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On the age of the Mangyshlakian deposits of the northern Caspian Sea

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ABSTRACT

The distribution, sedimentology, and age of early Holocene Mangyshlakian deposits beneath the northern Caspian Sea are studied. Analyses and interpretations derive from high-resolution sub-bottom profiling, lithological analysis of core sections and boreholes, biostratigraphic analysis of mollusc shells, and radiocarbon dating. We show that the Mangyshlakian deposits overlie Upper Pleistocene Khvalynian deposits, filling valleys and depressions that formed during lower water levels, similar to present lacustrine water bodies (ilmeni) of the Volga Delta. Transgressive marine Holocene Neo-Caspian sediments that are filling facies overlie the Mangyshlakian deposits. The deposits are composed of both organogenous and terrigenous materials. The flora and fauna in the sediment indicate deposition into freshwater, differing from marine biota in the underlying and overlying sediments. Eighteen radiocarbon ages indicate that the Mangyshlakian deposits accumulated between 9 and 12 ka.

Introduction

The Caspian Sea is the largest inland body of water on Earth and is an isolated basin, with outflow through the Manych valley into the Black Sea (Fig. 1A) only during extensive transgressions (Arkhangelsky and Strakhov, 1938; Ross and Degens, 1974; Kvasov, 1975; Shimkus et al., 1975; Fedorov, 1978; Ross et al., 1978; Popov, 1983; Arslanov, 1993; Ryan et al., 1997, 2007; Svitoch and Yanina, 1997; Svitoch et al., 1998; Aksu et al., 2002; Major et al., 2002, 2006; Chepalyga, 2007; Sorokin and Kuprin, 2007; Yanina, 2012). The late Quaternary record of the Caspian Sea differs, yet complements, that of the Black Sea, that is connected to global sea level via the Bosporus Strait and the Mediterranean Sea during interglacials.

The late Quaternary, starting from the time of the last Pleistocene interglacial (Eemian–Riss–Würm–Mikulino), is the best-investigated period in the history for the Black and Caspian seas. Four vast transgressions and three deep regressions have been identified for the Caspian Sea during the late Quaternary. These include the Late Khazarian interglacial transgression, simultaneous with the Karangatian transgression of the Black Sea, the Late Pleistocene Early Khvalynian and Late Khvalynian transgressions, and the Holocene Neo-Caspian transgression. These episodes of high lake levels are separated in time by the Atelian, Enotaevkian, and Mangyshlakian regressions (Leontyev, 1961; Lebedev et al., 1973; Kvasov, 1975; Fedorov, 1978; Popov, 1983; Sorokin et al., 1983; Varushchenko et al., 1987; Arslanov et al., 1988; Arslanov, 1993; Rychagov, 1997; Svitoch and Yanina, 1997; Svitoch et al., 1998; Leonov et al., 2002; Bezrodnykh et al., 2004; Maev, 2006, 2009; Vronskii, 2006; Badyukova, 2007; Chepalyga, 2007; Bolikhovskaya, 2011; Yanina, 2012; Leroy et al., 2013). The timing of these lake-level changes remains uncertain, as are their correlation with glacial events (Table 1). The uncertainty is due to different dating methods (U/Io, ^{14}C, thermoluminescence) and to ambiguity concerning the causes of the Caspian transgressions. For example, the Early Khvalynian transgression may have occurred during the Kalinin stadial (Rychagov, 1997; Vronskii, 2006; Badyukova, 2007), Mid-Valdai interstadial (Fedorov, 1978; Popov, 1983), or the first half of the Ostashkov stadial (Svitoch and Yanina, 1997; Yanina, 2012). Similarly, the Late Khvalynian transgression may have occurred during the Ostashkov stade, at the end of the Ostashkov stadial, or at the end of the late glacial and post-glacial. According to Bezrodnykh et al. (2004), on the basis of ^{14}C age determinations, the Early Khvalynian transgression occurred during 36,000–20,000 cal yr BP (31,000–17,000 ^{14}C yr BP), while the Late Khvalynian was 18,000–12,000 cal yr BP (16,000–11,000 ^{14}C yr BP). The same uncertainty characterizes the position of the Mangyshlakian deposits, formed during the last regression. The uncertainty of the timing of Caspian sea-level changes challenges correlations between the Black and Caspian seas.

The Mangyshlakian regression of the Caspian Sea is associated with a decline of sea level by about 80 m below present-day global sea level (gsl), about 50 m lower than its present level at −28 m gsl (Lebedev et al., 1973; Fedorov, 1978; Rychagov, 1997; Svitoch and Yanina, 1997; Bezrodnykh et al., 2004; Maev, 2006, 2009; Yanina, 2012). This was the last major regression prior to transgression to Holocene lake levels. Previous understanding of the Mangyshlakian regression is based mainly on landforms and data acquired as a result of investigating of sediment cores taken mostly in the deep-water parts of the sea. By contrast, data from shelf environments is scarce and fragmented; thus,

