**Formation of the Sefidrud delta in Khvalynian time against the background of gradual lowering of the Caspian Sea level after the Khazarian transgression**

***Badyukova E. N., Svitoch A.A.***

*Lomonosov Moscow state university, faculty of geography*

Keywords: sections, clays, coastal zone, sea level fluctuations, paleogeography

**Introduction.** In recent years there have been several new articles on the structure of the

Caspian Iranian coastal plain (Kazanci & Gulbabazadeh, 2013; Kakroodi et al., 2015). Despite

this fact in the history of its development at the end of the Pleistocene, there are, in our

opinion, a number of unresolved problems. One of them is the history of the Caspian Sea level

fluctuations. In a recently published work by one of the authors of this article stated that it was

not a deep Atelian regression and hence the subsequent Great Khvalynian transgression

(Badyukova, 2017). From these new positions, the data on the structure of the Iranian coastal

plain, published in recent years, are considered.

**Materials and methods.** During the field work a detailed geomorphological description of the

seaside plain and the coasts of Gilan was carried out with the taking of the mollusks shells, as

well as the drawing the profiles from the coastline to the Novocaspian terraces. In total, 64

areas located in the Western Gilan part of the Iranian coast were chartered and described,

about 50 profiles were made (Fig.1). A number of published works examined the geological

and geomorphological structure of the shore and concluded that there were extensive lagoons

on the coastal plain, which were later blocked by alluvial and alluvial fan deposits, which

formed the aggradation plain (Badyukova et al., 2012).



Fig. 1. Study area: 1-points of the coastal zone detailed description;

2-sections where dense heavy clays are exposed; 3-borehole L (Kazanci & Gulbabazadeh, 2013).

The aggradation plain occupies almost the entire coastal plain, except the recent marine

terrace and the areas near towns Astara, Anzali and Amir-Abad where lagoons of the

Novocaspian and modern age are located. Judging by the investigated sections (Fig.1 - p. 3, 4,

6), silty lacustrine deposits with a lot of shells (including *Cerastoderma glaucum*) with a sharp

contact overlain in boulder-gravel deposits composing the regressive terraces.

**Results.** Interesting data were obtained from the outcrops on the sides of erosion cuttings of

many rivers, in wells and quarries, lying at higher levels (Fig.1 – p. 1, 10, 24, 25, 31.33, 35, 37,

39, 40). In all outcrops located at different hypsometric levels, under thick layers of alluvial and

alluvial fan deposits with a clear contact over red-brown or bluish-gray very dense clay and silt

are found (which is important to emphasize as this clay not at all similar to the lagoon

sediments) These deposits are very poorly eroded, so often observed not only on the banks of

rivers, but even directly in their beds (Fig.2). Clays with visible layers in some sections have

thickness up to 4 m or even more (for example, in p. 35). Unfortunately, the deposits do not

contain shells of mollusks, which precludes the possibility of determining their absolute age.



Fig. 2. The outcrops along the rivers and in the career.

Early Khvalynian marine terraces on the surface of the coastal plain are not revealed, as they

are covered by a thick layer of alluvial and alluvial fan material. Accumulation of this material

continued for a long time, currently, it forms the surface of the coastal plain up to the foothills.

After the deposition of massive layers of boulder-pebble sediments erosion phase began. As a

result, incised valleys were formed, and later a series of terraces and wide floodplains were

developed in them.

Analysis of the geological and geomorphological structure of the coastal plain suggests that the

accumulation of such massive alluvial-alluvial fan deposits, followed by their erosion and then

the formation of wide valleys with series of terraces and wide floodplains requires a long time.

Unfortunately, we could not find any shells of mollusks, which could allow to determine the

age of the terraces. Fragments of the sea terraces are preserved only on the slopes of

mountains and on the sides of river valleys at their exit to the plain (Fig.1 – p. 1, 5, 8, 9, 10).

An interesting detailed study of the Sefidrud rivers delta and the southern coast of the Caspian

Sea are given in the article of Kazanci & Gulbabazadeh (2013) which allow to suggest another

history of the Caspian Sea level fluctuations in the Late Pleistocene. This assumption is

consonant to our ideas about the history of the development of the Northern Caspian plain

during the Late Pleistocene.

