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• *Taman – Geoarchaeology – Greek colonisation – Sea level curve – Azov Sea – Black Sea*

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Geoarchaeology of Taman Peninsula (Kerch Strait, South-West Russia) – the Example of the Ancient Greek Settlement of Golubitskaya 2

Zur Geoarchäologie der Taman-Halbinsel (Straße von Kertsch, Südwestrussland) – das Beispiel der antiken griechischen Siedlung Golubitskaja 2

With 10 Figures, 1 Table and 1 Photo

In the framework of an extensive archaeological survey and excavation programme on Taman Peninsula, geoarchaeological research was carried out in this *terra incognita* of the north-eastern Black Sea region. In the present study, a small area was surveyed in detail with respect to its geomorphological and archaeological situation. Geoarchaeological scenarios were generated for the last seven millennia. For the first time, the sea level rise and its effect on the landscape could be documented in time and space, showing, among others, that Taman Peninsula had evolved out of an archipelago.

1. Introduction

Steep cliffs and extended beach ridges are major landscape features of the Taman Peninsula which separates the north-eastern Black Sea from the Sea of Azov (*Fig. 1*). They are evidence of strong coastal erosion (cliffs as sediment sources) and a high influence of longshore currents on the shape of the coast (beach ridges as sediment sinks). Due to these coastal dynamics the landscape in general and the coastline in particular have changed dramatically during the past millennia.

The evolution of the Taman Peninsula was studied in an interdisciplinary geoarchaeological project which was part of joint research between Russian and German scientists that focused on the Greek colonisation of the Taman Peninsula and the colonisation phase in the core area of the early Bosporan Kingdom. This empire had its centre in

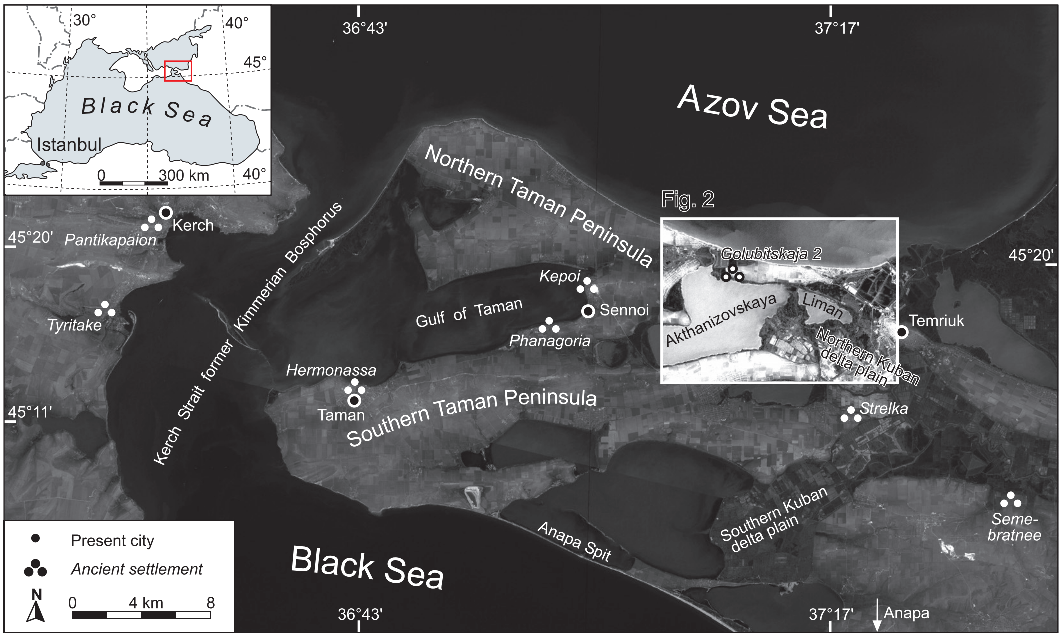


Fig. 1 Overview of Taman Peninsula. The research area around Golubitskaya 2 is highlighted. Source: ETM+ satellite images and SRTM data, slightly changed / *Übersicht der Taman-Halbinsel. Das Untersuchungsgebiet ist hervorgehoben. Quelle: ETM+-Satellitenbilder und SRTM-Daten, leicht verändert*

the region around the Bosporus and, as it turned out in the course of the investigations, on the lower course of the Kuban river as well.

During the 1st millennium BC, Greek settlers colonised – beside coasts in the western Mediterranean – many coastal areas of western Anatolia, the Marmara Sea (Propontis) and the Black Sea (Pontos). The first Greek trading posts in the northern Black Sea region were Berezan (Ukraine), Taganrog and perhaps Alekseevskoje (both in SW Russia) in the last quarter of the 7th century BC (*Boardman* 1981: 285ff., 294ff., *Salov* 1986). After checking the hinterland for trade and grain cultivation they spread along the whole coastline. Among the earliest Greek colonies in the northern Pontos is Golubitskaya 2, today situated on a headland in the Akthanizovskaya Liman (*Figs. 1* and *2*; note that also the transcriptions Golubickaja/Golubickaya and Achtanisovskaja, respectively, exist).

It should be noted that there is still the ongoing debate about the flooding of the Black Sea in the course of the glacio-eustatically caused late Pleistocene/early Holocene sea level rise that was triggered by *Pitman* and *Ryan*'s book "Noah's Flood. The New Scientific Discoveries about the Event that Changed History" in 1998. The early evolution and settling of the Black Sea coasts may hold the key for the solution of the as yet open debate. Further, any solidly based contribution to the reconstruction of the sea level fluctuation curve of the Black Sea is important since the so-far officially acknowledged curve by *Balabanov* (2007) is very problematic. We discussed this issue at length in a recent paper as a contribution to the IGCP 521 and INQUA 501 projects (*Brückner* et al. 2010).

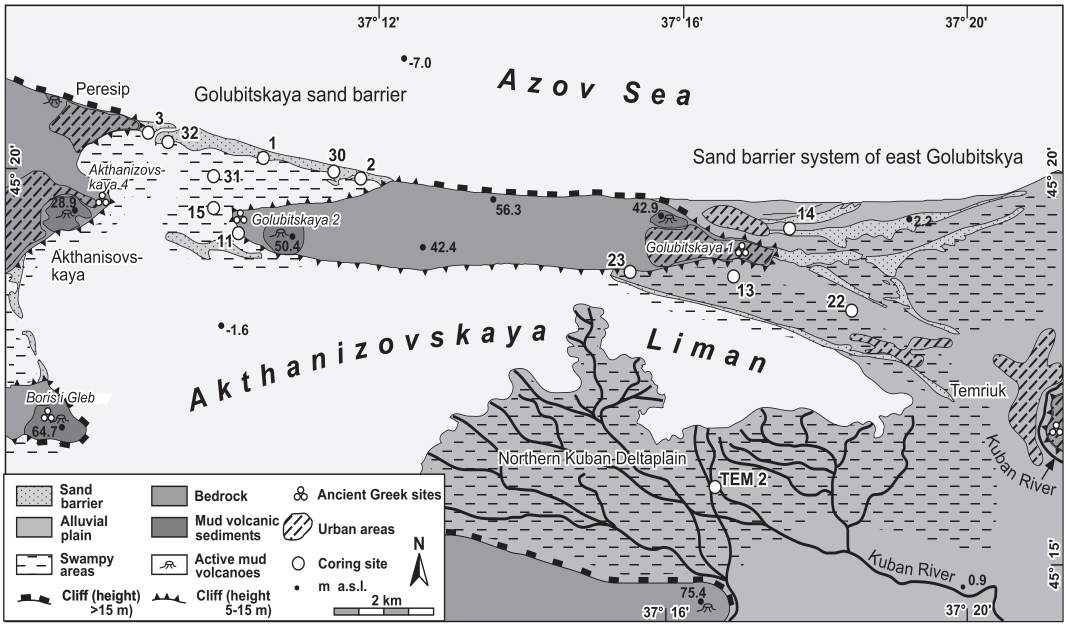


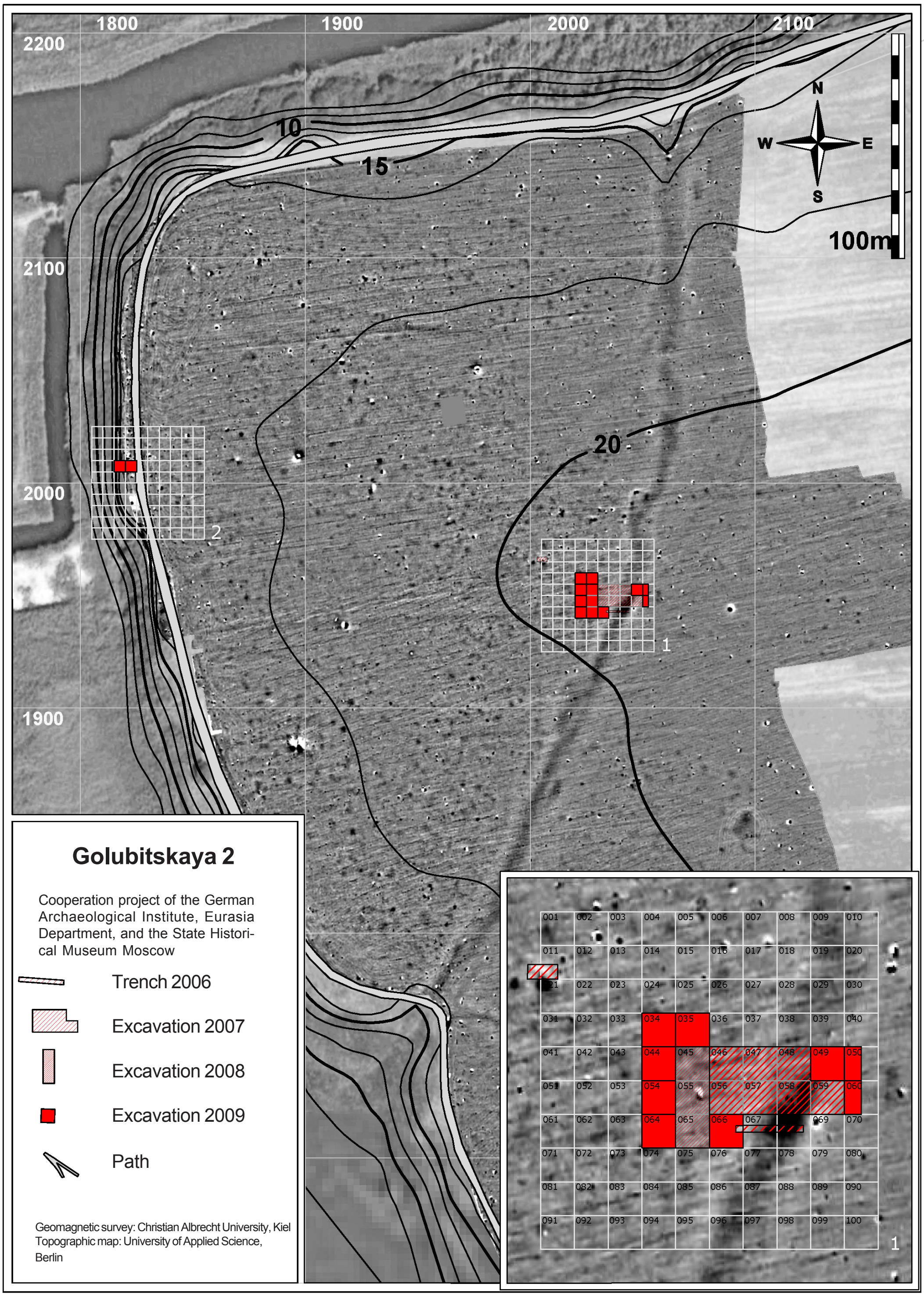
Fig. 2 Coring sites and geomorphological map of the area around Golubitskaya and the northern Kuban delta. Source: authors' own research / *Bohrpunkte und geomorphologische Karte des Gebietes um Golubitskaya und das nördliche Kubandelta. Quelle: eigene Forschung*

