

HOLOCENE TRANSGRESSIONS IN THE AREA OF THE BURGAS LAKES COMPLEX – MANIFESTATION OF GLOBAL CLIMATIC FLUCTUATIONS

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ABSTRACT. Modern climate changes, heavily overexposed by the media and unscrupulous scientists, have led to understandable panic among much of the world's population. It has been taken seriously not only by ordinary citizens but also by the governments of advanced countries. However, geologists know that global warming is not measured in degrees, but in millimeters due to the melting of ice caps at the poles that cause rising of the global sea level. Cyclically repeated glacial and interglacial ages, known as Milankovitch cycles, have an astronomical forcing. They can really cause global sea level fluctuations of tens of meters, however, not in a few tens of years, but in tens of thousands of years. Against the background of these cycles, there are also short-term (from a geological point of view) stages of warming and cooling, which have no unambiguous explanation. Similar trend has been observed since 1850, without it being associated with any human activity. The main Holocene warming events that led to the last transgressions in the Earth's history – the Flandrean (Novochernomorian) and Nymphaean transgressions, are well expressed on the Black Sea coast in the form of old marine terraces. The Novochernomorian (New Black Sea) terrace is at ~4 m above the modern sea level. On this surface is the town of Pomorie and some neighborhoods of the town of Burgas. The Nymphaean terrace, disposed ~2 m above sea level, is well defined on the shores of the Burgas Lakes which are protected from abrasion acting on the open Black Sea coast. Transgressions played an important role in antiquity by providing a navigation access to the ancient Deultum (now Debelt) inside the Mandra Liman, thanks to which this important Roman polis became a flourishing port for 2–3 centuries.

Keywords: Burgas Lakes complex, Novochernomorian terrace, Nymphaean terrace

ХОЛОЦЕНСКИТЕ ТРАНСГРЕСИИ В БУРГАСКИЯ ЕЗЕРЕН КОМПЛЕКС – ПРОЯВА НА ГЛОБАЛНИ КЛИМАТИЧНИ КОЛЕБАНИЯ

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РЕЗЮМЕ. Съвременните климатични промени, силно преекспонирани от медии и безскрупулни учени, доведоха до разбираема паника сред голяма част от населението на Земята. Те се възприемат сериозно не само от обикновените граждани, но и от правителствата на развитите страни. Геолозите обаче знаят, че глобалното затопляне не се измерва в градуси, а в милиметри, поради топенето на ледените шапки на полюсите и покачването на глобалното морско ниво. Циклично повтарящите се ледникови и междуледникови епохи, известни като цикли на Миланкович, имат астрономичен произход. Те наистина могат да причинят колебания на глобалното морско ниво от порядъка на десетки метри, но не за няколко десетки години, а за десетки хиляди години. На фона на тези цикли има и краткотрайни (от геоложка гледна точка) периоди на затопляне и захладяване, които нямат еднозначно обяснение. Подобна тенденция се наблюдава от 1850 г. насам, без тя да е свързана с каквато и да е човешка дейност. Главните холоценски събития на затопляне, предизвикали последните трансгресии в историята на Земята – Фландърската (Новочерноморската) и Нимфейската, са добре изразени по Черноморието под формата на стари морски тераси. Новочерноморската тераса е на ~4 m над съвременното морско ниво. Върху тази повърхност е град Поморие и някои квартали на Бургас. Нимфейската тераса, разположена на ~2 m над морското ниво, е добре изразена по бреговете на Бургаските езера, които са защитени от абразията на откритото крайбрежие. Трансгресиите са играли важна роля в древността, осигурявайки достъп до античния Деултум (днес Дебелт) в Мандренския лиман, благодарение на който този важен римски полис се превръща в процъфтяващо пристанище в продължение на 2–3 века.

