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RUSSIAN SALINE LAKES ELTON AND BASKUNCHAK AS CHALLENGERS TO THE UNESCO WORLD HERITAGE LIST

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Abstract
The article considers the main aspects of the nature of the saline lakes of the southeastern part of Europe, located on the Caspian lowland: Elton and Baskunchak, the genesis of their basins, landscapes and economic loads. A brief analysis of the nature and geo-ecology of saline lakes is carried out in a comparative aspect. The conclusion is made about the need for further protection, both of zonal vegetation, and especially of salt deposits of the lakes. It is stated that in this aspect the "Bogdo-Baskunchak" State Reserve and the Elton Nature Park have been created. The idea of creating the "Elton-Baskunchak" cluster biosphere reserve is proposed. We believe that their landscape may be of interest to European readers and scientists.
The main methods are: expeditionary method: automobile and walking routes; paper method, including processing of the collected field material, as well as decoding of space and aerial photographs, and analysis of published sources.
In practical terms, the creation of a cluster reserve allows resolving the geo-environmental and economic problems and preservation of the unique landscapes for future generations.

Key words
Semi-desert, azonal landscapes, comprehensive soil, salt mining, spa resort, mud baths, brine

INTRODUCTION

The so-called "All-Russian Salt Cellar" is located on the Caspian lowland. Two neighboring salt lakes Elton and Baskunchak are similar in occupied area but rather different in the genesis of the depressions and the salts that fill them, mainly potash salt (sylvinites) on Elton and common salt (halites) on Baskunchak. They are especially attractive for people. That is why we have formulated a number of tasks the solution of which will allow perceiving the nature of the unique "lakes without water" more consciously. These tasks are: brief information on the nature of the phenomena; coverage of similarities and differences; possibility of combining the reserve and Natural Park in the "Elton-Baskunchak" cluster biosphere reserve challenging for the UNESCO World Heritage List.

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RESEARCH METHODOLOGY AND TECHNIQUES

This paper is based on the concept of the nature reserve creation for unique natural objects of different content, size and location in the natural area, which is enshrined in the Federal Law of the Russian Federation of March 14, 1995 No. 33-FZ "On Specially Protected Natural Territories "(with amendments and additions), as well as international criteria allowing to classify the objects of study to the required level.

To accomplish the tasks outlined, published scientific sources of recent years, as well as of previous decades and centuries, were collected and analyzed. The data of regional geo-ecological and ecological committees and of field (expeditionary) studies, which were carried out intermittently since the late 60s of the 20th century, were required. At the first stage, the author of the paper worked in the geomorphology laboratory of Volgograd Scientific Research Institute of Oil and Gas, later he became a lecturer at the Volgograd State Pedagogical Institute (nowadays University) where he currently works. At this large stage, it was necessary to pedagogize the accumulated material of both domestic (Isachenko and others, 2013) and foreign authors, for example, Rene Matlovich and co-authors.

Circular routes around saline lakes Elton and Baskunchak and radial ascents to the highest points of the salt dome relief structures were accomplished: to Mount Bolshoye Bogdo and Mount Bolshoy Ulagan, Fresh Liman hill and others. Hiking routes to the karst craters, caves, local rivers and springs (Vaucluses) were carried out. Geobotanical transects were also studied with geobotanist V. Sagalaev.

During the office period, space photographs and detailed aerial photographs were reviewed and interpreted. Topographic maps of medium and detailed scales were used.

At all stages of the study, there was interaction with scientists and practitioners, such as staff of the All-Russian Research Institute of Agroforestry and employees of the Environmental Committee, and intermediate results were presented at scientific conferences at various levels.

The surroundings of Lake Baskunchak in different times were visited by natural scientists – English geologist F.I. Murchinson (1841), German naturalist A. Humboldt (1829), Russian scientists - K.M. Rem (1853), I.B. Auerbach (1854), I.V. Musketov (1895) and others (e.g. Matlovič, Matlovičová 2015).

Famous writer Alexandre Dumas père also visited Mount Bolshoye Bogdo and left his impressions about it in the book "From Paris to Astrakhan."

In the Soviet times, lakes and the surrounding territories were studied by scientists from Moscow, Volgograd, Kazan, Saratov and other cities.

THE RESULTS OF THE STUDY

The territory of the Caspian lowland amazes with its surprisingly smooth surface, monotonous at first glance relief and scarcity of vegetation cover. An almost ideal plain spreads around. It is livened up only by the souslikovinas of ground squirrels, gullies and estuaries covered with rare semi-desert vegetation. In hot summer days mirages appear on the horizon, so one can see buildings, lakes, and hills. And suddenly the mirage disappears, the hills turn into mountains, lakes into a snow-white plain. Such a landscape is characteristic of the saline lakes Elton and Baskunchak well known in Russia (Brylev 1984).

