Synergia

Festschrift für Friedrich Krinzinger

Sonderdruck

PHOIBOS

Inhalt von Band I

Ephesos – Metropolis Asiae

John C. Kraft – Helmut Brückner – İlhan Kayan

The Sea under the City of Ancient Ephesos

Summary

In Neolithic times, the marine waters of the embayed southern coast of the Gulf of Ephesos were over 30 m deep in the area that later became the lower city and harbor of Hellenistic, Roman and Byzantine Ephesos. From Geometric to Classical times, the prodelta silts were deposited far seaward of the Kayster River (Küçük Menderes) delta shoreline. These sediments infilled the embayment at the foot of Mts. Preon (Bülbüldağ) and Pion (Panayırdağ) to shallow waters only 2 to 5 m deep. Here, Hellenistic and Roman engineers built the great harbor and lower city of ancient Ephesos. A large amount of debris and fill was used to provide a firm construction base over formerly coastal swamps and shallow marine waters.

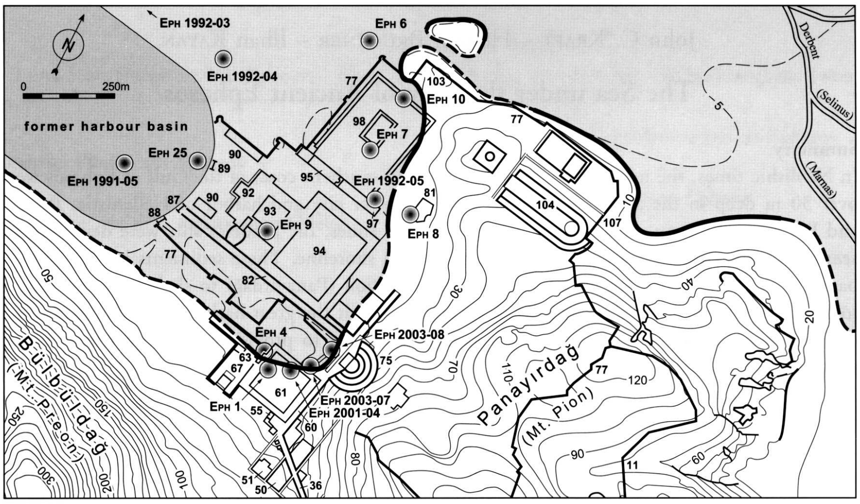
Our drill core studies of the sediments, their fossils, and radiocarbon dates from the strata under the buildings, walls and harbor works allow delineations of the ancient coastline, swamps, and sea bottoms. Over a millennium, the peoples of Ephesos continued their struggle to maintain their harbor and access to the sea, as the Kayster River delta continued to move over 7 km seaward.

Introduction

The global warming at the end of the last Ice Age caused an enormous worldwide rise in sea level from –120 m close to its present position circa 5–6 millennia ago. During the late Pleistocene to Holocene Epoch transgression, the marine waters of the Mediterranean Sea inundated the ancestral valley of the Kayster River (Küçük Menderes), which occupied a large Neogene graben. Flanked by mountainous horsts to the north and south, and punctuated by tributary streams in north-south valleys (sometimes grabens), marine embayment waters extended over 15 km landward of the present coastline. Since Neolithic times, the delta floodplain of the Kayster River has rapidly prograded seaward. The rate of infill of the formerly clear waters of the ancestral Gulf of Ephesos was exacerbated by the surge of eroding soils and rocks that accompanied the intensification of deforestation and concomitant agriculture in Neolithic and Bronze Age times.

We know little of the impact on peoples of the Kayster River's relentless delta progradation in Bronze Age. As early as the 7th century BC, both alluvium of the Selinus River (Derbent) as well as the Kayster River's prodelta marine silts began to impact the site of the Artemision and its harbor to the north-east of Mt. Pion (Panayırdağ). Homer's »Meadow of Asia« on the lower floodplain of the Kayster River with its swamps, coastal marshes and shallow lagoons was already visible to the north-east of the Artemision and Ayasoluk hill in Geometric to Archaic times. At the same time, the river's prodelta silts were rapidly infilling the formerly 30 m deep marine embayment for many kilometers seaward. Also, these silts were actively infilling the marine waters of all of the harbors of Ephesos – including the later site of the great harbor of Hellenistic and Roman times. In several papers we have developed temporal and spatial scenarios for these processes of ever changing landscapes[1].