Out of the many research topics, this paper focuses on (i) the evolution of the Taman Peninsula; (ii) the reconstruction of a (locally valid) sea level curve; (iii) the palaeogeographic setting of Golubitskaya 2 (*Fig. 3)* during the 1st millennium BC, and (iv) the identification of reasons for the abandonment of the settlement in the 3rd/2nd century BC.

2. Historical Background

Situated between the Taman Peninsula (South-West Russia) and the Crimea (Ukraine), the Strait of Kerch (Cimmerian Bosporus in Antiquity) has always been a shipping route from the Black Sea to the Sea of Azov and farther east to the Don. The Kuban provided access to the Caucasus region, which is rich in natural resources. Therefore, it is not surprising that Greek colonists founded cities in this area since the early 6th century BC. In the 5th century BC these cities united to form the Bosporan Kingdom. This was probably the result of pressure exerted by steppe peoples (in particular the Scythians), who were on the move as a consequence of a Persian attack in the later 6th century BC. The Bosporan Kingdom maintained its relative independence for almost one thousand years, while expanding around the entire Sea of Azov and incorporating numerous indigenous peoples (*Gajdukevič* 1971).

The existing scientific model of the Greek land acquisition in the area that later became the Bosporan Kingdom is based upon the assumption that the Greek colonisation was limited exclusively to the littoral zones along the present-day Strait of Kerch (*Boardman* 1981: 297ff., *Koshelenko* and



1800
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2
1
Golubitskaya 2
Cooperation project of the German Archaeological Institute, Eurasia Department, and the State Historical Museum Moscow
Trench 2006
Excavation 2007
Excavation 2008
Excavation 2009
Path
Geomagnetic survey: Christian Albrecht University, Kiel
Topographic map: University of Applied Science, Berlin

Fig. 3 Golubitskaya 2 – founded by Greek colonists in the 6th century BC on a promontory with access to the Sea of Azov and the Kuban river mouth. The topographical map of the site is combined with an aerial photograph, geomagnetic results and the depiction of excavation areas. Detail of Excavation square 1: trench in the ditch and rampart fortification system. Source: *A. Kai-Browne* (HTW Berlin)
Golubitskaja 2 – gegründet von griechischen Kolonisten im 6. Jh. v. Chr. auf einer Landspitze mit Zugang zum Asow'schen Meer und der Kubanmündung. Die topographische Karte der archäologischen Stätte ist verschnitten mit Luftbildern, geomagnetischen Resultaten und der Darstellung der ausgegrabenen Areale. Detailbild des Ausgrabungssektors 1: Schnitt durch Graben und Wallanlage des Befestigungssystems. Quelle: A. Kai-Browne (HTW Berlin)

Kuznetsov 1998: 254ff., esp. 255; *Tsetskhladze* 2007: esp. 562f.). The settlements in our area of investigation were characterised as later, smaller, rural settlements in what was then considered as hinterland. They were dealt with for the first time in an article written by *J.M. Paromov* who already recognised that they had been established as early as the third quarter of the 6th century BC (*Paromov* 2006: 370f.). The special circumstance that settlements of such an early date developed virtually at the same time as the earliest settlements on the Cimmerian Bosporus is explained by *Paromov* with their location on the ancient branches of the Kuban river, for instance in the vicinity of the Peresip' Liman and the Shemardansky Liman. However, the author bases his statements on a landscape reconstruction favoured by many scholars which included an archipelago at the place of the (later) Taman Peninsula in antiquity. It is assumed to have consisted of a group of islands, among them Kimerijsky, Phanagoria, Sindikos, Kandauros and the smallest island of Golubitskaya (*Paromov* 2006: 365; see also the informative maps in *Tsetskhladze* 2007: 552, *Fig. 2,* which quote *Koshelenko* and *Kuznetsov* 1998: 256, *Figs. 1-2*). Meanwhile, this landscape reconstruction has been disputed (*Gorlov* 1996; *Gorlov* et al. 2002).

Regardless which of the two scenarios one follows, *Paromov's* results on the early settlements in the so-called hinterland at least cast doubt on the hitherto prevailing perception that the early land acquisition had taken place exclusively on the banks of the Cimmerian Bosporus. It is obvious that the historical sequence of the Greek land acquisition and the later development of the settlements in the region of the Bosporan Kingdom can be reconstructed with temporal and spatial landscape scenarios that are based on geoarchaeological evidence.

3. Geological and Geomorphological Setting

Taman's topographic border to the east consists of the recent deltaplain of the Kuban river, the Hypanis in antiquity, its former southern estuary, which had debouched into the Black Sea, and the present-day northern estuary flowing into the Sea of Azov.

The landscape can be described as undulating, reaching heights of 157 m above mean sea level on the mud volcanoes which are situated on the SSW-NNE striking ridges covering the whole peninsula. These ridges result from the Caucasian uplift during the Alpine orogeny in which the foreland basin of the Indolo-Kuban trough was included in the folding and faulting processes (*Fig. 4, Saintot* and *Angelier* 2000).

The coastal geomorphology of the Taman Peninsula is that of a wave-dominated non-deltaic coastline, showing typical features of a microtidal regime. Steep cliffs are established due to strong abrasion, especially in the western part of the peninsula. Strong longshore currents built up

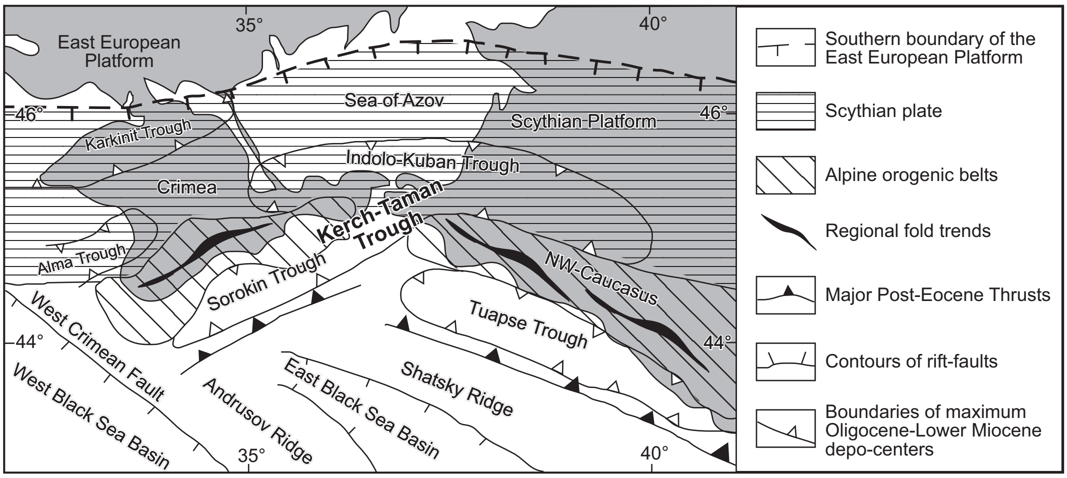


Fig. 4 Geological setting of the Taman Peninsula. Source: *Saintot* and *Angelier* 2000
Geologische Situation der Taman-Halbinsel. Quelle: Saintot and Angelier 2000

sand barriers and spits; thus, former open marine embayments were transformed into lagoons, as, e.g., Akthanizovskaya Liman and Blagoweschenskaya Liman (see *Photo 1*). Meanwhile, parts of the former lagoons have been silted up due to the prograding Kuban delta.

