Short communication

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Ponto-Caspian basins development during MIS 5

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ABSTRACT. The aim of this paper is reconstruction and correlation of events within the Ponto-Caspian basin system, and the response of the systems to the global climatic changes during the MIS 5 epoch. The Pontian and Caspian basins belonged to different types of the water basins, and evolved differently in the Pleistocene responding in different ways to the climate changes. The study is based on the analysis and integration of the drilling material and data published by numerous investigators of the region who have been working on the paleogeography of the Ponto-Caspian region in the Late Pleistocene.

Keywords: Caspian Sea, Azov-Black Sea basins, Manych, MIS 5, sea level change, climate change, correlation

1. Introduction

The Ponto-Caspian is a system of intracontinental water bodies, different in their paleogeographic development. The Caspian Sea is an isolated basin, the Azov–Black Sea is a basin, which at certain periods connects with the ocean. The Manych Depression occasionally functioned as a passage between the Caspian and the Pontian basins. The development of the basins is influenced by multiple factors. This paper aims to reveal connections between the climate changes, as well as between sea level fluctuations in the Caspian and Pontian seas and the evolution of their environments. The paleogeographic analysis focuses on the time interval MIS 5 (Late Pleistocene). The interval covers global climatic events: Mikulino interglacial (MIS 5e) and beginning of the Valdai glacial epoch (MIS 5d-a).

2. Materials and methods

The study is based on the analysis and integration of the drilling material (from the Caspian Sea, Manych depression and the Black Sea) and published data. The laboratory studies included lithological and geotechnical analysis of the cores, floristic and faunal studies of the organic remains extracted from the cores. We summarize published and novel data on the transgressive and regressive events and climatic changes in order to reconstruct paleogeographical evolution of the region during the MIS 5 epoch. The recent decades are marked by a sharp increase in the amount of such publications, which indicates a growing interest of the scientific community in the history of those intracontinental basins.

3. Results and discussion

Caspian Sea

In the Caspian region the Upper Pleistocene sedimentary series have been studied mostly within the limits of oil producing fields in the course of prospecting works. The exploratory boring to a depth of 90 m has been carried out in three areas in the Northern Caspian Sea. The obtained core was studied with lithological, faunistic, palynological, and geochronological methods (Yanina et al., 2018; Sorokin et al., 2017). There are two transgressions (stages) distinguished within the late Khazarian epoch – the Late Khazarian and the Hyrcanian. The level of Late Khazarian transgressive basin reached about minus 10 meters at its maximum (Yanina, 2013). The water was rather warm, as suggested by the composition of the mollusk assemblage dominated by *Didacna nalivkini* and *D. surachanica*, is corroborated by the *Corbicula fluminalis* in the freshened water. The salinity was higher than at present (10–12‰ in the Northern Caspian). The Hyrcanian transgressive stage was identified in the Caspian history by G. I. Popov (1967) on the base on the analysis of boreholes drilled in the northwest of the Caspian Lowland and the Manych valley. The position of G. I. Popov was subjected to a harsh criticism by many specialists, most of which rejected the idea of the Hyrcanian stage. Our drilling materials allowed to return to the problem (Yanina et al., 2014; 2018; Sorokin et al., 2017). We have identified the Caspian deposits corresponding to

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the Hyrcanian transgressive basin. The typical feature of its fauna is the joint occurrence of *Didacna subcatillus, D. cristata* and rare Late Khazarian mollusks. The basin was freshened and exceeded the late Khazarian basin in size. The pollen assemblages suggest a somewhat cooler and wetter climate (Yanina et al., 2014).

The late Khazarian transgressive epoch is attributed to the beginning of the Late Pleistocene. As has been shown by uranium series dating, the Late Khazarian transgressive stage corresponds to 127–122 ka BP, while the entire Late Khazarian epoch is dated at 127–76 ka BP (Shkatova, 2010). The continental deposits exposed in the Srednyaya Akhtuba section in the lower reaches of the Volga correspond to the Late Khazarian and Hyrcanian stages in the Caspian Sea evolution. Their age determined by the OSL (optically stimulated luminescence) technique corresponds to the entire MIS 5 stage (Yanina et al., 2017).