1 J. C. Kraft – H. Brückner – İ. Kayan, Paleogeographies of ancient coastal environments in the environs of the Feigengarten excavation and the 'Via(e) Sacra(e)' to the Artemision at Ephesos, in: P. Scherrer – H. Taeuber – H. Thür (eds.), Steine und Wege. Festschrift D. Knibbe, SoSchrÖAI 32 (1999) 91–100; J. C. Kraft – İ. Kayan – H. Brückner – G. Rapp, A geologic analysis of ancient landscapes and the harbors of Ephesos and the Artemision in Anatolia, ÖJh 69, 2000, 175–223; J. C. Kraft – İ. Kayan – H. Brückner, The geological and paleogeographical environs of the Artemision, in: U. Muss (ed.), Der Kosmos der Artemis von Ephesos, SoSchrÖAI 37 (2001) 123–133; J. C. Kraft – İ. Kayan – H. Brückner – G. Rapp, Sedimentary facies patterns and the interpretation of paleogeographies of ancient Troia, in: G. A. Wagner – E. Pernicka – H.-P. Uerpmann (eds.), Troia and the Troad –



11 Hellenistic city wall
36 Curetes Street (Embolos)
50 Terrace House 1
51 Terrace House 2
55 Celsus Library
60 Marble Street
61 Tetragonos Agora (Common Market)
63 West Gate of the Agora
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90 Market buildings at the Harbour
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94 Xystoi / Halls of Verulanus
95 Church of Mary
97 Episcopium of the Church of Mary
98 Olympieion
103 Crevice Temple
104 Stadium
107 Coressian Gate

Fig. 1: The city area of Ephesos with indication of the maximum extension of the marine transgression (grey area). Solid line: proven by excavations and corings, dashed line: presumed. Names and numbers of buildings according to G. Wiplinger (in: P. Scherrer [ed.], Ephesos. Der neue Führer [1995] 248ff.). Coring numbers by the authors

Thus began the fascinating story of delta progradation, embayment shoaling, and partial preservation of the delta flanking waters (harbors) of the city of the Ephesians. The people's struggle for their harbors continued for more than 1.5 millennia; occasionally, a relocation of the harbors was necessary[2]. The story of the geographic and environmental changes around Ephesos and neighboring areas has been told by many scholars[3].

Drill Core Studies Used in the Determination of Ancient Geographies

The various depositional environments within a river delta, prograding into a marine embayment as well as the adjacent marine embayment sediments, have distinctive characteristics. These may be used to delineate or map ancient coastal landscape and marine (sea bottom) conditions. As one sedimentary environment of deposition changes to another due to delta progradation, layers of sediment accumulate one over another. Sandy sea bottoms with an abundant clear water molluscan fauna are overlain by marine silts (muds) with their own characteristic fauna and flora. These are in turn buried under prograding delta distributaries with their channel sands and gravels, sandy levees and interdistributary brackish marshes and lagoons. Finally, the river floodplain aggrades upward with its fertile soils, backswamps, lakes and ponds. Thus, sedimentary strata, one layer over another, accumulate in vertical sequence.

Scientific approaches (2003) 361–377; H. Brückner, Holocene shoreline displacements and their consequences for human societies: the example of Ephesos in western Turkey, 137. Suppl. Zeitschrift für Geomorphologie N. F. (2005) 11–22; İ. Kayan, The Troia bay and supposed harbour sites in the Bronze age, Studia Troica 5 (1995) 211–235.

2 Kraft et al. (note 1:2000).

3 s. list of references e. g. Kraft et al. (note 1:2000).

