs. The description of the Karabucak swampland as a lagoon may be correct. However, core drills conducted here did not bring up any marine sediments. On the other hand, it must be said that drill number 05 was conducted toward the edge, and that in order to reach a satisfactory finding on this topic, new core drills need to be carried out.

Here, the more important issue from a geomorphological point of view is, that "the Tarsus river first flows into the Karabucak, and then, the Rhegma lagoons." This is simply not possible. The Tarsus river is a body of water that carries a lot of water and causes large floods. Accordingly, it has created a delta-floodplain large enough to be considered as a part of Çukurova. If such a body of water flowed into a shallow lagoon pond, that pond should have rapidly filled with water, and it would need to be accompanied by geomorphological formations such as filling sediments and delta lobes. Conversely, both Karabucak, and Rhegma are both depression areas that were recently drained via the use of modern day technology; in other words, they are still present-day swamplands. Moreover, the morphology of the old Tarsus river alluvial fan is not suitable for the Tarsus river to flow toward the Karabucak area through Tarsus. Only smaller brooks coming from the slopes beyond Tarsus, and especially beyond Huzurkent flow toward the Karabucak and Rhegma low areas. Also, as mentioned above, the use of the "harbor" concept should not be over estimated here. The shallow waters of a lagoon are not appropriate for long-term docking. As a matter of fact, it is known that when the harbor filled up here, it had damaging effects on the city. In this case the harbor was filled not by the alluvium brought by the brooks from the north, but more by sands of the sand dunes that developed from the mouth of the Tarsus River toward the west, which blew in a northerly direction. There are other examples of similar occurrences all along the Mediterranean coastline (Öner 1999).

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