Pont

In the Pontian region the Upper Pleistocene sediments have been studied within the Tamanian area of shelf. The exploratory boring to a depth of 60 m has been carried out in the deps 26 m. The obtained core was studied with lithological, faunistic, and geochronological methods (Bezrodnykh et al., 2019). There is Karangatian marine basin distinguished. It developed as a result of the Mediterranean water inflow. Its deposits are widespread and the basin paleogeography has been studied in details. The Karangatian transgression exceeded the present-day sea level by 6-7 m, the water salinity reached up to 30 ‰. There are two stages distinguished in the transgression development – the Karangatian and Tarkhankutian, each of them characterized by faunal assemblages with different proportions of stenohaline and euryhaline groups of mollusks. Two phases are also noted in the Karangatian stage. The earlier (Tobechik) phase was marked by a wide distribution of species typical for the present days (*Cerastoderma glaucum, Abra ovata* and others). The sea level in the basin was below that of today. The second phase (Karangatian) was characterized by the dominance of the halophilic species including those that are currently absent from the basin (*Cardium tuberculatum,* et al.). A series of the U/Th dates obtained for the transgression fall within the period of 140–70 ka BP (Dinamika…, 2002). According to the OSL data, the earlier stage of the transgression developed around 131–120 ka BP, and the later one – around 120–100 ka BP (Kurbanov et al., 2019). The Tarkhankut stage deposits yielded faunal assemblage, that included Mediterranean mollusk fauna, barren of halophilic elements and dominated by *Cerastoderma glaucum* and *Abra ovata*. The entire basin was confined within the present-day outlines of the Black Sea coasts and the salinity did not exceed 14-15‰. There were some Caspian species – *Didacna cristata, D. subcatillus, D*. ex gr. *protracta*, in the Tarkhankut basin (Bezrodnykh et al., 2019).

Manych

The analysis of the Manych Strait functioning based on the Quaternary series studies plays an important part in correlating the events and understanding the connection between the Caspian and Pontian basins. Judging from the stratigraphic position and malacofauna recovered from the Manych valley deposits, there was an ingressive bay there at beginning of the Late Pleistocene (the Karangatian transgression maximum) which penetrated as far east as the Caspian – Black Sea water divide (Popov, 1983; Kurbanov et al., 2018). The presence of the Karangatian fauna in its deposits (*Cerastoderma glaucum, Chione gallina, Chlamys glabra, Ostrea edulis*) suggests a rather high salinity in the central part of the bay (~18–20‰). The head of the bay was close to the Kalaus River mouth. A wide distribution of *Cerastoderma glaucum* and disappearance of more halophilic species indicates considerably freshened water (up to 10‰) (Popov, 1983). G. I. Popov (1983) identified two stages in the Karangatian Sea ingression. The earlier stage corresponded to the development of an inlet of the Late Khazarian basin. The 2nd stage of the ingression correlates with the Hyrcanian transgression with a bay deeply penetrating westward via the Eastern Manych valley. When the level of the Karangatian basin dropped and the ingressive inlet shrank, the Hyrcanian water penetrated into the strait bringing mollusks *Didacna cristata, D. parallella, D. subcatillus, Monodacna caspia, Dreissena polymorpha*. The faunal content of core on the Taman shelf indicates this event. The salinity in the strait was about 8–10‰. The Hyrcanian deposits in the central part of the Manych depression are dated using OSL at 107 ± 7 ka BP (Kurbanov et al., 2018). It supports the earlier conclusion about the Karangatian sea level lowering (Tarkhankut stage) and the inflow of the Hyrcanian water during the cooling at the transition from the Mikulino Interglacial to the Valdai glaciation.

4. Conclusions

The Pontian and Caspian basins belonged to different types of water basins and evolved differently in the Late Pleistocene. The interglacial epoch (MIS 5e) was marked by transgression in both basins in the Ponto-Caspian System, which could be attributed to different reasons. Marine transgression in the Pont resulted from the rise of the global sea level and the opening of the straits (as the sea level exceeded the strait threshold) between the Mediterranean and the Black Seas. The Caspian lake transgression resulted from the positive water balance of the basin. The marine transgression reached its highest level, while the Caspian transgressive basin stayed below present mean sea level.

During the transition to the glacial period (MIS 5d-a), the Mediterranean Sea level was unstable: its development was interrupted twice (MIS 5d and 5b) by the level drop below the Dardanelles Strait threshold. Those events also affected the Marmara Sea, where marine transgression developed in two stages. During the first stage (MIS 5c) the level exceeded the Bosporus threshold, which led to the rise of the Black Sea level. In the Caspian Sea, the climatic conditions of the transitional period resulted in positive water balance, which caused transgressive evolution of the Caspian basin. The Caspian water flowing through the Manych

into the Pontian basin opened the Caspian-Pontian strait.

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Conflict of interest

The authors declare no conflict of interest.

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