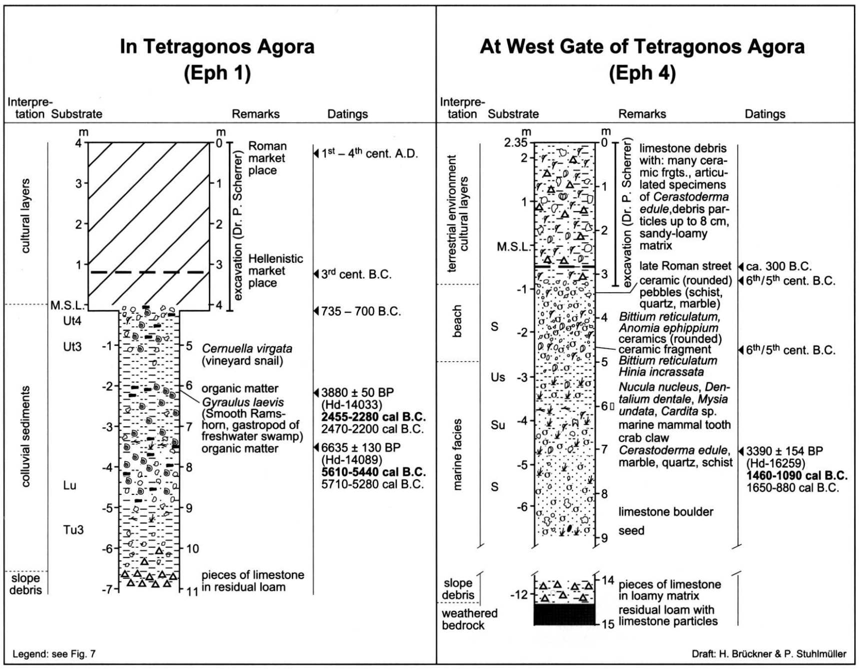

Fig. 2: Coring profiles Eph 1 and Eph 4 in the area of the Tetragonos Agora (Common Market)

Physical geographers and geologists can interpret the past history of landscape changes by obtaining drill cores of the buried strata. Sediment analysis, including fossil remains (flora and fauna), provide us with important palaeo-environmental information. Radiocarbon dates of fossils and dates of ceramic finds provide us with the chronostratigraphic framework for our interpretations of ancient marine, coastal and delta landscapes in the environs of ancient Ephesos. In previous works we have analyzed the entire lower Kayster River region. Herein, we present our drill core evidence for changing geometries of the former sea that underlay the lower city of ancient Ephesos[4].

Drill Core Logs and their Interpretations: Under the Lower City of Ephesos

In the following sections we describe and interpret the different sediment cores. The core sites are shown in figure 1. Our research was concentrated around the areas of Tetragonos Agora (Common Market), Episcopium of the Church of Mary and Olympieion.

Tetragonos Agora (Common Market)

Core Eph 4, at West Gate of Tetragonos Agora, ca. 300 BC, in an excavation trench by P. Scherrer (fig. 2)

A thick layer of slope debris was deposited on top of weathered bedrock, encountered at 12 m below present sea level (b.s.l.). The slope debris is overlain by marine fossils, pebbles and rock fragments (limestone, quartz, mica schist). This testifies to a mixture of marine and terrestrial sources; i. e. sheet flow deposits from the surrounding slopes were washed into a shallow marine

4 For the methods of our geoarchaeological approaches s. H. Brückner, Delta evolution and culture – Aspects of geoarchaeological research in Miletos and Priene, in: Wagner – Pernicka – Uerpmann (note 1) 121–144.

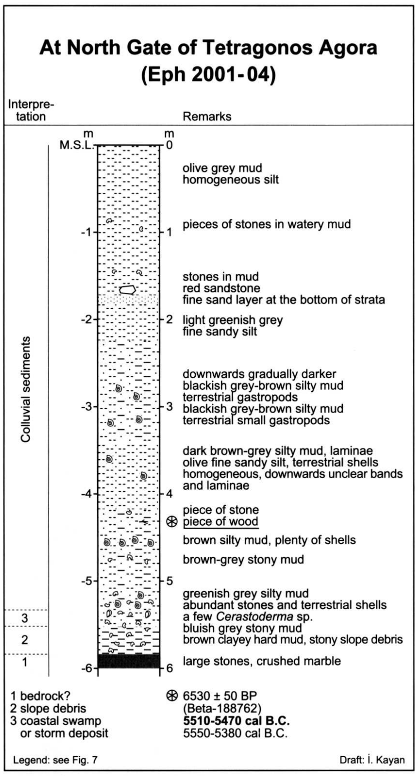

Fig. 3: Coring profile Eph 2001–4 at the North Gate of the Tetragonos Agora (Common Market)

embayment. Finally, the area turned into a coastal swamp and shallow marine embayment (silt with a lot of plant remains, sea grass). A specimen of *Cerastoderma edule* at 4.55 m b.s.l. was deposited in late Mycenaean time. Of interest is the transition to littoral facies at 2.60 m b.s.l. The gravels, grading upwards in size, are within a sandy matrix and well rounded – an indication of relatively high wave energy. The artifacts are also rounded. The youngest ceramic find dates this beach to the late Archaic/early Classical times. Around 0.90 m b.s.l. follow disturbed layers with much cultural debris (up to 8 cm pieces with edged ceramic fragments). At 0.55 m b.s.l. a street was unearthed, which dates from 300 BC (oral communication by Dr. P. Scherrer). Since that time the site must have been solid ground.