Ключови думи: Бургаски езерен комплекс, Новочерноморска тераса, Нимфейска тераса

Introduction

The term “climate change” is used for significant and long-standing global climate change. The geological meaning of “significant and long-standing” is quite different from the generally accepted notions of time. In geology it is usually millions of years. However, when we talk about global climate changes, we most often mean Quaternary glacial and interglacial stages, known as Milankovitch cycles that last for tens and hundreds of thousands of years. The term “global warming” is formulated as a slow increase in the average temperature of the atmosphere due to the heat coming from the sun, which is retained in it and is not radiated into space. Like any theory, the concept of global warming has both supporters and opponents. The former consider global warming to be an indisputable fact that is directly related to human activity, in

particular the increase in carbon emissions. Opponents believe that there is no global warming or climate change. There is a third category of scientists who believe that global warming is a natural cyclic process which is not caused by human activity. Firmly convinced of the latter statement, the author of this paper belongs to a fourth category of scientists considering that the present global warming belongs to small-scale non cyclic climatic change of complex origin superimposed on the interglacial Milankovitch astronomical cycle that began after the end of the last ice age 11.7 ka ago.

Holocene climate fluctuations

There are several proven examples in the Holocene history of the Earth for interruptions to the gradual warming of the climate after the severe Last Glacial Maximum (LGM), about 27

to 24 ka BP. The most recent large-scale event of cooling since the LGM, the Younger Dryas stadial (YD), occurred between 12.9 and 11.5 ka ago (Fig. 1). It is characterized by very low temperatures for the most part of the YD, rapidly rising afterwards to reach the warm Holocene temperatures. The YD is one of the three major abrupt cold events that interrupted the warming during the last deglaciation, recognizable in a variety of tracers in terrestrial, marine and ice records across the

Northern Hemisphere (Meissner, 2007). The first explanation of this event belongs to Johnson and McClure (1976) postulating that an increased freshwater influx of the St. Lawrence River triggered the YD cold event by causing an increase in North Atlantic sea ice. Against the background of these minor (compared to the Milankovitch cycles) climatic changes, smaller sea level fluctuations could be also recognized by investigation of the ancient shorelines and archeological artifacts.

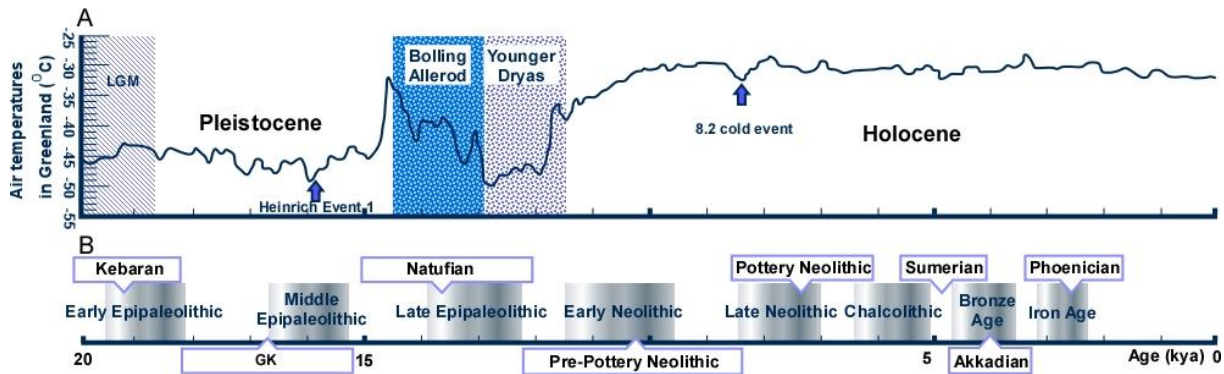


Fig.1. Curve of air temperature variation in the latest Pleistocene and Holocene (after Platt et al., 2017): (A) Reconstructed air temperatures from the GISP 2 Ice core in Greenland; (B) Chronology of cultural entities in the Levant

Modern climate changes

Modern climate changes, heavily overexposed by the media and unscrupulous scientists, have caused a wide response among much of the world's population. The world is flooded daily with statistics showing high average annual temperatures in the late 20th and early 21st centuries. As a result, the idea of global warming is being taken more and more seriously not only by common people, but also by the governments of advanced countries, which have begun to allocate funds to "fight global warming". The apocalyptic predictions were joined by influential figures from the fields of culture, politics and business, who in fact have no idea what it is all about. The escalation of this global hysteria has left behind the real problems of the humanity – hunger, environmental pollution and overpopulation of the planet.