4. Methods of Research

During fieldwork several corings were carried out by means of the percussion coring device Cobra 248 of Atlas Copco Co. Using augerheads of 6, 5 and 3.6 cm in diameter, a maximum depth

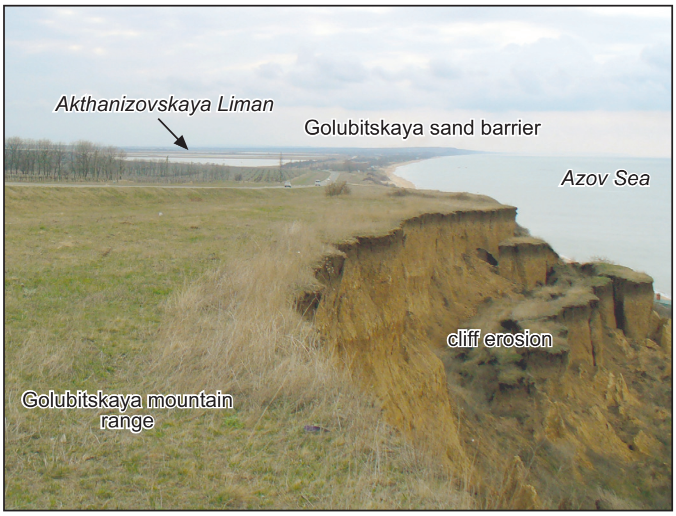


Photo 1 View to the west from the Golubitskaya mountain range on the sand barrier of Golubitskaya (height approx. 40 m a.s.l.). Note the heavy ongoing cliff erosion in soft loess and Pliocene sediments which makes the archaeological excavations of the coastal sites so much more urgent. Photo: *Kelterbaum*, spring 2007 / *Blick nach Westen vom Höhenzug von Golubitskaja auf die vorgelagerte Nehrung von Golubitskaja (Standhöhe ungefähr 40 m ü. M.). Bemerkenswert ist die starke Klifferosion in lockerem Löss und pliozänen Sedimenten, was verdeutlicht, dass Ausgrabungen von archäologischen Stätten in Küstennähe besonders notwendig sind.*

of 12 m below the present surface (b.s.) was reached. The coring strategy was based on transects through nearshore geoarchives, chosen by means of satellite images and field surveys (*Figs. 1* and *2*). Position and elevation of each coring site were measured by differential global positioning system (DGPS of Leica Geosystems Co.). On site, the coring tubes were studied for colour (MUNSELL Soil Color Charts), grain size, rounding and texture as well as macrofaunal and -floral remains. Then they were sampled in order to carry out geochemical analyses in the laboratories of the Faculty of Geography at Philipps-Universität Marburg (Germany). Samples were air-dried and pestled by hand. After digestion with concentrated HCl (37 %), Ca, Na, Fe, K and Mg concentrations of the fine-grained fraction (< 2 mm) were determined using atomic absorption spectrometry (AAS; Perkin Elmer A-Analyst 300). $CaCO_3$ was gas-volumetrically measured according to the Scheibler method. The loss on ignition (LOI) was determined by oven-drying at 105 °C for 12 h and ignition in a muffle furnace at 550 °C for 4 h (*Beck* et al. 1995). These analytical proxies represent the major basis of distinct facies differentiation at the sites of interest. Combined with the grid of corings, the vertical and horizontal variations of the different facies – marine, littoral, lagoonal, limnic, fluvial – are the basis for the reconstruction of the palaeogeographic evolution of the area of research.

In a geoarchaeological context, the proper calibration and dendrochronological correction of the radiocarbon ages play a major role since at a given archaeological site, the ^{14}C age estimates have to be compatible with the chronologies provided by the archaeological and the historical sciences. In our case, we used ^{14}C-dated mollusc shells, plant remains and peat, as well as OSL age estimates on the eastern Golubitskaya sand spit system of *Izmailov* (2007), in order to establish a geochronology of the coastal changes in the vicinity of the Golubitskaya mountain range.

When applying the AMS-^{14}C dating technique on marine carbonates, articulated bivalves were preferably used. These ages were corrected for an average marine reservoir effect of 408 years (*Hughen* et al. 2004). However, it has to be considered that the palaeo-reservoir effect is still unknown and may have varied widely in different marine environments, such as lagoons, coastal swamps or littoral zones; it may also differ in different seas, like the Mediterranean, the Black Sea and the Sea of Azov. Additionally, the discharge of rivers and their input of ^{12}C play a role, especially in semi-enclosed basins, such as the Black and Azov Seas. The ^{14}C ages presented in this study were taken from five vibracores which contained the most reliable sea level indicators. All dates are calibrated ages in cal BC/AD or cal BP (calibration with Calib 5.0.2; *Stuiver* and *Reimer* 1993 and *Reimer* et al. 2004; see *Tab. 1*).

Using the DGPS Leica 530 SR, the elevation of each vibracoring site was determined in relation to local sea level with a precision of < 2 cm. Remote-sensing data – Corona satellite photographs (USGS, 1964), Landsat 7 ETM+ (2003) and Aster (2001) images – helped to establish the palaeogeographic scenarios.

5. Results

5.1 Coring profiles arranged in transects A, B and C

In the following the vibracore profiles will be presented in three transects. Today, the westernmost part of Akthanizovskaya Liman is separated from the open sea by the west-east trending sand barrier of Peresip'-Golubitskaya. Transect A consists of five corings carried out on this barrier (*Fig. 5*). It is connected with the archaeological site of Golubitskaya 2 by transect B (four corings; *Fig. 6*). To the east, a system of sand barriers has developed between the mountain range and the mainland of the Scythian plain (see *Figs. 1* and *2*).

To decipher its evolution, transect C (three corings; *Fig. 7*) was carried out.

5.1.1 Transects A and B: drillings near Golubitskaya 2

Transect A: the western Golubitskaya sand spit

Five vibracore profiles make up transect A (*Fig. 5*). Each drilling reached the pre-Holocene sediment. On Taman Peninsula the latter is mostly composed of colluvial sediments of reworked loess, sometimes bearing a still preserved palaeosol (Taman Peninsula is covered by loess and loess-like sediments up to 20 m thick).

Coring GOL 1 was carried out in the middle of the sand barrier. There, the boundary between the weathered bedrock (palaeosol on loess) and the marine transgression is at 7.35 m below sea level (b.s.l.). Marine sediments, fine-grained clayey silts, follow at 7.35-3.59 m b.s.l. In the contact zone of 20 cm between the palaeosol and the marine facies, freshwater gastropods occur together with a brackish fauna. Towards the top, the faunal elements are mostly represented by *Cerastoderma glaucum (C. glaucum)* and some specimens of *Abra ovata*, a typical marine bivalve of the Black Sea. Other species could not be determined due to the weathered and abraded tests of the molluscs. Between 3.59 and 2.68 m b.s.l., the sediment is coarsening and the faunal elements mostly consist of broken valves. The next part of the profile (2.68 m b.s.l. – 0.65 m a.s.l.) is represented by fine- to medium-grained sands with an abundance of shell fragments. In the upper part of this section (0.70 m b.s.l. – 0.65 m a.s.l.),

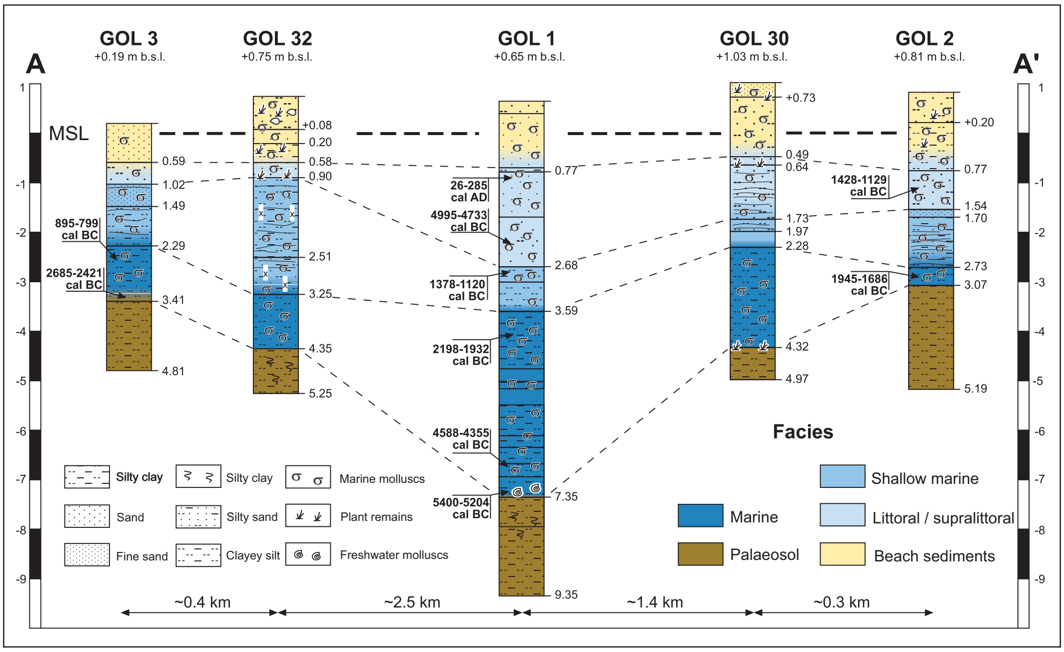


Fig. 5 Transect A on the western Golubitskaya sand barrier. For location of coring sites see *Fig. 2*. Source: authors' data / *Transekt A durch die westliche Nehrung von Golubitskaja. Zur Lokalität der Bohrpunkte siehe Fig. 2. Quelle: eigene Daten*

strongly developed hydromorphic elements such as manganese and iron spots reflect the fluctuating water table near the beach. At 0.77-0.70 m b.s.l., clayey silt is intercalated, representing sediments of a lagoonal backbeach facies.

The western part of transect A is represented by corings GOL 3 and 32. GOL 3 is situated next to the headland of Peresip', ~300 m south of the recent coastline. GOL 32 is ~400 m east of GOL 3 on the sand barrier. Both corings reached the palaeosol underlying the Holocene sediments, GOL 3 at 3.41 m and GOL 32 at 4.35 m b.s.l. In both cases sediments of shallow marine origin follow, i.e. silty fine sands and intercalated clayey silts. With a coarsening upwards sequence, the sand fraction becomes dominant. Faunal elements, however, are mostly found in the layers of the silt fraction. In GOL 3 the first elements of the recent sand barrier – coarse to medium sands – can be detected at a depth of 1.49 m b.s.l. In GOL 32 the influence of the sand barrier starts at 0.90 m b.s.l. A thick clayey silt layer is intercalated at 0.58-0.20 m b.s.l. which marks the influence of the still existing lagoon in the south.