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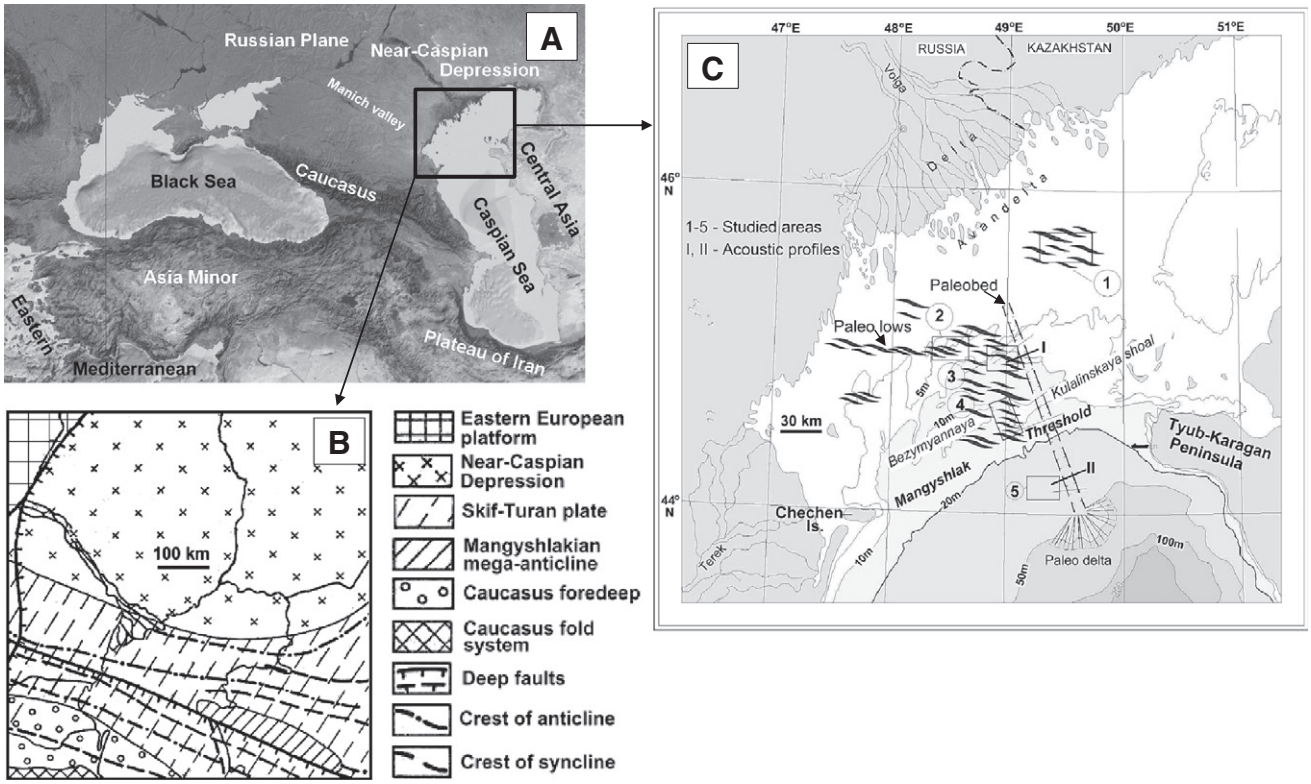

Figure 1. Topography, geology, and detailed locations of the study area. A) Caspian and Black seas shown on part of the GEBCO world map; B) geology of the Northern and Middle Caspian Sea (Khain, 1958); C) detailed study areas.

notions of conditions of sedimentation and distribution of the Mangyshlakian deposits are limited. Our new data on the age of the Mangyshlakian regression better defines the timing of the Late Khvalynian transgression and the start of the Neo-Caspian transgression. Based on the available data, the Mangyshlakian regression is coincident with the final stages of the Neo-Euxinian lacustrine transgression of the Black Sea, which was interrupted several times by considerable short-time reductions of its rise (Balabanov, 2009). Thus, it is possible to identify either synchronous or asynchronous character of the relevant variations of the sea levels, which is one of the problems of the Late Quaternary paleogeography of this region.

Mangyshlakian deposits occur only within the limits of the existing sea area. They lie between the Khvalynian and the Neo-Caspian strata in the stratigraphic sections. Available numerical ages bracketing deposits are ambiguous (Arslanov et al., 1988; Rychagov, 1997; Svitoch and Yanina, 1997; Leonov et al., 2002; Bezrodnykh et al., 2004; Leroy et al., 2013). For example, the age of the youngest Khvalynian deposits investigated onshore is 8500–8000 cal yr BP (7700–7300 ^{14}C yr BP), and that of the oldest Neo-Caspian deposits 8800–7600 cal yr B (8000–6800 ^{14}C yr BP) (Rychagov, 1997). Radiocarbon dating of Mangyshlakian sediments sampled on the eastern shelf of the Caspian Sea at depths of 90–105 m (−60 to −75 gsl) yield ages of 17,000–

Table 1
Correlations of Upper Quaternary deposits of the Caspian Sea and glacial events on the Russian plain.

Authors	Mikulino Interglacial	Valdai glaciation			Holocene	
	MIS-5	Kalinin stade MIS 4	Interstadial MIS 3	Ostashkov stade MIS 2	MIS 1	
Rychagov (1997)	Upper Khazarian	Lower Khvalynian	Enotaevkian	Upper Khvalynian →		
Vronsky (2006)					Mangyshlakian	Neo-Caspian
Badyukova (2007)						
Popov (1983)	Girkanian	Gudilo-Atelian	Lower Khvalynian	Enotaevkian ← Upper		
Fedorov (1978)	Upper Khazarian	Atelian	Lower Khvalynian →	Khvalynian		
Svitoch and	Upper Khazarian	← Atelian →		Lower	Enotaevkian	Upper
Yanina (1997)				Khvalynian		Khvalynian
Yanina (2012)	Girkanian →	Akhtubinsk -Atelian →		Lower Khvalynian	Mangyshlakia	