It is widely known that the best lie is the half-told truth. Based on mass measurements of temperatures in different parts of the world, "scientific" models are constantly being created that predict an apocalyptic picture until the end of the century: glacier shortening, powerful cyclones, prolonged droughts, submerged cities, destroyed crops, fires, floods, deforestation, misery and famine. Speculating on strictly scientific facts, such as the greenhouse gases ratio in the atmosphere, most of these models do not involve important natural processes, such as the absorption of CO₂ from the oceans, but involve human activity, such as the industrial release of heat-trapping greenhouse gases into the atmosphere. Ordinary people are not experts and find it difficult to orient in this avalanche of information. They accept these apocalyptic predictions for granted and believe that they should participate in the "salvation of future generations", according to the principle of sustainable development,

formulated in the report of the UN "Brundtland" Commission entitled "Our Common Future" (UN World Commission on Environment and Development, 1987). The truth is that we cannot influence such global processes and even if there is global warming, we can in no way fight it. We all remember the ozone hole that made us feel guilty about using deodorants. What happened with it?

Now many scientists tend to exaggerate human participation in global processes, as is the case with global warming and the ozone hole. However, many facts are ignored simply because they are not in line with the "global trend" in science. Robinson et al. (2007) provided data that refute the main arguments for the anthropogenic causes of global warming, which gives the United States a reason not to sign the global climate accords. They apply an example from Sargasso Sea, suggesting that the Earth's temperature today is essentially at the 3000-year average global temperature (Fig. 2A), and glacier shortening started about 1850, 25 years before the start of intensive fossil fuel use (Fig. 2B). Respectively, at the same time started the sea-level increase with 7 inches per century. The "medieval climate optimum" with temperature 24°C higher than the average global temperature corresponds to the high sea level at the maximum of the Nymphaean transgression during 10–11th century. Historically the pick of the Nymphaean warming coincides with the Viking Age (793–1066 AD). During this time, the Norsemen conquered Greenland and called it "Grœnland" because of its green shores. This simply means that very recently, in historical times, the southern shores of Greenland were grassed. This has led neither to the sinking of medieval civilizations nor to the halting of the Gulf Stream, as speculated by proponents of global warming, widely popularized in Al Gore's documentary "An Inconvenient Truth" winning the Academy Award for best documentary feature in 2007.