Corings GOL 2 and 30 near the Golubitskaya mountain range also reached the underlying pre-Holocene palaeosol, GOL 2 at 3.07 m and GOL 30 at 4.32 m b.s.l. In GOL 30, the marine environment, represented by clayey silts with an abundance of macrofaunal remains, prevailed up to 1.73 m b.s.l. Towards the top, sand becomes the dominant component, thus creating the sand barrier. The coarse fraction mostly consists of edged shell fragments in the lower part of the sediment column, while above 0.46 m b.s.l. the fragments are rounded due to wave abrasion.

GOL 2 was carried out on the sand barrier near the prominent palaeo-cliff. The marine stratum is between 3.07 m and 2.73 m b.s.l. Then, with alternating layers of sand and clayey silt, the evolution of the sand barrier started in shallow marine to sub-littoral conditions. Above 1.70 m b.s.l., only sand was deposited. The occurrence of a clayey silt layer with a thickness of 0.97 m – containing many single valves and articulated bivalves together with plant fragments in its upper part (0.21 b.s.l. – 0.20 m a.s.l.) – hints to a fully evolved sand barrier seawards of the drilling site. This led to the evolution of a lagoonal swamp which was later topped by dune sands containing fewer fragments of mollusc shells than below.

Transect B: the lagoon of Golubitskaya 2

South of the western Golubitskaya sand barrier an extended lagoon had evolved (*Fig. 2*). This area was artificially transformed into fishponds for sturgeon breeding. In order to construct the basins large dams were built using the upper lagoonal layers. This is why the upper part of the drillings is disturbed.

Transect B, consisting of vibracores GOL 3, 31, 15 and 11B (*Fig. 6*), reveals the sedimentation pattern for the lagoon of Golubitskaya 2. It crosses the lagoon from north to south, starting with GOL 3 on the western part of the sand barrier of Golubitskaya and ending in GOL 11, a possible harbour site of the Greek settlement of Golubitskaya 2.

GOL 3 was already described above in transect A. GOL 31 was carried out in one of the dried-up fishponds, reaching down to 6.11 m b.s.l. The lowermost 3.78 m consist of loamy to clayey silts, deposited before the Holocene transgression, which starts at 2.33 m b.s.l. with the occurrence of grey silty sand. At 2.23 m b.s.l., a 3 cm big valve of *C. glaucum* was found. At 1.96-1.41 m b.s.l., a coarsening upward sequence of clayey silt to silty fine sand occurs. It is rich in shell fragments and shows hydromorphic features. At 1.41-0.84 m b.s.l., the dark grey clayey silt is rich in shell fragments and plant remains. The uppermost 0.73 m consists of the loamy deposit of the last decades, including many plant remains and hydromorphic spots.

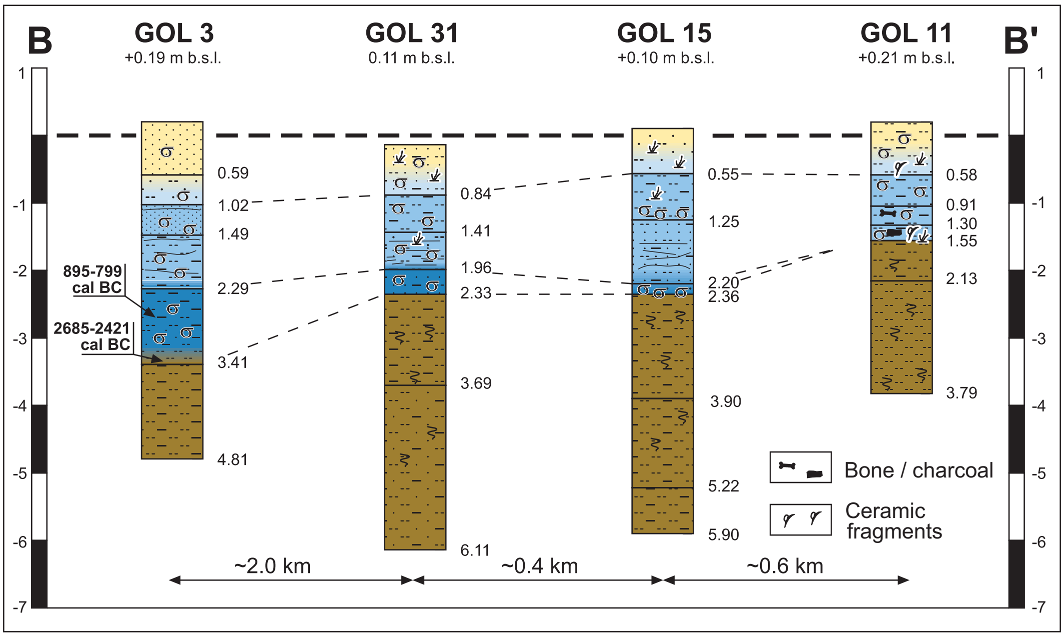


Fig. 6 Transect B through the Golubitskaya 2 lagoon. For location of coring sites see *Fig. 2*. Source: authors' data / *Transekt B durch die Lagune von Golubitskaja 2. Zur Lokalität der Bohrpunkte siehe Fig. 2. Quelle: eigene Daten*

GOL 15 was cored further south next to a water pump for the regulation of the watertable of the fishponds. Drilling reached down to 6.00 m b.s.l. (surface: 0.10 m a.s.l.). The fossilised palaeosol is at 2.36 m b.s.l. A small sediment layer between 2.36 and 2.28 m b.s.l. is built up by greyish fine to medium sand with a lot of mollusc shell fragments. It is topped by a coarse shill hash of up to 8 cm thickness. The following 0.95 m consist of grey clayey silt and silty fine sand. It can be stated that the sediment was formed under lagoonal conditions behind the not yet fully evolved barrier; occasionally, the access to the sea was opened by storm events or annual water level changes. Above 1.25 m b.s.l. the sediment consists of fine-grained clayey silt, rich in organic matter (plant remains, very dark, nearly blackish colour). A few mollusc shell fragments as well as small gastropods occur at 1.18 m b.s.l. This hints to a low energy wave climate during the time of deposition. Obviously, by then the sand barrier was fully evolved, separating the lagoon of Golubitskaya from the open Sea of Azov. The *in-situ* deposited sediments end at a depth of 0.55 m b.s.l. with a brownish to blackish mixture of clayey silt and silty loam. The following stratum is the result of the construction of the fishponds and the nearby water management station.

GOL 11, the southernmost vibracore profile in transect B, is situated at the southern exit of the artificial ditch, a fortification measure of the Greek settlement of Golubitskaya 2. The situation can be described as a natural outlet of a formerly periodically water-filled gully which was integrated into the fortification by the Greek settlers during the time of colonisation (cf. *Fig. 3*). GOL 11 reached a depth of 4.50 m below surface (surface: 0.21 m a.s.l.). The pre-

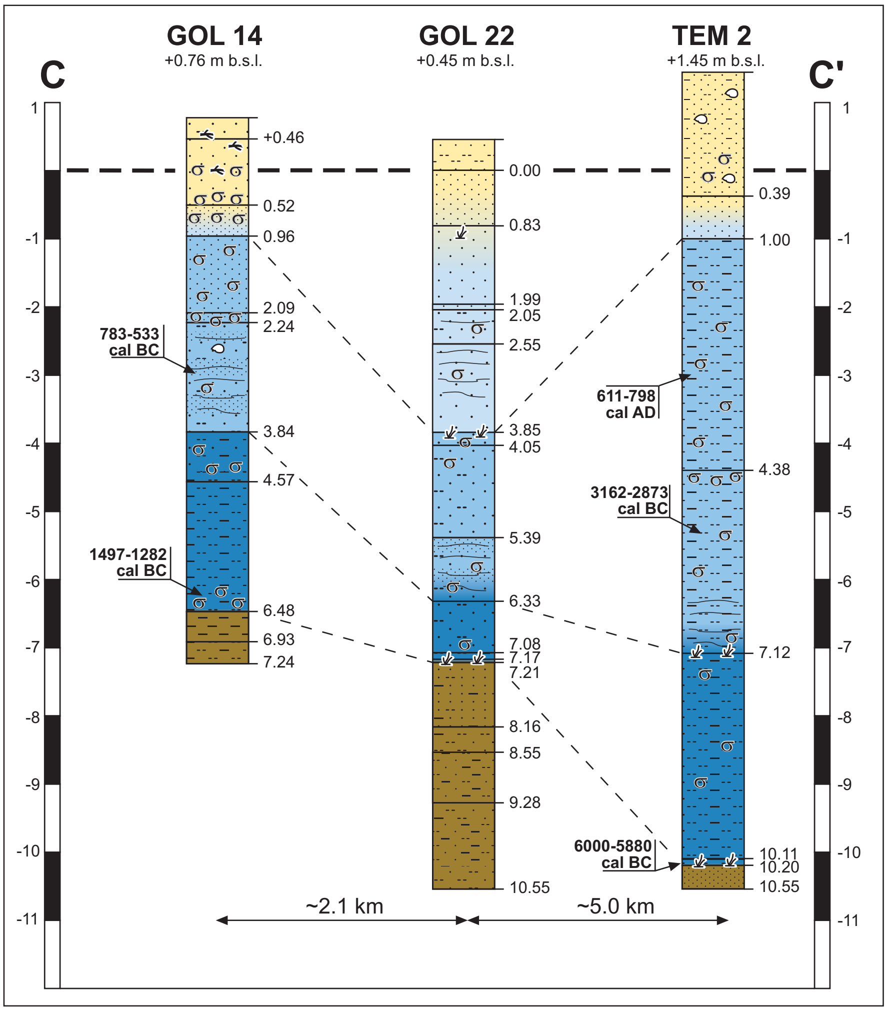


Fig. 7 Transect C east of the modern town of Golubitskaya in the sand barrier system (GOL 14 and 22) and the northern Kuban delta plain (TEM 2). For location of coring sites see *Fig. 2*. Source: authors' data
Transekt C östlich der modernen Stadt Golubitskaja durch das dortige Nehrungssystem (GOL 14 und 22) und in das nördliche Kubandelta hinein (TEM 2). Zur Lokalität der Bohrpunkte siehe Fig. 2. Quelle: eigene Daten

transgression surface is at 1.55 m b.s.l. Between 1.55 and 1.30 m b.s.l., a layer of clayey silt has developed. It is rich in mollusc and gastropod fragments; its upper 10 cm show indications of fire and very small pieces of ceramics. The layer at 1.30-0.91 m b.s.l. has a high organic content in a clayey silt matrix. An unidentifiable bone fragment and small gastropods occur at 1.18 m b.s.l. The uppermost 1.12 m consist of dark brownish clayey silts with tiny pieces of ceramics as well as strong hydromorphic features caused by the nearby lagoon of Golubitskaya.