Core Eph 1, ca. 50 m south-southeast of Eph 4, in P. Scherrer's excavation of the Hellenistic market place and down to the late 8th century BC (fig. 2)
The detection of a former beach at the West Gate of the Agora between Eph 4 and Eph 1 is confirmed by this coring inside the Agora. Here, only terrestrial sediments occur as confirmed by the occurrence of *Gyraulus laevis,* a gastropod living in a swamp, and the terrestrial gastropod *Cernuella virgata.* Bedrock was reached at 6.50 m b.s.l. (slope debris: boulders of limestone and marble in residual loam). The radiocarbon ages of 5,610–5,440 cal BC (3.50 m b.s.l.) and 2,455–2,280 cal BC (2.15 m b.s.l.) as well as the fact that no marine fauna was encountered, confirm that the accumulation of colluvium had already occurred before the sea reached this area. Thus, the Neolithic to late Archaic/early Classical Greek shoreline is the farthest landward coastline to be encountered in this area. As there is no source of river alluvium in this angular restricted area by the later Theater and Tetragonos Agora, the shoreface of the marine waters dropped off steeply in the area of the later Arcadiane. At Eph 4 by late Mycenaean time, marine waters were only about 3 m deep, yet were probably more than 10 m deep in Neolithic time.

Core Eph 2001–04, at North Gate of Tetragonos Agora, in deepest part of P. Scherrer's trench (fig. 3)
The pre-Holocene slope debris at about 5.5 m b.s.l. is a hard brown mud with large rock fragments, at the foot of Mt. Pion. Sediments from sea level to the underlying slope debris include 5.5 m of interbedded silts and silty clays (muds) with scattered terrestrial gastropods. Fragments of the pelecypod shell *Cerastoderma* sp. at 5.2 m b.s.l. must be considered as part of a coastal swamp or storm wave overwash. A detrital wood fragment at 4.3 m b.s.l. is late Mesolithic in age. Thus, the muds are Mesolithic-Neolithic colluvium bordering on a coastal swamp as nearby marine waters approached their mid-Holocene high sea stand.

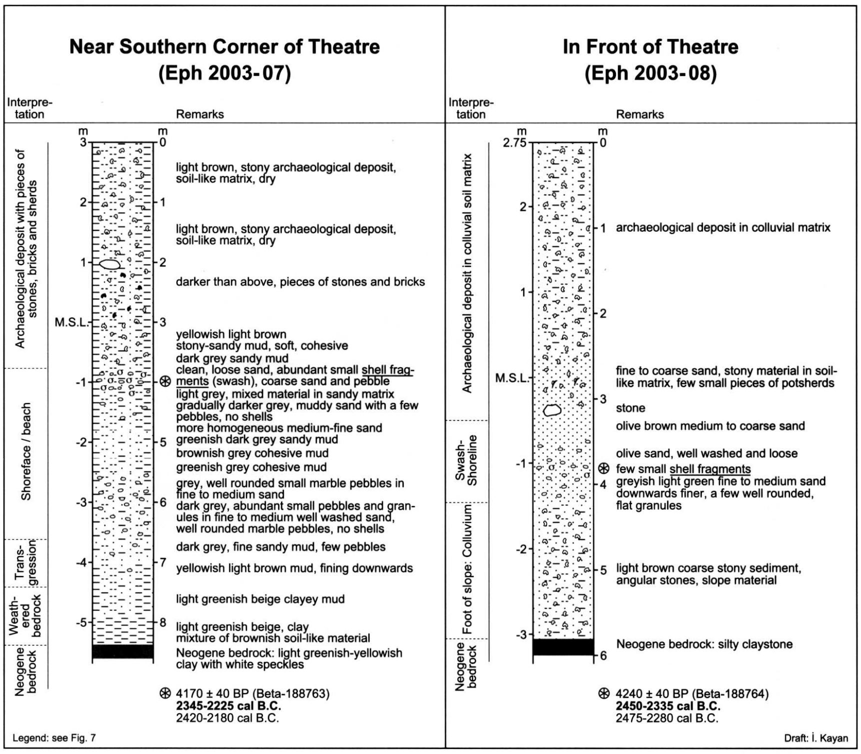

Fig. 4: Coring profiles Eph 2003–07 and 2003–08 in front of the Theater

North Gate of Tetragonos Agora, immediately West of the Theater

Core Eph 2003–08, at North Gate of Tetragonos Agora, in front of the Theater, along the Theater Place, in stony sediment with cultural debris (fill) (fig. 4)

3 m of coarse rock fragments and slope colluvium overly Neogene silty claystone at 3 m b.s.l. A medium to coarse loose sand with rounded granules occurs at around 1–0.25 m b.s.l., deposited in a wave swash zone with marine shell fragments. Thus, in early Bronze Age time, wave activity formed a beach here at the foot of Mt. Pion.