Europe's largest saline lake, Elton, with an area of 180 km^2, has a rounded, slightly elliptical outline; its surface is located at -16 m above sea level (Atlas 1993). Actually, there is no lake in the usual sense of the word, there is a basin filled with salt, covered with a thin layer of concentrated brine. The banks of Elton are low, only in some places they are rather steep, with relative heights of up to 10 m. Between the coast and the salt deposit there is usually a viscous, sometimes almost impassable belt of mud several tens of meters wide.

The surface of Elton acquires a very peculiar golden-pink shade at sunset and sunrise. This feature explains the origin of the name of the lake. Kazakhs call it *Altyn* which means "golden"; Kalmyks who used to live here earlier called it *Altyn-Nur*, or *Altyn-Nor*, which means "Golden Lake". The red colour of the brine of the lake and the streams flowing into it was also noticed by P. S. Pallas (1788). The reason for the reddish colour of the surface of Elton is the presence of a special unicellular alga, called dunaliella (*Dunaliella salina*), which, in addition to the green chlorophyll, contains red carotene pigment, which gives it a characteristic pink-red colour. It is the presence of dunaliella in the water of Lake Elton that determines the distinctive crimson-pink colour of its brine. After the death of the algae, the red pigment gets into the brine and concentrates on the surface of salt crystals. And mineral of sylvinite which is potash salt is itself of a pink color.

In the past, the so-called "raspberry" or "royal" pink salt with a special odor, vaguely reminiscent of the smell of violet or raspberry, was mined at Lake Elton. Such salt was supplied to the imperial court of Catherine II in the amount of up to one hundred pounds per year, and no one else was allowed to mine it.

The concentration of salts in the brine of the lake, depending on the season, varies from 19 to 37%, but averages 270 grams per liter. The chemical composition of salts is diverse – sodium chloride prevails, there are also salts of magnesium, potassium and calcium. It is quite remarkable that such chemical element as bromine was also found in Elton's brine.

The unique combination of the chemical composition of brine with microorganisms largely explains the characteristic feature of the lake itself which is the unique colour palette of its surface (Fig. 1).

Figure 1
Lake Elton.

Figure 2
Photo of karst landscapes of Lake Baskunchak

The lake basin is considered as a compensatory mould located between salt dome structures.

On the eastern bank of Lake Elton, there is "Mount Ulagan" with a mark of +67 meters, and on the west side there is the low Fresh Liman hill, whose plane was cut by the Khvalyn Sea transgression, while "Mount Ulagan" rose above its level by 17-25 meters. These "mountains" are formed by salt domes and geomorphologically they are cuestas on the slopes of domes. Cuestas from the surface are composed of Paleogene (Bolshoy Ulagan) and Jurassic-Cretaceous sediments (Fresh Liman). In the depths of the salt domes, the Triassic-Permian salts are deposited: halite with layers of carnallite, polyhalite, sylvite. In the Soviet era of planned economy, it was supposed to mine potash salt with a shaft method in the area of the Mount Bolshoy Ulagan. Today, potash salt is mined in the mine of the Gremyachinskoe deposit 200 km from Elton Lake.

The basin of the lake Baskunchak is composed similarly, but tectonically it is more complex. It is surrounded by five salt domes. If we look at them from the Southern Gypsum field which is most elevated by Mount Bolshoye Bogdo, clockwise will be seen the following: domes of the West and North fields and the Vak-Tau and Kuba-Tau elevations.

The gypsum fields are composed of an anhydrite-gypsum cap - "caprock" and they are heavily karsted: thousands of karst craters are scattered across the surface like pockmarks, creating a unique "lunar" landscape (Fig. 2)

Some craters lead to underground passages and caves. Especially popular are the caves of the Northern gypsum field.

During the newest transgressions of the Caspian Sea, Mount Bolshoye Bogdo, which is up to 150 m high, was a large island in the sea. It is composed from the surface by sandstones of yellowish cream colour and Triassic limestones with petrified pelecypods (*Mitilus sp.*), Ammonites (*Zeratites sp.*). The redbeds of the Permian system, lying below, encolour brightly the base of the mountain. The geological

section of Mount Bolshoye Bogdo is considered to be the classic one in the south of European Russia – it has been studied since the time of I.B. Auerbach (Auerbach 1871).

The lake basin itself, with a geophysical depth of 600–800 meters, is filled with common salt, which is of a redeposited origin, partly from saline Caspian sediments. In addition, 14 springs flow into the lake, probably coming from the salt domes. The total surface area of Baskunchak is estimated at 130 km^2. (Atlas 1968) dimensions 13 × 10 km. The salt concentration in brine reaches 300 grams per liter.

HYDROGRAPHY

Let us return to the Elton Lake area. 7 rivers flow into its basin. The largest of them are Bolshaya Smorogda, Khara, Chernavka, Lantsug. The Smorogdinsky mineral spring, located 4 km from the resort, pours out into Bolshaya Smorogda. The spring with mineralization of 8 grams per liter has the local name of "Narzan", its flow rate is 1.6 liters per second, its water is used to treat gastrointestinal diseases.

