



Chocolate clays of the Northern Caspian Sea Region: Distribution, structure, and origin



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ABSTRACT

The chocolate clays commonly comprise a part of the Lower Khvalynian sequence in the northern Caspian Lowland and in the Volga region. The mode of occurrence varies from continuous to patchy mosaic. All the clay deposits are confined to Pre-Khvalynian depressions of various origins. There are several sub-facies distinguishable within the chocolate clay facies: mono-clayey (typologic), stratified sandy-clayey and silty-clayey. Judging from specific features of lithology, geomorphic position, mode of occurrence, mollusc fauna composition, and radiocarbon dates, the chocolate clays represent a specific facies of the Lower Khvalynian sediments and cannot be considered as an individual stratigraphic unit.

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1. Introduction

Among the Pleistocene marine deposits of the Caspian Sea, one of the most interesting facies are the “chocolate clays”. They are widely distributed in the Volga and Ural river valleys of the North Caspian Sea region in the form of sporadic or continuous covers.

The first description was obtained by Baer (1856) from outcrops near Enotaevka in the Volga River valley. Detailed description of a section that contained chocolate clays was first introduced by P.A. Pravoslavlev. The first researchers described chocolate clays as chocolate-brown slaty clays. A laconic and concise description of the chocolate clays was proposed by Shantser (1951): “... Chocolate clays represent horizontal bedding that contains alternation of thin dense layers, heavy clays and light silty clay”. These layers, especially clays, split into parallel platy parting.

Since K. Baer first mentioned the clays in 1856, they were discussed in a number of papers (Pravoslavlev, 1908; Britsyna, 1954; Prikloonsky et al., 1956; Fedorov, 1957; Arkhipov, 1958; Vasiliev, 1961; Obedientova, Gubonina, 1962; Svitoch, Yanina, 1997; Badyukova, 2000; Chistyakova, 2001; Shantser, 1951; Leonov et al., 2002; Tudryn et al., 2013). In spite of long-term investigations performed by many specialists, numerous problems are still under discussion, including the topic considered below: are the chocolate clays to be considered as a specific formation or facies? To analyze the problem, the authors give attention to the

spatial distribution, occurrence and structure, characteristics of the clay facies and lithology, color, and the type of fossil mollusc fauna.

2. Materials and methods of the analysis

All materials and data about chocolate clays have been obtained by field research expeditions in key sections of the North Caspian Sea Region and the Volga Region. A wide range of methods was used, such as lithological, mineralogical, geomorphological, malacofaunistic and radiocarbon. The key sections were minutely layer-by layer studied, fossils recovered from the sections were described, and ¹⁴C dates were obtained.

3. Results

3.1. Spatial distribution of the chocolate clays

The chocolate clays are mostly confined to the middle and lower reaches of the Volga R. (Fig. 1), including the left and right sides of the Volga and Akhtuba valleys and the Volga R. delta, as well as the Kalmykia region adjoining the Volga valley. They are found also within a linear zone of depressions from the Kaisatskoe settlement to Elton and Verkhniy Baskunchak lakes, and in the Ural R. valley. The largest area of the chocolate clays is found in the Volga valley, on its 2nd terrace between the city of Samara and the Yenotaevka settlement. Farther east, on the Volga-Ural interfluvium, typical chocolate clays practically disappear (Svitoch, 1968). The clays occur in the Ural R. valley and form the sedimentary cover of the Khvalynian plain.

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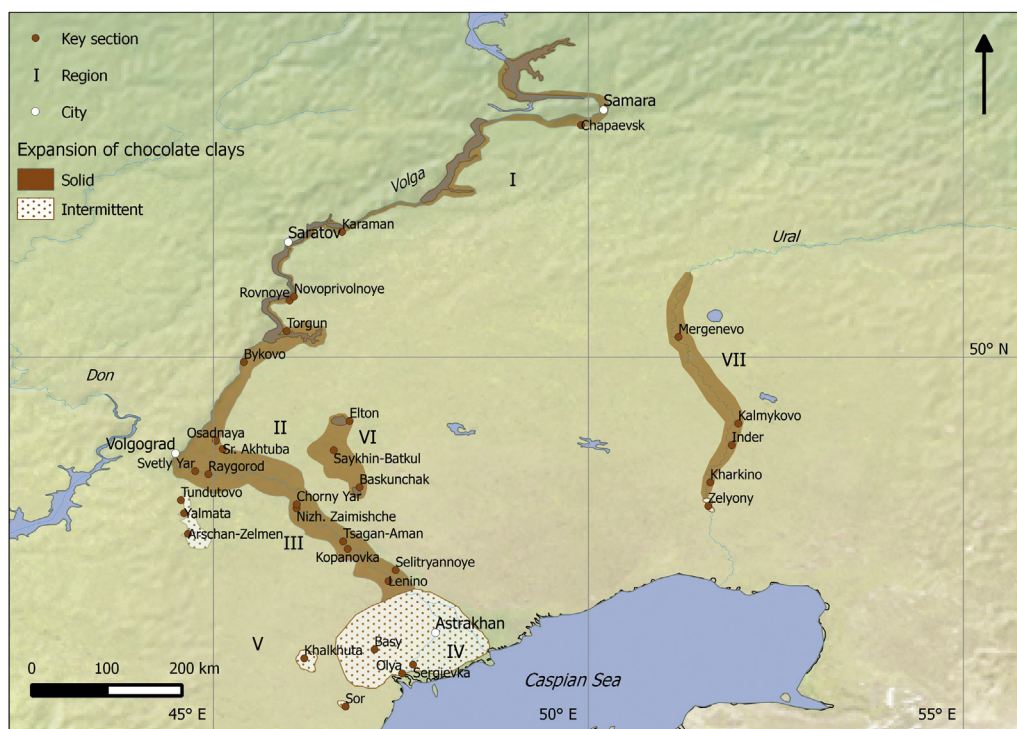


Fig. 1. Spatial distribution of chocolate clays in the Northern Caspian and Volga regions. (I – Middle reach of the Volga R, II – left side of the Lower Volga valley, III – right side of the Lower Volga valley, IV – delta Volga, V – Kalmykia, VI – Kaysatskoye – Elton – Verkhniy Baskunchak, VII – Ural River valley).