Core Eph 2003–07, at North Gate of Tetragonos Agora, immediately west of the southern corner of the Theater (fig. 4)

Weathered Neogene bedrock was encountered at 4.35 m b.s.l., with unaltered bedrock at 5.35 m b.s.l. On top of transgression facies, nearshore marine shoreface and beach sediments occur from 3.50 up to 0.80 m b.s.l. These sublittoral sediments include muddy sands with rounded marble granules and pebbles, as well as cohesive, sandy muds indicating deposition in a quiescent marine shoreface with varying times of wave activity. At the top of the marine sediments occurs a clean loose sand with granules, pebbles and abundant marine shell fragments. These beach (swash) deposits date to early-middle Bronze Age time, similar to those of nearby Eph 2003–08.

We conclude that at core site Eph 2003–07 marine waters were up to 3 m deep. The shoreface was deepening off to the north-west. The nearby bedrock slopes of Mt. Pion by the

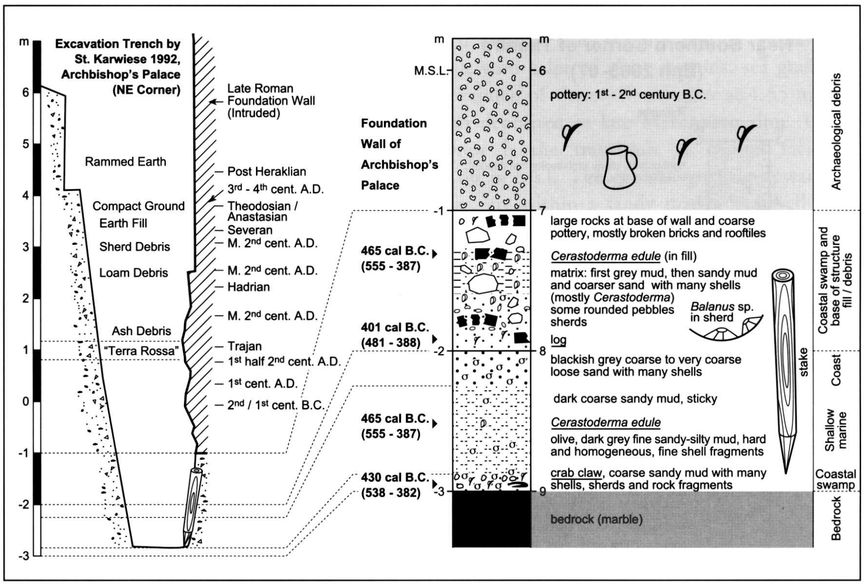

Fig. 5: Combined excavation and coring at the Episcopium of the Church of Mary (coring profile Eph 1992–05)

Theater limit the maximum landward shoreline in this area. The shoreline with coastal swamps lay nearby to the west in late Archaic/early Classical times (at Eph 4, see figs. 1 and 2).

Episcopium of the Church of Mary and the Byzantine Palace

Eph 1992–05, Episcopium of the Church of Mary, in St. Karwiese's trench along the north-east corner (fig. 5)

The trench was dug at the base of the foundation wall of the Episcopium of the Church of Mary. As a result of our drill core, St. Karwiese deepened the excavation to the bedrock. Therefore, greater detail was determined about this shallow nearshore marine and coastal swamp. Marble bedrock of the foot of Mt. Pion occurred at 3 m b.s.l. Up to 2 m b.s.l. we encountered a coarse sand with many marine shells (beach deposit) overlying sandy mud with shell fragments and a basal coarse sandy mud with a crab claw. These coastal and shallow marine sediments date to Classical times. From 2–1 m b.s.l. occur mud and sandy mud of a coastal swamp infilled with large rock fragments, roof tiles, sherds, marine pelecypod shells and *Balanus* sp. (barnacle) attached to a large pottery sherd. A wooden stake with a sharpened point was found driven vertically through this fill debris into the coastal deposits below. In a whimsical manner we interpreted this stake to be an anchor for a rope to a small boat. The overlying 6 m of fill includes an impressive continuum of sherds dating from the Roman Republican time upwards to the post-Heraclian period (3rd–4th century AD).