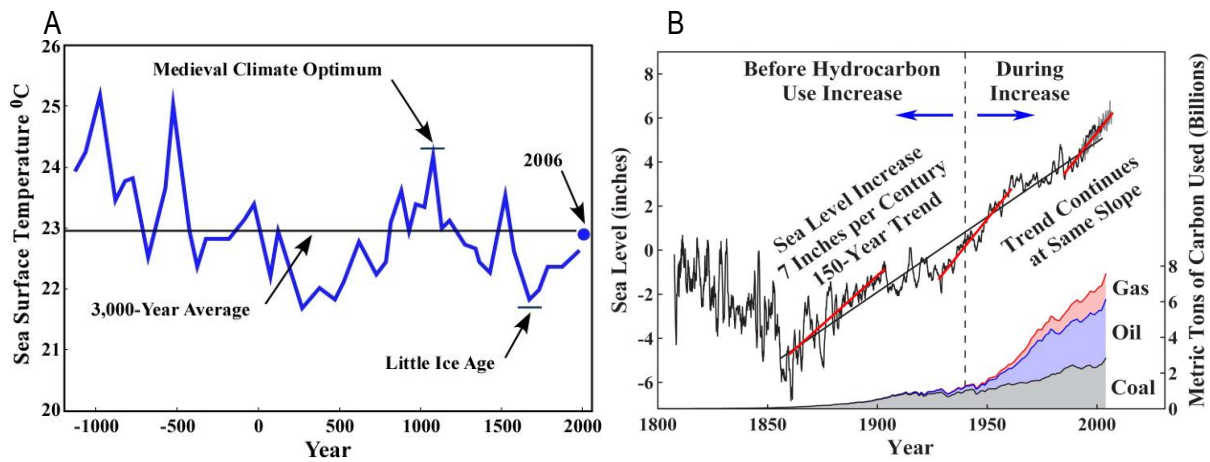


Fig. 2. Climatic and sea-level fluctuations in historic time (after Robinson et al., 2007): (A) Surface temperatures in the Sargasso Sea, the horizontal line is the average temperature for this 3,000-year period corresponding to the present one, the Little Ice Age and Medieval Climate Optimum were naturally occurring, extended intervals of climate departures from the mean. (B) Global sea-level measured by surface gauges between 1807 and 2002, and by satellite between 1993 and 2006; this trend lags the temperature increase, so it predates the increase in hydrocarbon use, and it is unaffected by the very large increase in hydrocarbon use

The Black Sea level fluctuations in the post-glacial period

The continuous alternation of warming and cooling in the Earth history, which is repeated in 20 ka, 43 ka, and 100 ka, known as Milankovitch climatic cyclicity, is of astronomical origin. Every geologist or geomorphologist is acquainted with these cycles and knows that global warming is not measured in degrees, but in millimeters due to the melting and freezing of the ice caps at the poles, causing global sea-level fluctuations of tens of meters. Today, the Black Sea is a continental marine basin, but it has been oscillating between lacustrine and marine stages following, respectively, glacial and interglacial global sea-level changes. The Black sea level fluctuations during the post-glacial period are synchronous and unambiguous with the global sea-level fluctuations (Fedorov, 1959). In the end of the last glacial stage about 10–12 ka ago, the Black Sea inherited the Late Neoeuxinian sea-lake which level was tens of meters below the present one. The melting of the ice shield covering the northern part of the continent led to a high fresh water influx into the Neoeuxinian basin and its level started to rise. The first penetration of saltwater and reconnection with the Mediterranean Sea, recently dated to 8400 years BP on strontium isotopes and ^{14}C (Major et al., 2006; Marret et al., 2009 and others) led to stratification of the marine water due to different salinity (Fedorov, 1983).

There are two hypotheses about the transition between Neoeuxinian and Black Sea basins. According to the so called “Noah’s Flood” hypothesis (Ryan et al., 1997a, b; Ryan, Pitman, 1998; Ryan, 2007, and other authors) an abrupt Mediterranean saltwater flooding of the Black Sea’s ice-age freshwater lake occurred 8400 years ago. Due to this catastrophic inundation, the sea level increased from -90 to -30 m in the frame of one year. As an alternative to this hypotheses, Aksu et al. (2002), Yanko-Hombach and Tchepaliga (2003), Yanko-Hombach et al. (2004), Yanko-Hombach (2007), Sorokin and Kuprin (2007), Kuprin and Sorokin (2007) and many others argue that the sea-level rise was gradual. This is based on abundant scientific data recovered directly from the Black Sea by USSR and Former Eastern Bloc scientists, which have unfortunately been largely

ignored in the global scientific debate, apparently due to language barriers and the lack of west-east scientific dialogue (Yanko-Hombach, 2007).

Since then there have been several minor fluctuations of the Black Sea level, the most remarkable of which is the Novochernomorian (New Black Sea) Holocene transgression (Fedorov, 1956) which reached the maximum sea level of 4–5 m higher than today’s level during the Chalcolithic and Bronze Ages (~6000–3000 years BP). It corresponds to the Nice transgression in the Mediterranean, Flandrean transgression of the Atlantic coast and Littorina transgression in Baltic Sea (Fedorov, 1959). The Novochernomorian transgression is followed by a small regression called “Phanagorian regression” (Fedorov, 1956), that resulted in 2–3 m fall of the Black Sea level compared to the present sea-level between 3000 and 2000 years ago. The last transgression in the Earth’s history is the so called “Nymphaean transgression” (Fedorov, 1959) that caused 1.5–2 m sea-level rise above the present sea-level in the Middle Ages between 6th and 12th century. The short-term warmings and coolings, such as the Nymphaean transgression, have no unambiguous explanation. It is established in many places on the Black Sea coast in the form of a marine terrace located 1.5–2 m above the modern sea level.