In the middle reach of the Volga R., the chocolate clays were studied by Mazarovich (1935), Koptev (1966), and Obedientova and Gubonina (1962). The clays form a continuous mantle over the 2nd terrace of the Volga R. and of its large tributaries, such as Bolshoi Irgyz, Maly Irgyz, Yeruslan, and Bolshoi Cheremshan. They penetrate far into the interfluvial plateau along ancient erosional landforms. They are found in the Bolshoi Irgyz valley 70 km east of the Volga R. The zone of their occurrence in the ancient Volga estuary between the Caspian Lowland and the Zhiguli Heights is 2 to 30–40 km wide (Obedientova and Gubonina, 1962) and about 600 km long (from S to N). The northernmost point of occurrence of the chocolate clays is recorded at the Bolshoi Cheremshan River mouth. The chocolate clay interlayers are found in the sequence of the 1st terrace of the Volga within the reservoir area of the Volzhskaya hydro-electric power station (Obedientova and Gubonina, 1962). Over the greater part of the Volga valley in its middle reaches the top of the chocolate clays occurs at an altitude from 30–40 m to 25–20 m a.s.l. gradually lowering towards the Caspian Lowland (Vasiliev, 1961; Moskvitin, 1962; Obedientova and Gubonina, 1962).

The Khvalynian deposits in the middle reaches of the Volga are dominated by the chocolate clays that occur usually at the base of the sequence. In the north of the region (Chapaevsk (~28 m a.s.l., N 52°53'41.37", E 49°38'04.43"), Maly Karaman (~30 m a.s.l., N 51°40'18.20", E 46°50'13.54") and Rovnoye (~15 m a.s.l., N 50°45'27.90", E 46°01'41.38") sections), the clays are overlain by stratified sands and loams. Farther south (Novoprivolnoye (~18 m a.s.l., N 50°48'08.03", E 46°05'22.05") and Torgun (~15 m a.s.l., N 50°17'33.04", E 45°57'55.28") sections), the Khvalynian sequence is more complicated, including several members of the chocolate clays in the upper part and at the base of the section. Typically, the index species of the brackish-water mollusc fauna are completely absent, while freshwater molluscs are found occasionally.

The Lower Volga region is known as the largest area of the chocolate clay distribution. They form the vast 2nd terrace of the Volga and occur in depressions of the Early Khvalynian plain on the

Caspian Lowland. It was here, at the Chorny Yar (~5 m a.s.l., N 48°01'55.47", E 46°06'43.04") section, that they were first described by Baer (1856). Later, they attracted an interest of many specialists (Pravoslavlev, 1929; Nikolaev, 1935; Zhukov, 1945; Kovda, 1950; Britsyna, 1954; Fedorov, 1957; Arkhipov, 1958; Vasiliev, 1961; Menabde et al., 1991; Svitoch et al., 1995; Svitoch and Yanina, 1997).

The deposits are exposed in picturesque erosional scarps on the left bank of the Akhtuba (the left tributary of the Volga R.) and on the right side of the Volga. The latter displays the section of the ancient Volga estuary filled with the chocolate clays and other marine deposits. The top of the clays is at 25–20 m a.s.l. in the north of the Caspian Lowland and descends gradually southward to –5 m at the Chorny Yar and Selitryannoye settlements and to 10 m below sea level at the head of the Volga delta. The depth of the Pre-Khvalynian erosion (which controls the thickness of the chocolate clays) in depressions averages to 2–4 m, although it may change over a small distance. For example, the clays are 10 m thick in the Svetly Yar (~5 m a.s.l., N 48°29'10.37", E 44°46'36.42") section, while 5 km south, at Raygorod (~6 m a.s.l., N 48°25'49.82", E 44°57'41.10"), the thickness is reduced to 2 m, which suggests a considerable irregularity of the Pre-Khvalynian bed topography.

On the left side of the Lower Volga valley and its tributary Akhtuba, the chocolate clays are exposed in the sections of Bykovo, Osadnyaya, Srednyaya Akhtuba, and Selitrennoe. Their position and structure vary considerably from one exposure to another. At the northern localities of Bykovo and Srednyaya Akhtuba (~15 m a.s.l., N 48°41'54.22", E 44°54'33.26"), the sequence is dominated by the chocolate clays underlain or overlain with sands. In the middle part, interbeds of sand and silt with shells of index Khvalynian molluscs are common. In the south, the chocolate clays also include sand and silt interbeds with shells of index species *Didacna protracta*, mostly in the central part of the sections. Noticeable variations in the sedimentation environments occur from south to north.

On the right side of the Lower Volga valley, chocolate clay outcrops are found in abundance from Volgograd to Lenino settlement.

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