Eph 8, south-west corner of Byzantine Palace (Sarhoş Hamam), approx. 60 m east of Eph 1992–05
This core unearthed cultural debris to 0.80 m b.s.l. covering slope debris and weathered bedrock. No marine or coastal stratum was found.

A synoptic view of Eph 1992–05 and Eph 8 shows that these cores define the landward limit of marine waters on the rocky shoals that formerly underlay the Church of Mary complex

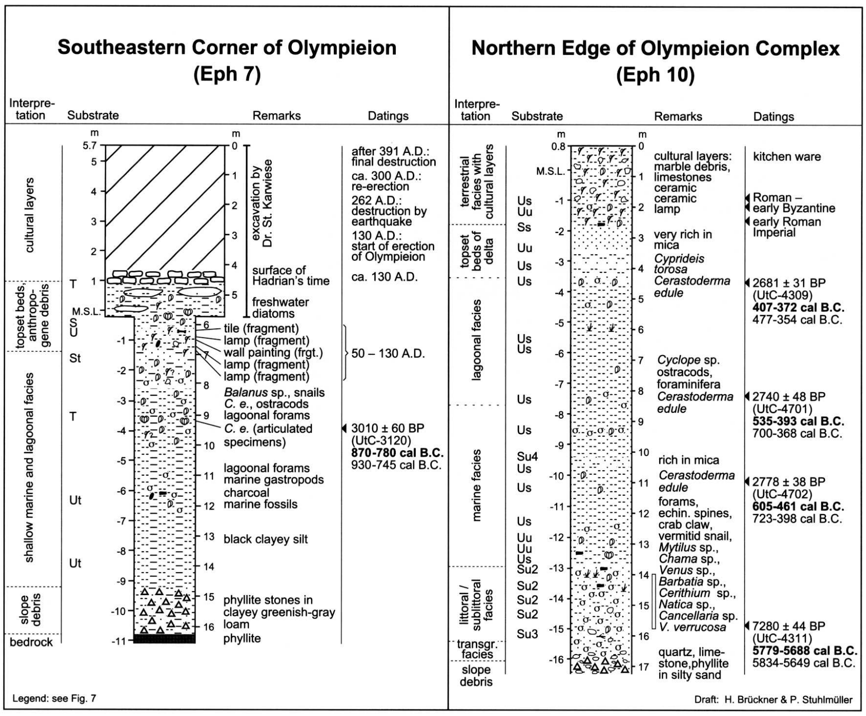

Fig. 6: Coring profiles Eph 7 and Eph 10 in the area of the Olympieion

and south-east corner of the Olympieion complex. The Byzantine Palace is built on solely terrestrial ground.

The Olympieion

Eph 7, at south-east corner of Olympieion, in an excavation by St. Karwiese (fig. 6)

Slope debris (colluvium) was encountered at 9.3 m b.s.l. overlying bedrock phyllite at 10.8 m b.s.l. From sea level to the top of the slope debris, the drill core contained marine silts becoming more sandy towards the top. Above the middle of this sequence, lagoonal foraminifera became mixed with marine-brackish pelecypods *(Cerastoderma edule),* ostracodes, and *Balanus* sp. (barnacles). At 3.6 m b.s.l. an articulated specimen of *Cerastoderma edule* lived in Geometric/Proto-Geometric times. From sea level to 2.2 m b.s.l., abundant tile, wall painting and lamp fragments (debris) were mixed in sands and mud. The first meter above sea level underlay the construction surface of Hadrian's time and included freshwater diatoms in clayey silt with thin layers of sand. Articulated specimens of *Cerastoderma edule* occur to mean sea level.

Eph 10, at north edge of Olympieion complex (fig. 6)

Slope debris is overlain by a thin marine transgressional sand at 16 m b.s.l. A 2 m thick silty sand with numerous marine molluscs (sublittoral/littoral facies) dates the marine transgression over the rocky north-west promontory of Mt. Pion to late Mesolithic times. Marine silty sands and silts extend upward to 7.7 m b.s.l. with an essentially clear water marine assemblage. A *Cerastoderma edule* shell dates marine waters approximately 8–10 m deep into the Archaic period. Lagoonal sedimentary facies (brackish waters) extend from 7.4 m b.s.l. to 1.9 m b.s.l. where sandy