Novochernomorian and Nymphaean transgressions in the Burgas Lakes area

The Burgas Lakes complex includes four separate basins: three estuaries (limans) – Burgas (Vaya), Atanasovsko and Mandra Lakes, and one lagoon – Pomorie Lake. Novochernomorian and Nymphaean transgressions are well expressed on the shores of the lakes, which are protected from the active abrasion of the open coast and have preserved flat surfaces, formed during the periods of high sea level. The Holocene terraces along the Bulgarian Black Sea coast were established by Fedorov et al. (1962) and Fedorov (1963) shortly after Fedorov (1959) introduced the Nymphaean transgression into literature. These authors described Novochernomorian terrace as an abrasive-accumulative surface 5 m above the

present sea-level east of the town of Balchik, and as abrasive flat surfaces 5–6 m above the present sea level along the southern Black Sea coast (Strandzha) incised in Upper Cretaceous tuffs (Fig. 3). The Nymphaean terrace characterized as “younger terrace disposed 2 m above sea level” is established near Batova River (west of Balchik town), Varna estuary, Kamchia River estuary, between cape Emine and Burgas, and south of Burgas till the town of Michurin (now Tzarevo). The authors noted that the Sunny Beach resort is located on this terrace, which corresponds also to the coastal accumulative forms such as the Pomorie tombolo, connecting the Sarmatian carbonate island (old town of Pomorie) with the beach. Christov (1967) mentioned the presence of the Nymphaean terrace in the vicinities of Burgas and Pomorie. Mishev et al. (1970) noted that the Holocene terraces – the Novochernomorian and probably the Nymphaean one, form a narrow beach strip as well as the adjacent estuary and lagoon lowlands. Popov and Mishev (1974) especially noted that Pomorie town is disposed on the Novochernomorian terrace and the Nymphaean terrace is present around the Burgas Lakes. Our recent investigations confirm the presence of the Nymphaean terrace along the shoreline of the Burgas Lakes (Sinnyovskiy et al., 2018) and fossil humus deposits 1 m above the present sea level (Sinnyovskiy et al., 2019).



Fig. 3. The Novochernomorian terrace at Foros Cape, south of Burgas, incised in Upper Cretaceous tuffs

As mentioned above, most of the authors believe in a gradual transgression between Neoeuxinian and Black Sea basins, with the average rate of sea-level rise ~3 mm/yr. According to Larchenkov and Kadurin (2011) the late Pleistocene and Holocene transgressions occurred in pulsing, transgressive-regressive stages. The highest Holocene global sea level was reached 5000–6000 years ago during the Flandrean transgression, known in the Black Sea as Novochernomorian. At that time the Pomorie lagoon did not yet exist, but the Burgas Lakes were wide bays of the Black Sea, as evidenced by archaeological artifacts of the ancient Roman ports Deultum and Skafida, located at the Gulf of Mandra. At this time the higher part of Pomorie town, built of Sarmatian limestones of the Odartsi Formation, was an island. Such coastal islands are often connected to the beach with a sandbar, called “tombolo”. Sometimes the sandbars may appear on both sides of the island forming a “double tombolo” which may form an enclosed lake (lagoon). In the course of the high sea level during the Late Chernomorian transgressive interval, submarine barrier

bars were formed on both sides of the Pomorie Island connecting it with the mainland. After the retreat of the sea these sandbars (double tombolo after Popov and Mishev, 1974), emerged above the surface and formed the Pomorie lagoon (Fig. 4).



Fig. 4. The northern sandbar of the Pomorie tombolo separating the Black Sea (left) from the Pomorie lagoon (right)

At the same time, the three limans, known as Burgas Lakes, have undergone a maritime regime. During the Early Chernomorian transgressive interval (Vityazevian Stage, 8.9–7.1 ka BP) the Black Sea waters invaded the land and many limans were established along the southern Black Sea coast. For several thousands of years they have existed as open marine embayments with marine sedimentation. After the Novochernomorian transgression to the end of the Kalamitian stage (until 4 ka BP) the sea level dropped to its present position and the Burgas Lakes regain the appearance of limans. Probably during the Phanagorian regression they became closed lakes without direct connection with the sea. However, the connection was carried out by infiltrating the seawater through the barrier sandbar as is now the case with the Pomorie lagoon.