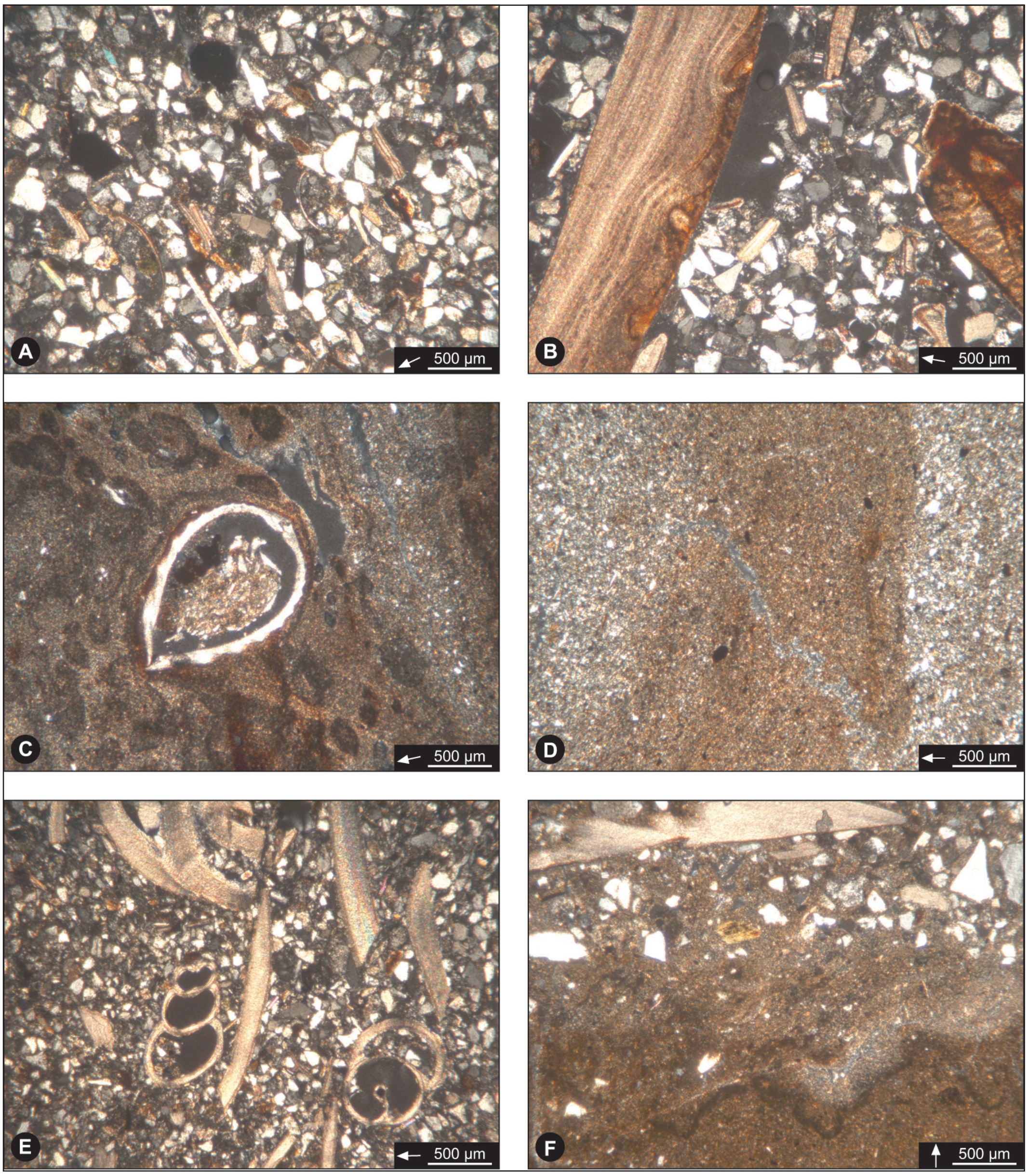


Fig. 8 Thin-section photographs of selected samples from vibracore profile GOL 14: (A) coarse sand of sand spit sediment, with shell fragments (sample GOL 14 DS 1, 2.13 m b.s.l.); (B) big mollusc fragments in coarse matrix (GOL 14 DS 2, 2.97 m b.s.l.); (C) juvenile bivalve in fine-grained matrix (GOL 14 DS 3, 4.06 m b.s.l., crossed nichols); (D) laminae of different grain sizes – mostly silt (same sample as for C); (E) gastropods and shell debris in silty to fine sandy matrix (GOL 14 DS 4, 4.92 m b.s.l.); (F) contact zone between the softrock with palaeosol and the marine transgression facies (GOL 14 DS 5, 6.47 m b.s.l.), crossed nichols. Arrows point to surface, showing the orientation of the thin sections. Source: authors' research / *Dünnschliffe ausgewählter Proben des Bohrprofils GOL 14: (A) grober Sand eines*

5.1.2 Transect C: the eastern Golubitskaya sand barrier system

To the east of the Golubitskaya mountain range a sand barrier system with several ridges has developed. Transect C (*Fig. 7*) – based on corings GOL 14, GOL 22 and TEM 2 – crosses the geomorphological feature from north to south and ends in the bird's foot delta of the Kuban.

GOL 14 is situated in the middle part of the sand barrier system, ~ 250 m east of the present town of Golubitskaya (*Fig. 2*; surface: 0.76 m a.s.l., total depth: 8 m). The marine transgression facies (14 cm, rich in macrofossils) starts above the palaeosol at 6.48 m b.s.l. The thin section (*Fig. 8F*) shows that the latter, represented by the fine-grained structure in the left side of the photo, is topped by coarse sediments with shell fragments and angular calcites. Then follows a marine facies up to 4.57 m b.s.l., void of macrofauna besides a small layer of shell debris at 4.89-4.93 m b.s.l. (*Fig. 8E*). Interbedded silty fine sands and clayey silts, 0.73 m thick, follow. This stratum shows an abundance of faunal remains (e.g., mollusc shell fragments; microfauna can be seen in *Fig. 8C*). Obviously the water depth turned more and more shallow. The sand bar evolution starts at 3.84 m b.s.l. with silty sands that persist up to the surface. Up to 2.24 m b.s.l. the sediment is very poor in fossils; this may have been the effect of fast sedimentation. Then shell debris is again included in the sediment column (*Figs. 8A, B*). The coarse sediment texture in the uppermost layers can be attributed to higher wave energy. After the rise of the sand bar above sea surface the sands were controlled by aeolian morphodynamics.

GOL 22 was carried out between the eastern Akthanizovskaya sand spit, which developed at the northeastern edge of the Akthanizovskaya Liman, and the first sand spit structure developed by the longshore current of the Azov Sea (cf. *Fig. 2*). The drilling reached a depth of 11.00 m b.s. (surface: 0.45 m a.s.l.). The lowermost 3.34 m are made up of floodplain sediment (greyish loamy fine sand) with very few plant remains. A peat layer occurs at 7.21-7.15 m b.s.l. This can be interpreted as the evolution of a coastal swamp in connection with the postglacial marine transgression. The fact that the topographic position of the peat is ~ 0.70 cm deeper, compared to the transgression layer in GOL 14, leads to the conclusion that a former valley structure was established between the modern villages of Temriuk and Golubitskaya. The marine stratum – silty fine sands with several pieces of marine molluscs – which covers the peat reaches up to 3.85 m b.s.l. A sharp texture boundary between the marine (silty fine sand) and the following sublittoral facies (coarse sand) indicates the developing sand spit which reaches up to 2.05 m b.s.l. At the coring site a lagoonal environment was established when the sand spit of Akthanizovkaya in the south and the first Golubitskaya ridge in the north were formed. The lagoonal sedimentary unit is in some parts interrupted by smaller strata of fluvial or storm-event origin.

The site of TEM 2 is situated in the bird's foot delta of the northern branch of the Kuban river and also in the former centre of the Akthanizovskaya Liman, now filled with delta sediments. Coring depth reached 12.00 m b.s.

Nehrungssediments, mit Muschelfragmenten; (B) großes Muschelschalenfragment in grobkörniger Matrix; (C) juvenile Bivalve in feinkörniger Matrix; (D) Laminierung unterschiedlicher Korngrößen – meist Schluff (gleiche Probe wie C); (E) Schnecken- und Muschelbruch in schluffig bis feinsandiger Matrix; (F) Kontaktzone zwischen dem anstehenden Lockergestein mit Paläoboden und der marinen Transgressionsfazies. Die Pfeile weisen zur Oberfläche der Bohrung und zeigen damit die Orientierung der Dünnschliffe an.

(10.55 m b.s.l.). The lowermost 35 cm consist of dark greyish homogeneous sands of pre-transgressive age. They are covered by a transgressional peat of 9 cm thickness. Due to the palaeogeographic situation in the centre of Akthanizovskaya Liman, only very clayey silts were deposited from 10.11 m up to 1.00 m b.s.l. In some sections they are rich in macrofauna and plant remains. The border between open marine and lagoonal ("Liman") conditions is at 4.38 m b.s.l. After the area had been cut off from the open Sea of Azov, the macrofauna disappears while the macroflora increases. The lagoonal facies persists up to 1.00 m b.s.l. The top is formed by Kuban delta deposits: sand layers, first with intercalated clayey silts, then as pure sand (0.39 m b.s.l. – 0.21 m a.s.l.). After the deltafront had prograded further to the northwest – the present drainage direction – the accumulated material changed to highflood deposits (clayey silts and fine sandy silts of brownish colour).