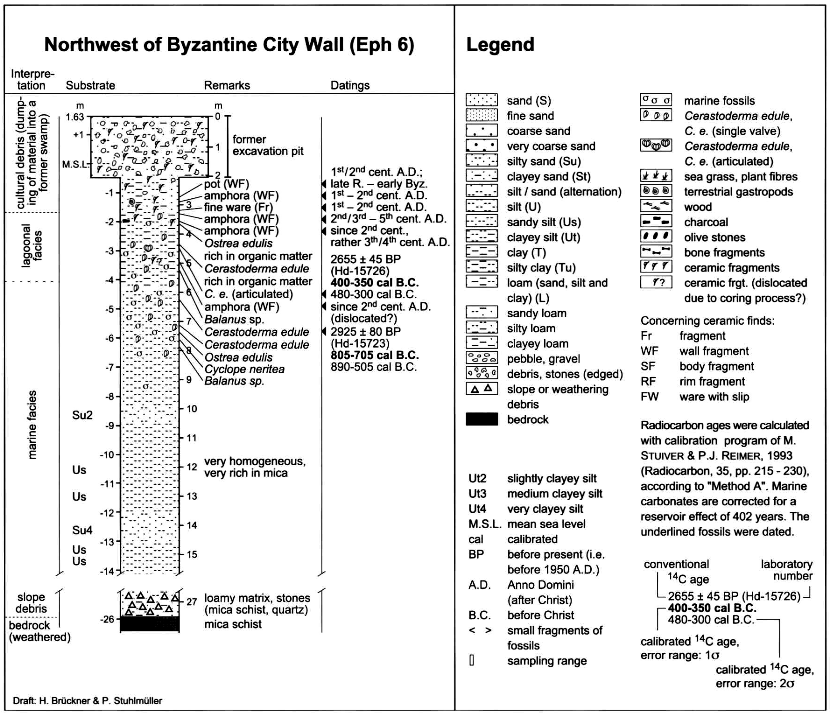

Fig. 7: Coring profile Eph 6 northwest of the Byzantine city wall

silts include *Cyprideis torosa* and *Cerastoderma edule* and scattered marine grasses. Water depth dropped from 8–10 m b.s.l. to ca. 3 m b.s.l. from Archaic through Classical times. Around 2 m b.s.l. occurs a micaceous sand. The top 2.7 m of this core (1.9 m b.s.l. – 0.8 m a.s.l.) are sandy silts infilled with cultural layers of marble and limestone debris with many ceramic fragments of Roman Imperial and early Byzantine periods.

From the cores in the Olympieion complex it can be deduced that marine waters became much shallower in Archaic to Classical times. The silts deposited were prodelta muds spreading out across the Gulf of Ephesos as the Kayster River delta advanced. Probably, the delta shoreline was 2–3 km to the north-east. However, the relentless shallowing of the marine waters, eventually exhibiting more brackish conditions prevailed through the Hellenistic period. The micaceous sands at 2 m b.s.l. are the first sedimentary facies indicating a nearby delta distributary channel. These sands typify the fan-shaped, wave redistributed sediments emerging from a river mouth in flood stage. Probably deposited in the Roman Republican period, these strata were later covered by sandy silts. The latter may either originate from inter-distributary shoaling marine-brackish waters or coastal marshes and swamps. The natural environments were ended by continuous dumping of debris in Roman Imperial to early Byzantine times.

West of the Rocky Promontory of the Crevice Temple

Eph 6, north-west of the Byzantine city wall, west of the rocky cape (fig. 7)

Weathered mica schist bedrock is found at 26 m b.s.l., thus showing the steep slopes of the Mt. Pion horst as the bedrock drops into the Küçük Menderes graben. Slope debris cover of the bedrock includes mica schist and quartz rocks in a loam matrix. Occurrences of single valves of *Ostrea edulis* and *Balanus* sp., both with rock attachment in living position, indicate transport and redeposition. The marine sedimentary facies from 25 m b.s.l. to 4 m b.s.l. consists of marine mica-rich sandy silts and silty sands. Near the top of the marine facies, marine water depths of approximately 4–5 m date from Archaic to Classical times as the formerly deep embayment was infilled by prodelta silts. Brackish water conditions prevail from 4 m b.s.l. to about 0.5 m b.s.l. Here occur *Cerastoderma edule* in living position, in a black anoxic (H_2S) mud milieu, probably indicating a delta bypassed embayment or lagoon. Cultural debris intruded into the muds vary from Roman Imperial to early Byzantine times. The uppermost layer of several meters seems intentionally dumped and may be rubble from the many earthquakes of the late Roman period, used to infill former swamps in this area which flanks the delta-floodplain.

Other Relevant Drill Cores

Eph 9, under the Harbor Gymnasium

The Harbor Gymnasium is one of the earliest major buildings in the lower city, erected in AD 96. It is built on fill material. Eph 9 unearthed thick marine strata. Bedrock was not encountered at a depth of 30 m b.s.l. (end of drill).