Fig. 5. Novochernomorian terrace west of Manrda Liman on the left bank of Sredetska River south of Debelt: the wave-cut surface 4 m above the lake level (the arable land) extends to the paleo-shoreline of the Mandra Bay composed of Upper Cretaceous tuffs

The genesis of these terraces is still the subject of controversy. The Novochernomorian terrace is well developed at the Black sea capes, where it is an erosional surface 4–5 m above today’s sea level. Popov and Mishev (1974) referred to the same terrace the wide flat surfaces at the lower reaches of Sredetska and Rusokastrenska Rivers elevated 4 m above the

lake-level and reaching to the ancient liman's shoreline of Upper Cretaceous tuffs (Fig. 5). However, the formation of accumulative terraces along the shoreline of the Burgas Lakes during the Middle Ages is indisputable. This flat surface, surrounding the lakes, is 1–2 m above water level. In the bays, where the shore is nearly flat, the Nymphaean terrace is overgrown with reeds but on the steep shores it reaches the rocky outcrops of the paleo-shoreline, composed of Upper Cretaceous tuffs (Fig. 6).



Fig. 6. Nymphaean terrace near Ezerovo village: a flat surface around the Vaya Lake (left), overgrown with reeds reaching the paleo-shoreline of Upper Cretaceous tuffs (right)

Archeological aspects

The unification of geological and archaeological data is difficult because of the different methodology used for recognizing ancient events. Paleogeographic reconstructions may serve as a basis for locating submerged ancient settlements during the past 7000 years. Historically, the Novochemomorian transgression is too far back in time to be used for comparing with events in ancient human history of the area. During this time one of the oldest Bulgarian towns – Sozopol was founded, known in the antiquity under the name Apollonia (Greek colony Apollonia Pontica). Submarine investigations of the shelf near Sozopol revealed relics of dwellings, ceramic pottery, stone and bone tools from the Bronze Age when the sea-level was still higher than today's.

Many artifacts obtained during the investigation of the roman settlements Skafida and Deultum support the assumption that in the Middle Ages the sea level was higher than today. Deultum was founded in 70 AD by the Emperor Vespasian who granted the veterans of Legio VIII Augusta the right to rule a large area near the estuaries of the rivers Sredetska, Rusokastrenska, Fakiyska and Izvorska, as well as Vaya and Mandra Lakes. The border stone between Deultum and Anchialo, which was found in 19th century near the old Burgas station, marks the northern border of the colony. Over the next three centuries, the city has grown and became one of the most important centers in the province of Thrace that acquired the right to mint own bronze coins between I and III century. According to a Hellenistic source of the Roman geographer Plinius, who characterized it as "stagnum" (open basin), the fairway navigation penetrated to the western coast of Mandra Lake, where the port of the ancient Deultum was found during the recent archeological excavations. These artifacts suggest that 1) the sea level during I–III century was higher and Mandra liman was connected to the sea before

the beginning of the Nymphaean transgression at about 6th century, or 2) the transgression began earlier.

Conclusions

The last 11 500 years have been filled with important events in geological history on which many events of the human civilization history are superimposed. Geological data about the Holocene climate changes are obtained through interpretation of the global sea level changes, as evidenced by the youngest marine terraces in the area of the Burgas Lakes complex. They carry a huge amount of information about both the paleoenvironment and the ancient civilizations on the coast of Pontus Euxinos. The archaeological artifacts obtained from the ancient Roman ports of Deultum near the village of Debelt and Skafida north of the village of Dimchevo, indicate a higher level of the Mandra liman at the beginning of the new era, ensuring a wide connection with the Black Sea. This proves that the sea level was higher many years before the beginning of the Nymphaean transgression in the Middle Ages. Traces of higher sea level in the Middle Ages are well recorded on the shores of the Burgas Lakes. This area is a wonderful place to demonstrate this geological event, which happened very recently in the human history, but long before the industrial revolution during the 18th century. This is a natural process that humanity cannot and does not need to fight.

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