5.2 Dating results

In this study 15 samples were ^{14}C-AMS dated (*Tab. 1*). Most of the samples are bivalves which were taken at sedimentary boundaries. Specimens in living position or at least articulated ones were preferred in order to minimise the effect of reworking. Sample TEM 2/32 is a peat, built up during the postglacial transgression; this is one of the most reliable sea level indicators (cf. *Brückner* et al. 2010). GOL 3/9 consists of a plant remain which was deposited in sublittoral facies. The dating results are also noted in transects A, B and C (see *Figs. 5, 6* and *7*). For the reconstruction of the sea level curve (*Fig. 9*) sample GOL 1/9 (marine bivalve *C. glaucum*) was rejected because of an age inversion, possibly due to reworking of the single valve in the littoral environment (see Section 4.1.1).

6. Discussion

6.1 Palaeogeographic evolution of the area around Golubitskaya

In transects A, B and C (see Sections 5.1 and 5.2) approximate time lines illustrate synchronous sedimentation for the drillings in the study area. In summarising the results, we reconstructed palaeogeographic maps for 5000 cal BC, 2000 cal BC, 500 cal BC, and 500 cal AD (*Fig. 10*).

Around 5,500 cal BC, the postglacial marine transgression reached the area of Golubitskaya 2 (see transects A and C). Former palaeo-valleys were inundated by the sea. Thus, pre-transgressional fluvial deposits (at coring site TEM 2) and terrestrial sediments (at GOL 1) were topped by marine sediments. The sea water engulfed the Golubitskaya mountain ridge. At first, the area between Golubitskaya 2 and Akthanizovskaya 4 was still connected via a small ridge, but later the rising sea level flooded this area as well. The palaeo-cliff structures at both archaeological sites document the marine abrasion of the outcropping softrock (Pleistocene loess).

When sea level rise decelerated around 2,000 cal BC, longshore drift became the dominant coastal morphodynamic agent. While cliff erosion provided the material, sand spits and bars formed in front of the former marine embayments which by then surrounded the Golubitskaya mountain range. Their evolution is well dated by OSL (*Izmailov* 2007) and ^{14}C-age estimates (this paper; samples GOL 1/14, GOL 2/10 and GOL 3/11). At GOL 14 the shift in coastline due to the accretion of sand spits is documented by sample GOL 14/8, when a younger beach ridge existed at the drilling site. This is also shown by the occurrence of laminated layers in GOL 14 (cf. *Fig. 8D*). Moreover, sand spits are still preserved at the coastline facing the Sea of Azov, as well as the one towards the enclosed Akthanizovskaya Liman. A formerly established gyre cre-

Tab. 1 Data sheet of the AMS-^{14}C dating results. All ages are calibrated using the calibration software Calib 5.0.2. For marine carbonates the reservoir age of 408 years (*Hughen* et al. 2004) is applied with a ΔR of 5 ± 35 years, according to *Jones* and *Gagnon* (1994); M = bivalve, articulated; M(s) = bivalve, single valve; PR = plant remains; UGAMS = University of Georgia Atomic Mass Spectrometry. The AMS-^{14}C datings were carried out by the Center for Applied Isotope Studies (CAIS) of the University of Georgia at Athens, USA / *Resultate der AMS-^{14}C-Datierungen. Alle Alter sind kalibriert mit der Kalibrationssoftware Calib 5.0.2. Für die marinen Karbonate wurden ein Reservoiralter von 408 Jahren (Hughen et al. 2004) und ein ΔR von 5 ± 35 Jahren nach Jones and Gagnon (1994) benutzt; M = Bivalve, geschlossen; M(s) = Bivalve, einklappig; PR = Pflanzenrest; UGAMS = University of Georgia Atomic Mass Spectrometry. Die AMS-^{14}C-Datierungen wurden durch das Center for Applied Isotope Studies (CAIS) der University of Georgia in Athens (USA) erstellt.*

Sample number	Sample description	Lab. No. (UGAMS)	$\delta^{13}C$	^{14}C Age	1 Sigma max; min	2 Sigma max; min	2 Sigma max; min
			ppm	BP	cal BP	cal BP	cal BC/AD
GOL 1/4	M	4137	-5.80	2201±25	1728; 1855	1665; 1924	**AD 26 – 285**
GOL 1/9	M (s)	4138	-0.43	6354±34	6747; 6879	6682; 6944	**4995 – 4733 BC**
GOL 1/10	M	3184	-1.68	3346±24	3140; 3275	3069; 3327	**1378 – 1120 BC**
GOL 1/14	M	3185	-0.87	4012±24	3951; 4084	3881; 4147	**2198 – 1932 BC**
GOL 1/22	M	3186	-1.09	6015±26	6370; 6483	6304; 6537	**4588 – 4355 BC**
GOL 1/24	M	3187	-0.62	6722±25	7197; 7297	7153; 7349	**5400 – 5204 BC**
GOL 2/6	M	4139	1.32	3383±44	3185; 3331	3078; 3377	**1428 – 1129 BC**
GOL 2/10	M	4140	2.06	3825±28	3699; 3830	3635; 3894	**1945 – 1686 BC**
GOL 3/9	PR	3188	-29.24	2672±26	2753; 2785	2748; 2844	**895 – 799 BC**
GOL 3/11	M	3189	-3.02	4356±26	4415; 4535	4370; 4634	**2685 – 2421 BC**
GOL 14/8	M	3190	-2.45	2869±23	2573; 2710	2482; 2732	**783 – 533 BC**
GOL 14/15	M	3191	-0.38	3467±24	3294; 3401	3231; 3446	**1497 – 1282 BC**
TEM 2/10	M	3198	-1.51	1699±29	1206; 1295	1152; 1339	**AD 611 – 798**
TEM 2/20	M	3199	-1.61	4717±27	4859; 4993	4822; 5111	**3162 – 2873 BC**
TEM 2/32	Peat	3200	-28.40	7045±27	7852; 7932	7829; 7949	**6000 – 5880 BC**

ated these structures in the proximities of the Akthanizovskaya liman; they are not active anymore, but mostly covered by reed and in the east by the sediments of the prograding Kuban deltaplain.

When the Greeks started to establish colonies along the coasts of the Taman Peninsula and also on Golubitskaya around the middle of the 6th century BC, the palaeogeography was dominated by cliffs and beach ridges. The shape of the Taman Peninsula was nearly that of an island only connected with the mainland via several small, partly fractured sand spits. Obviously, the ridges in the east, as well as the Peresip ridge were by then not yet totally closed. Present-day analogues are the Anapa spit in the south and the Golubits-

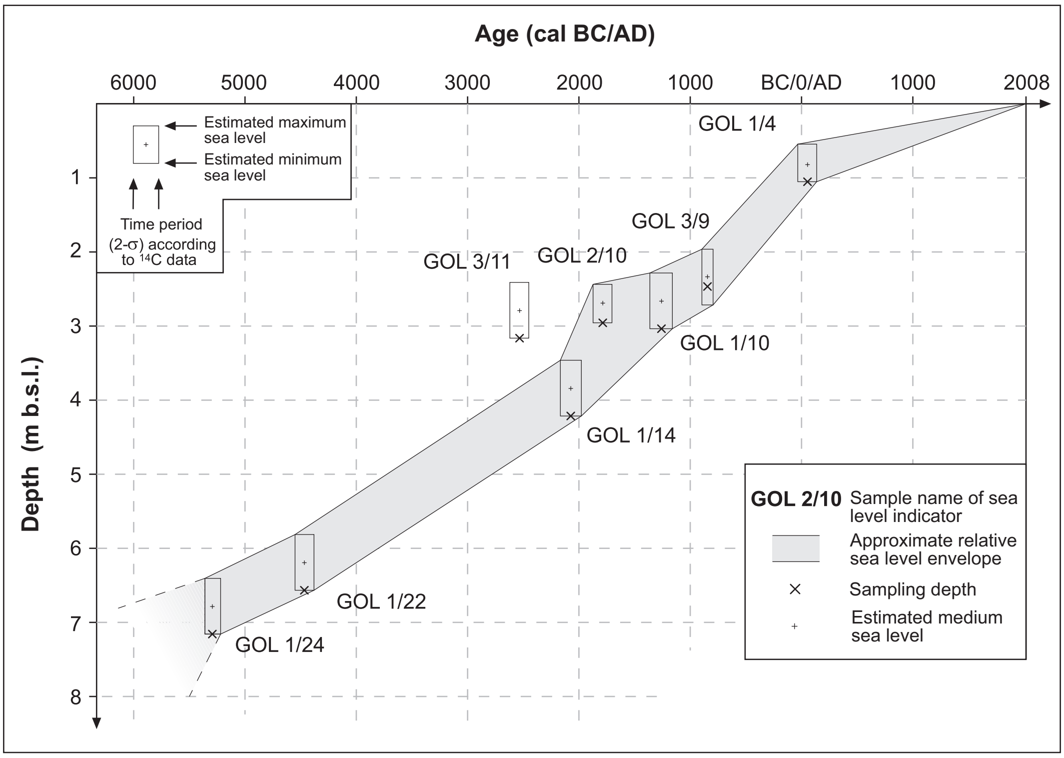
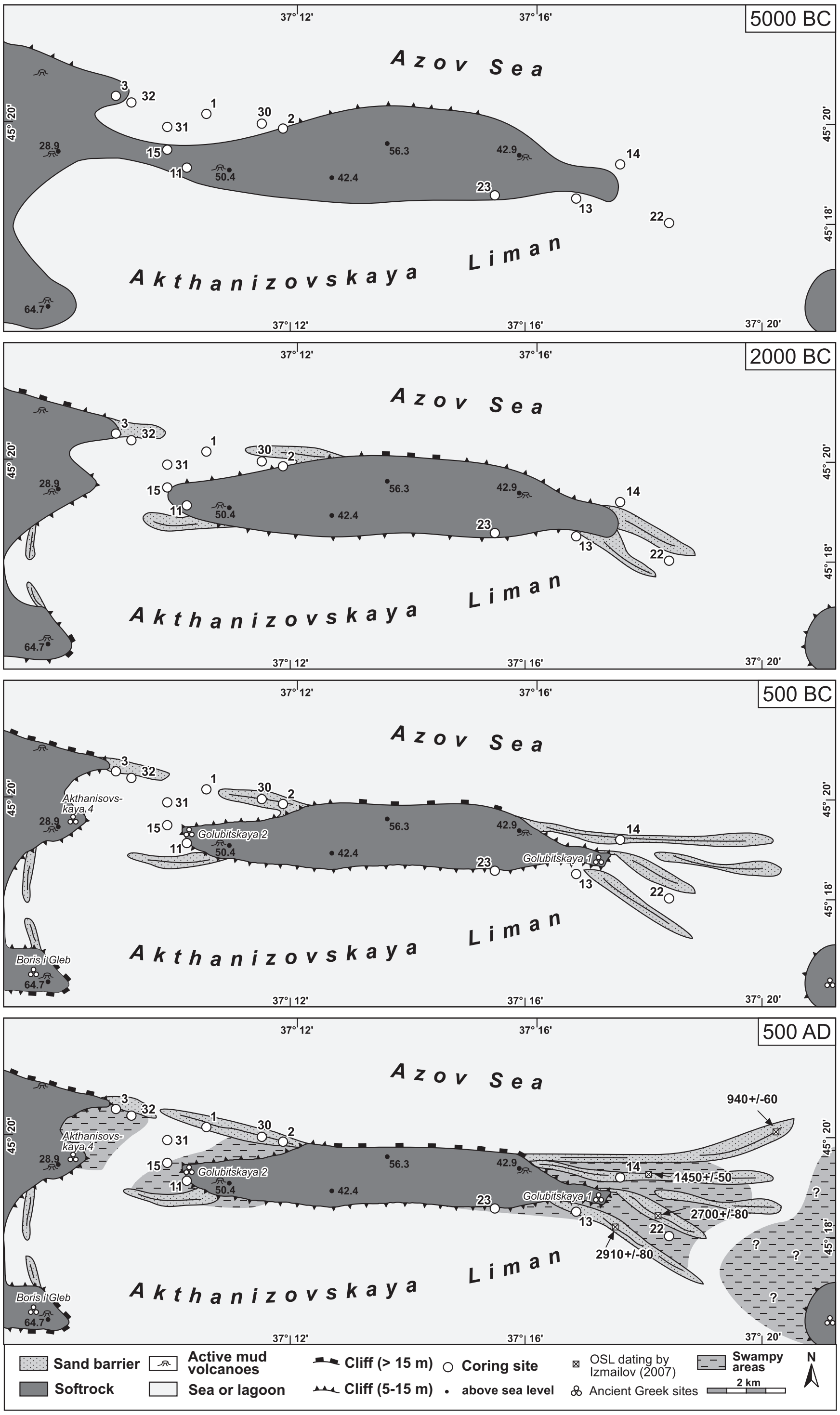