**Discussion.** Previously, a detailed study of literature and field studies showed that in all known

sections along the Lower Volga and the rivers of the Volga-Ural interfluve there are no

Khvalynian transgressive sediments of an open sea. This allowed to conclude that there were

no deep Atelian regression and the ensuing Great Khvalynian transgression.

The following suggestions were made. There was a Great Early Khazarian transgression, the

level of which, according to the literature and field research data, was slightly lower than the

Early Khvalynian transgression (Badyukova et al., 2015). Then, against the background of a

graduale Caspian Sea level fall, there were its positive oscillations. Early and Late Khvalynian

transgressions were some of these oscillations.

Each regression led to the rivers incision, increasing the accumulation of alluvial materials at

the mouths, the formation and extension to the Caspian Sea new deltas and avandeltas. Here,

according to the data of Kazanci & Gulbabazadeh (2013), alluvial-delta deposits with a clear

contact lie on the very plastic compact gray clays (Fig. 3). These offshore sediments are

exposed in the borehole Log L (Kazanci & Gulbabazadeh, 2013) and, probably, in the most of outcrops along rivers described in this thesis (Fig. 2). Possibly the comparable offshore

deposits were in the borehole at the depth of about 28 m in the south-eastern part of the

Iranian coast. Grey plastic clay and loam were discovered here, whose age at the Pliocene-

Pleistocene ostracodes, is 20 120 cal yr BP. (Kakroodi et al., 2015).

During the latest transgressions there were flooding of river mouths and formation of

extensive lagoons on the surface of the low-lying regressive terraces formed by that time. The

development occurred according to the same scenario that we observed in the Caspian Sea

coastal zone at the end of the twentieth century, and that is also discovered in the analysis of

the borehole L (Kazanci & Gulbabazadeh, 2013).



Fig.3. Cross section and model of the Sefidrud delta (Kazanci & Gulbabazadeh, 2013)

As can be seen in Fig. 3 a deep regression in the Late Pleistocene (Atelian), between

the Khazarian and Khvalynian transgressions is not fixed. The delta series consistently moved

towards the sea, lying on the offshore sediments formed during the high transgressions of the

Caspian Sea.

**Conclusion.** Thus, against the general background of the sea level retreat in the Khvalynian

time there were transgressive oscillations. Early and Late Khvalynian transgressions were some

of these oscillations. During this time stairs of marine terraces were formed. So it is impossible

to correlate deposits exposed in outcrops and boreholes located across the stretch of

coastlines. In contrast to the Northern Caspian plain, lagoons were not formed on the Iranian

coast during the Khvalynian time, as there was large pitch of the coastal plain. In this case

lagoons are not formed. Presented thesis constitutes only a preliminary view, it requires

further studies in order to confirm or refute the presented schema of the Caspian Sea level

fluctuations in the coastal zone of Iran during the Late Pleistocene.

**Acknowledgements.** The work was realized with the support from the Russian Foundation for

Basic Research, Project 17-55-560012.

**References**

*Badyukova E.N.* 2017. The role of coastal geomorphology in interpreting the history of the Northern

Caspian plain in the Late Pleistocene / IGCP 610 “From the Caspian to Mediterranean: Environmental Change and Human Response during the Quaternary”, p. 34-38.

*Badyukova E.N., Svitoch A.A., Yanina T.A., Makshaev R.R., Oshchepkov G.V., Khomchenko D*. 2015.

Geological and geomorphologic structure of the eastern foot of the Yergeni hills (preliminary results) /IGCP 610 Third Plenary Conference and Field Trip “From the Caspian to Mediterranean: Environmental Change and Human Response during the Quaternary”, p. 21-23.

*Badyukova E.N., Svitoch A.A., Sheikhi B*. Geomorphology and development history of Iran's Caspian

coast in the Holocene // Stratigraphy and sedimentology of oil-gas basins, 2012 (1), p. 52-74.

*Kakroodi A.A., Leroy S.A.G., Kroonenberg S.B., Lahijani H.A.K., Alimohammadian H., Boomer I., GoorabiA.* Late Pleistocene and Holocene sea-level change and coastal paleoenvironment evolution along the Iranian Caspian shore / Marine Geology 2015, 361, p. 111-12.

*Kazanci N., Gulbabazadeh T*. Sefidrud delta and Quaternary evolution of the southern Caspian lowland, Iran // Marine and Petroleum Geology 2013, 44, p.120-139.