Eph 25 and Eph 1991–05, eastern end of Great Harbor

Drilled to 8 m and 15 m b.s.l., respectively, in the reed swamp in the ancient harbor, these borings encountered 2–3 m of swamp muds underlain by black anoxic marine muds (with H_2S and methane gases). A slight color change at 4–6 m b.s.l. may indicate a dredged harbor bottom. Dredging was a continuing requirement for the ancient harbor and the long canal connecting it to the sea. It is often recorded in the ancient literature that the harbor was used as the city sewer; both industrial and household refuse was dumped into it.

Eph 1992–03 and Eph 1992–04, on the mole constructed along the northern rim of the harbor

The harbor mole was built to protect the harbor from infill and/or destruction by the prograding Kayster River delta. Occupied by buildings in antiquity, it was constructed of dredged fill from surrounding shallow marine sediments. Now oxidized, the mole surface is strewn with marine gastropods and tile debris. *Cerastoderma edule,* marine gastropods, and wood debris were dated from Hellenistic to Proto-Geometric times. Inconsistencies in depths preclude estimates of water depths and mixing is likely in this frequently dredged locale.

Conclusions: Geomorphologies of the Ancient Sea and Coastlines under the City

The lower city and harbor works of Ephesos were built over a former embayed indentation along the rocky southern coastline of the Gulf of Ephesos. Such wave sheltered indentations tend to be bypassed along the flanks of prograding deltas and their floodplains. Thus, the Hellenistic engineers picked an excellent site for the great harbor of Ephesos. Marine waters of the Neolithic sea were greater than 30 m deep in the area where the Harbor Gymnasium was to be built in Roman period. Initially the coastline of this deep area along the foot of Mt. Preon (Bülbüldağ) was bounded by a steep shoreface near the West and North Gates of the Tetragonos Agora. However, to the north, in the area of the Church of Mary, the Episcopium of the Church of Mary and the Olympieion, shallower waters up to 10 m deep covered a rocky shoal, the locale of a number of small islets. Coastal waters in this area were shallow. From the northern borders of the Olympieion complex and around the rocky cape (upon which the later Crevice Temple was built), marine waters rapidly dropped to depths of 25 m and greater.

By Archaic to Classical times the shorelines remained in nearly the same location. However, accompanying the pervasive advance of the Kayster River delta, the rate of deposition of marine muds increased. In Classical to Hellenistic times water depths throughout this embayed coastal area rapidly dropped to 2–5 m b.s.l.; the shoreface slope became low, while coastal swamps expanded. By Roman Republican period, thin prodelta sands were deposited in the area of the rocky cape, possibly indicating a nearby river distributary channel. At the time, the very shallow waters in the marine embayment at the foot of Mts. Pion and Preon were infilling with black anoxic marine-brackish muds along a shoreline of coastal swamps.

In the 1st century AD, there began a massive intentional infill of the area west of the Theater, in order to form a solid foundation for building construction. To the north, large quantities of sherds and waste were dumped into the shoaling waters and swamps, dating to the early Roman Imperial period. In Hadrian's time, the Olympieion was built, bringing an end to the former sea and the coastal swamps. To the west, the struggle of the peoples of Ephesos against the ever pervasive Kayster River delta progradation in order to maintain their great harbor and its access to the sea continued for many centuries.

Acknowledgements

Friedrich Krinzinger, General Director of the Austrian Archaeological Institute and Director of the Ephesos Excavations, has brought a renewed interest to our geoarchaeological research into the nature of the ancient landscapes in and around the city, its harbors and the Artemision. Thus, we are pleased to present this paper of the demise of the ancient sea that formerly underlay the lower city of Ephesos as a contribution to his felicitation volume. The cooperation of Peter Scherrer and Stefan Karwiese and their colleagues were very important to the success of our research.

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References of figures: Fig. 1: after Brückner (note 1); names and numbers of buildings according to G. Wiplinger in: P. Scherrer (ed.), Ephesos. Der neue Führer (1995) 248 ff.; figs. 2. 6. 7: after H. Brückner, Geoarchäologische Forschungen in der Westtürkei – das Beispiel Ephesos, Passauer Schriften zur Geographie 15, 1997, figs. 4–6; figs. 3. 4: İ. Kayan; fig. 5: after Kraft et al. (note 1:2000) fig. 12.

INHALT VON BAND II

Velia

Archäologie des Mittelmeerraumes

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Müller Marianne
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