Fig. 9 Relative sea level curve for the coastal area of Golubitskaya 2, northern Taman Peninsula, SW Russia, since the mid-Holocene. The sea level envelope is based on radiocarbon dated sedimentological sea level indicators and their interpretation with regard to the position of the palaeo-sea level / *Relative Meeresspiegelentwicklung seit dem mittleren Holozän für die Küstenregion um Golubitskaja 2 auf der nördlichen Taman-Halbinsel in Südwestrussland. Die Meeresspiegelhüllkurve basiert auf der Interpretation von radiokohlenstoffdatierten sedimentologischen Meeresspiegelindikatoren.*

kaya ridge system in the north of the Taman Peninsula. On the one hand, these sand spits are held open by the high discharge of the Kuban which during that time drained into the Kuban graben structure. It is only in the last millennium that the graben has been filled up by the sediments of the Kuban. On the other hand, the fact that the beach ridges do not yet totally close up the lagoons is due to their continued seaward migration. This kind of beach ridge accretion can, e.g., be studied on the eastern Golubitskaya ridge system. It can also be stated that, due to the ongoing sea level rise, the former connection between Akthanizovskaya 4

Fig. 10 Palaeogeographies of the area of Golubitskaya for the time slices 5000 cal BC, 2000 cal BC, 500 cal BC and 500 cal AD / *Paläogeographische Szenarien für das Untersuchungsareal um Golubitskaja für die Zeitschnitte 5000 v. Chr., 2000 v. Chr., 500 v. Chr. und 500 n. Chr.*


5000 BC
2000 BC
500 BC
500 AD
Azov Sea
Akthanizovskaya Liman
Akthanisovskaya 4
Golubitskaya 2
Golubitskaya 1
Boris i Gleb
940+/-60
1450+/-50
2700+/-80
2910+/-80
Sand barrier
Softrock
Active mud volcanoes
Sea or lagoon
Cliff (> 15 m)
Cliff (5-15 m)
Coring site
above sea level
OSL dating by Izmailov (2007)
Ancient Greek sites
Swampy areas
2 km
N

and Golubitskaya 2 was submerged; thereby, a navigable passage was established.

A thousand years later, in the 5th century AD, the coastal changes were only marginal, the most important one in the vicinity of Golubitskaya 2 being the southern expansion of the Peresip' sand spit which separated the lagoon of Golubitskaya 2 from the Sea of Azov. The sand spit system in the east of the modern village of Golubitskaya changed its orientation from NW-SE to W-E. During that time the settlements on the Golubitskaya mountain range were abandoned. The reason may have been the expansion of the sand spits which gave the Skythian raiders an easier access than before. This assumption is substantiated by a destruction layer in the graben of Golubitskaya 2 dating from the 2nd century BC. The recent cliffs of the Golubitskaya mountain range facing the Sea of Azov are still experiencing strong abrasion (see *Photo 1*). The eroded material, which is reworked and transported by the longshore current, is the sediment source for the continued extension of the sand spits as well as for the gradual siltation of the inland embayments which nowadays have water depths of up to 1.5 m only.

6.2 A new sea level curve for the area of Golubitskaya

The sea level curve for the area around the ancient settlement of Golubitskaya 2 is based on sedimentological criteria (*Fig. 9*). In most cases articulated bivalves at facies changes were used for ^{14}C dating due to the lack of peat layers which are much more reliable sea level indicators (*Allen* 1990; *Pirazzoli* 1991, 1996, 2005; *Brückner* et al. 2010). Therefore, the presented sea level curve shall be regarded as a first approximation.

The curve shows the postglacial sea level rise over the last seven millennia. The general trend of this curve confirms the one of the sea level curve which we reconstructed for the Kuban river plain around the ancient settlement of Semebratnee, c. 20 km SE of Golubitskaya 2 (cf. *Brückner* et al. 2010). Both curves show that the relative sea level around Taman peninsula since the mid-Holocene has never been higher than today. There has been an ongoing transgression which – besides the glacio-eustatic effect – is also an expression of the tectonic subsidence of the area as part of the Indolo-Kuban and the Kerch-Taman troughs (cf. *Fig. 1*). There is no sign of any regression – e.g., represented by erosional disconformities or palaeosols – in the last seven millennia.

This is all the more important to note since *Balabanov* (2007, 2009) shows in his sea level curve for the Black Sea about eight major regressions during this time span. According to our results there is especially no indication of the so-called Phanagorian regression: *Balabanov's* curve has sea level at its present position around 800 and 200 BC, while in between it drops down to -7 m when the Greeks started colonising the area. The lack of major regressions is also evidenced by the fact that in none of our coring profiles a palaeosol was found which would have been the sign of subaerial exposure to weathering during a sea level low stand. Plus, as already argued in our earlier paper (*Brückner* et al. 2010), the three seas – Mediterranean, Black Sea, Sea of Azov – must have similar sea level curves because they have been communicating water bodies at least since their connection via the Dardanelles, Bosporus and Cimmerian Bosporus. Why is it then that none of the sea level curves of the eastern Mediterranean shows the many regression/transgression wiggles of the Balabanov curve (see, e.g., the compilation in *Brückner* et al. 2010, *Fig. 3*)? Instead, the sea level fluctuation curves from other areas of the Taman Peninsula (e.g., Anapa Spit: *Fouache* et al. 2000, 2004) and from the adjacent Kerch Peninsula (*Porotov* 2007) confirm our findings.

There are also arguments for the non-existence of the Phanagorian regression from archaeology and the historical sciences. Had there been a regression of a magnitude as described above, all the harbour installations would have had to be shifted seawards by several kilometres, and back again during the following phase of transgression. We do not have any historical accounts or archaeological finds of such an occurrence. This argument is especially valid for Golubitskaya 2 which is situated at the Sea of Azov – a very shallow shelf sea with a greatest depth of only 19 m. One can easily imagine that a drop in sea level of 7 m would have shifted the shoreline for several kilometres away from the settlement.

If we take the surface areas of the Black Sea (424,000 km^2) and of the Sea of Azov (38,000 km^2) together and multiply the figures with a water column of 7 m, we calculate a water volume of c. 3,200 km^3. Which mechanism would cause a regression of this magnitude? It could not be the effect of evaporation, since this is partly balanced by precipitation. And which mechanism would then fill up the basins once again in a few centuries?

We have discussed the problem of the Holocene sea level fluctuations here at length, because again and again the Balabanov curve is quoted uncritically. Especially for an ancient settlement at the shores of the shallow Sea of Azov such as Golubitskaya, major sea level fluctuations would have played an essential role. For a further study of this matter the reader is advised to have a look at the vivid discussion in the "Forum comment" which follows our paper in Quaternary International (*Brückner* et al. 2010).

7. Consequences for Golubitskaya's Archaeology

The preliminary results of the geoarchaeological research within the Russian-German project, which are published in this article, now enable fundamental new insights into the history of the Greek land acquisition. A former archipelago in the area of the present peninsula with a second, an eastern Bosporus could be attested for Antiquity. With these results, a more comprehensive, strategically orientated settlement concept becomes evident for the islands, which – contrary to previous assumptions – were not accessed from the west, from today's Strait of Kerch, but from the east, from the foot of the Caucasus. Apart from this broader context, specific questions in local regions are of course of major importance for archaeological interpretations.

An early example for the opening up of the archipelago is represented by a settlement which is situated at the western tip of the small, so-called Golubitskaya island, and which so far has not been explored. The Greek colony Golubitskaya 2, of which the ancient name is unknown up to now, was already established at an early stage of the colonisation process. Built upon a headland, it could – together with the likewise fortified settlement Akhtanizovskaya 4 directly opposite – control the entrance into an embayment with further settlements and sanctuaries as well as to a second Bosporus (cf. the situation shown in the Barrington Atlas, ed. by *Talbert*: *Braund* 2000; *Braund* 2000a). This settlement is studied in detail as an example within the context of the above-mentioned archaeological project, in order to gain insight into the time of the Greek land acquisition and to delineate the process of transformation into a territorial state. In this context a reconstruction of the natural surroundings at the time of foundation and during the settlement's lifetime is crucial for comprehending the founders' and the later inhabitants' motives regarding the settlement. The present-day situation can only offer a vague idea of this place that controlled an important shipping passage, probably provided with safe harbours and with the natural protection of the settlement by the sea from two sides.

On the land side of Golubitskaya 2, a mighty fortification was uncovered, which constituted a border besides the cliffs of the sea side (*Fig. 3*). Namely, the discovered rampart and ditch (enclosure) was never shifted in spite of several rebuilding measures. So far, it is the first and moreover one of the earliest defensive structures of this kind in a Greek settlement in the North Pontos (*Tolstikov* 1997: esp. 208ff.). Equally early fortification walls, albeit constructed of stone, are known in the Crimea (*Gajdukevič* 1971: 184; *Podossinov* 2002: 23ff.).

In other settlements, some of which are also situated on Taman Peninsula, early fortifications can be anticipated, but have not yet been uncovered. Thus, the thesis about the so-called peaceful Ionian colonisation of the North Pontos, which was proposed mainly on the basis of the absence of fortifications earlier than the 5th century BC (cf. still for instance *Tsetskhladze* 1997: 59f., 77f.), becomes questionable.

In addition, the fortification ditch in Golubitskaya 2 also sheds light on the settlement's history. Apart from coins, amphorae and amphora stamps of different origins that point to dynamic commercial activities. A certain prosperity is also indicated by terracotta fragments, roof tiles, and jewellery, as well as sanctuaries and buildings. Furthermore, a rich variety of archaeozoological finds (determined by *Dr. M.V. Sablin*, Zoological Institute RAN, St. Petersburg, some horse bones also by *Prof. Dr. N. Beneke*, DAI) was recovered from the 10-metre-wide ditch area that has been excavated so far. Outstanding among these finds are more than one hundred horse bones from the 5th/4th century BC, which can be attributed to five individuals. Like the bones of sheep, cattle and pigs, which were deposited in the fortification ditch as well, they could be part of kitchen waste; on the other hand, they could also represent relics of armed conflicts, for horse breeding is not necessarily to be expected on such a small island. In this context, reference should be made to ancient reports that the (Cimmerian) Bosporus was frozen for months, thus enabling Scythian peoples to cross the passage from Europe to Asia. Such a scenario of passing rider nomads could also explain the strong land fortification on Golubitskaya island and perhaps the large number of horse bones in the excavation section as well. These would, thus, support the accounts of Herodotus (Herod. 4, 28) from the 5th century BC and of later ancient authors about the Bosporus being frozen. In consequence, the natural protection by the exposed sea location would have been disrupted seasonally, thus offering a plausible explanation for the surprisingly strong fortification endeavours which had been undertaken on an island from the very beginning of settlement activity.

Further archaeological investigations within the settlement will address these and other questions. However, one fact is already certain by now: The settlement of Golubitskaya 2 was entirely abandoned already in the 2nd century BC, and at least large parts of it were destroyed. Likewise, the abrupt end of all types of settlement activity in this place might have been caused by environmental conditions, entirely or at least partially. Whether or not, and if so to what extent, this was indeed the case can only be determined through the continuously improving methods of geoarchaeology (cf. *Zhuravlev* et al. 2009: 122ff.).

8. Conclusions

This paper presents, for the first time, palaeogeographic scenarios and a relative sea level curve for the northern Taman Peninsula since the mid-Holocene. The palaeogeographic scenarios (*Fig. 10*) are based on sedimentological, archaeological and historical evidence which can be summarised as follows:

(i) The postglacial sea level rise formed an archipelago, consisting of three islands in the study area of the present-day Taman Peninsula. Until the 6th millennium BC, the Golubitskaya mountain range was still connected to the mainland in the west. However, the marine transgression had formed a large marine embayment which extended south and east of the hilly region.

(ii) Around 3,000 BC, due to the decelerated sea level rise, coastal processes for forming secondary coasts became dominant. Thus, the longshore drift created sand spits and bars.

(iii) In the 6th century BC, when the Greeks started colonising the area of the (later) Taman Peninsula, they settled mostly on headlands of small islands and peninsulas which were connected to the Skythian hinterland via small sand spits and bars.

(iv) The palaeogeographic setting made it possible to sail into the lagoons that had evolved behind the sand spits and bars which offered well protected natural harbours. This is one possibility to explain why quite a good number of Greek colonies were founded as harbour cities on the headlands of the (later) Taman Peninsula.

(v) During the following centuries, the sand spits, bars and barriers grew in amount and extent; thus, access to the open sea was sometimes cut off or at least hindered. The progressing siltation of the lagoons and limans, e.g. Akthanizovskaya Liman, led to a shallowing of the water depth. Therefore, on the one hand, navigability of the marine waterways was reduced, and on the other hand, attacks from enemies were made easier. This may have been the cause for the abandonment of some minor settlements such as Golubitskaya 2.

(vi) A relative sea level curve for the area of Golubitskaya is also presented. It shows a continuous sea level rise with its peak only today. We cannot confirm the wiggles representing re- and transgression cycles that are shown in other sea level curves published for the Black Sea.

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Geoarchaeology of Taman Peninsula (Kerch Strait, South-West Russia) – the Example of the Ancient Greek Settlement of Golubitskaya 2

This study focuses on the Middle and Late Holocene evolution of the northern Taman Peninsula (SW Russia) since 5,000 cal BC. By then, the postglacial transgression had created an archipelago. During the following three millennia, the continued sea-level rise eroded steep interior cliffs. These primary coasts were later separated from the sea by the formation of beach barrier-lagoon systems. Thus, the former islands were connected with each other, finally forming the Taman Peninsula. In particular, the palaeogeographic evolution of the area around Golubitskaya 2 is reconstructed. When Greek colonists founded this settlement in the 6th century BC, it was situated on a promontory which had still good access to the Sea of Azov and to the Kuban river mouth. During the 4th to 2nd centuries BC, a beach barrier evolved out of a former sand spit which cut off the navigable access to the sea. This was possibly the main reason for the abandonment of the city. The timeframe for the chronology of events is given by ^{14}C ages as well as by archaeological and historical evidence. Methodically the study is based on percussion corings.

Zusammenfassung: Zur Geoarchäologie der Taman-Halbinsel (Straße von Kertsch, Südwestrussland) – das Beispiel der antiken griechischen Siedlung Golubitskaja 2

Diese Arbeit stellt die mittel- bis spätholozäne paläogeographische Entwicklung der nördlichen Taman-Halbinsel während der letzten 7000 Jahre dar. Am Beginn dieses Zeitraums hatte die postglaziale Transgression einen Archipel gebildet, der in den folgenden drei Jahrtausenden durch starke Klifferosion und Küstenlängstransport beträchtlich umgeformt wurde. Es bildeten sich Strandhaken und später Nehrungen, welche die einzelnen Inseln miteinander verbanden und Anschluss an das Festland herstellten, was schließlich zur Entstehung der heutigen Taman-Halbinsel führte. In dieser Studie geht es insbesondere um die paläogeographische Entwicklung der antiken griechischen Siedlung Golubitskaja 2 aus dem 6. Jh. v. Chr. im Norden der Halbinsel am Asowschen Meer. Diese Siedlung, auf einem Vorsprung einer der vielen Inseln des Archipels gelegen, hatte noch zum Zeitpunkt ihrer Gründung guten Zugang zum Meer und auch zur Mündung des Kubans. Im 4.-2. Jh. v. Chr. entwickelte sich die nördlich vorgelagerten Nehrung zu einem unüberbrückbaren Hindernis für den Seehandel und führte damit zum schleichenden Niedergang der Siedlung. Die Chronologie der Ereignisse und des Landschaftswandels wird durch ^{14}C-Datierungen und archäologische Befunde gestützt. Die Untersuchungen basieren auf mittels Schlagbohrhammer gewonnenen Bohrkernen.

Résumé: Géoarchéologie de la péninsule de Taman (sud-ouest de la Russie) – l'exemple de l'ancienne colonie grecque de Golubitskaya 2

Cette étude a pour objectif de reconstruire l'évolution holocène (moyen et tardif) de la partie septentrionale de la péninsule de Taman (au sud-est de la Russie) depuis 5,000 cal av. J-C. A cette époque, la transgression post-glaciaire fut responsable de la création d'un archipel. Au cours des trois millénaires suivants, l'élévation continue du niveau marin éroda des falaises intérieures escarpées. Ces côtes furent ultérieurement séparées de la mer par la formation de systèmes composés de cordons littoraux et de lagons de telle manière que les anciennes îles furent reliées les unes aux autres et formèrent au final la péninsule de Taman. Dans ce cadre, l'évolution et la reconstruction paléogéographiques de la zone aux alentours de Golubitskaya 2 sont en particulier considérées. Lorsque les Grecs s'y établirent au cours du 6ème siècle av. J-C, ils installèrent leur colonie sur un promontoire qui présentait toujours à cette période une bonne accessibilité à la mer d'Azov ainsi qu'à l'embouchure du fleuve Kuban. Cependant, en raison du développement d'un cordon littoral à partir d'une ancienne flèche littorale à partir du 4ème jusqu'au 2ème siècle av. J-C, l'accès à la navigation fut interrompu. Ceci constitue vraisemblablement la raison principale de l'abandon de la cité. Le cadre chronologique des différents événements débattus dans cette étude nous est fourni par des datations au ^{14}C ainsi que par des preuves archéologiques et historiques. D'un point de vue méthodologique, cette étude repose sur des forages à percussion.

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