The waters of the Khara and Lantsug rivers are of sodium chloride type with salt content from 5 to 12 grams per liter. The water of the Chernavka River belongs to the sodium chloride type with salt content up to 26 grams per liter.

The mud of the mouths of the Lantsug, Khara, Chernavka, and Bolshaya Smorogda occupy an area of up to 6 km^2. But the main mud deposit is located in the gulf of the lake, near the "Old resort". The thickness of the mud layer here reaches 0.2-0.5 meters, and the reserves of mud exceed 600 thousand m^3. Elton's mud is a homogeneous, black (due to iron sulphide) oily mass with a consistency of thick sour cream, and with the smell of hydrogen sulfide. It is exceptional in its purity. Contamination by particles with a diameter of more than 0.25 mm is minimal, so the mud feels soft and velvety to the touch. While storing, due to oxidation of sulfur iron, it becomes covered with a gray crust. Sulfur iron and aluminum, humic acids, hydroxides of iron and aluminum, mixed with thin clay, represent the colloidal complex. Besides the Elton spa resort, the mud is also supplied to the Volgograd health resort and it does not lose its healing properties.

Thus, judging from the above, the uniqueness of the natural complexes of the Elton-Baskunchak region is largely determined by geological and geomorphological conditions, that is, lithology of rocks and relief, which leads to the redistribution of precipitation on heterogeneous soils. There is no doubt that these differences are primarily seen between the basin of Elton and Mount Bolshoy Ulagan, which have already been mentioned. The salt-domed hills of the Ulagan and the Fresh Liman are composed of fragile aleuritic sandstones of the gray colour of the Triassic system with magnificent imprints of ammonites. Up the section, they are replaced by Jurassic, Cretaceous and Paleogene quartz sandstones, clays, aleurites with fossil fauna.

The base of the "mountains" and the surface of the Pre-Caspian lowland itself are covered with Lower Khvalyn sediments – chocolate-coloured clay, fawn loam, and sandy loam, and the banks of lake basins – with modern silt and salty mud.

The territory under consideration is climatically formed in the region of a sharply continental climate. Despite the fact that the region is almost equidistant from the equator and the pole, it is characterized by frosty winters with average multi-year temperatures of January minus 10.5° C (Elton) and minus 8.5,5 C° (Baskunchak). The Caspian Sea does not have a significant impact on the temperature regime of the region, causing its extreme aridity and continentality. This is expressed in an insignificant annual amount of precipitation – 292 mm (Elton) and 260 mm (Baskunchak), while evaporation reaches 900 - 950 mm per year.

The Elton meteorological station apparently holds the absolute record of Russia in the summer temperature maximum, reaching plus 45° C (Baskunchak – plus 44° C). The high total amount of active temperatures, increasing from north to south from 3380° C to 3500° C (table 1), is also impressive.

Table 1 Climatic indicators of the Elton-Baskunchak macro-region

Meteorological station	Average temperature of the year in °C	Average January temperature in °C	Average July temperature in °C	Absolute min in °C	Absolute max in °C	Evaporation mm per year	Annual precipitation in mm	Annual amount of temperatures in °C
Elton	+7	-10,8	+25	-36	+45	900	292	3380
Baskunchak	+8,5	-8.5	+25	-36	+44	950	260	3500

Source: (Atlas of Volgograd Oblast (1993), Atlas of Astrakhan Oblast (1968))

The alternation of frosty weather in winter with thaws, when the snow melts completely, and the subsequent deep freezing of soils, and in summer their strong warming, draining, cracking, is characteristic. The biotic and landscape features of the salt-dome region under consideration are largely predetermined by the extremums indicated above.

The non-leaching regime of soils causes the accumulation of easily and moderately soluble salts, primarily gypsum and carbonates, as well as Na ions, which accounts for zonal soil types – light chestnut and solonetz on Elton, brown semi-desert with solonetz on Baskunchak. Along the shores of the lakes, both basins are covered with salt marshes. As for the zonal soils, the number of solonetz in them usually approaches 50%.

The solonetz developed on salted heavy loams, in the depth of water-soluble salts, are mostly moderately saline, while the solonetz formed on chocolate clays are mostly highly saline.

The gully-estuary micro- and meso-relief causes the redistribution of surface runoff and the formation of dark-coloured meadow-chestnut soils, which, according to the depth of groundwater, are hydromorphic. Seasonality is characteristic of moistening, i.e.: in spring washing out to groundwater, while in the second half of summer and in autumn, ascending currents from groundwater predominate.

The nature of the vegetation cover in the outskirts of Lake Elton and the entire Elton-Baskunchak region is determined by its geographical location. The zonal type of vegetation here is fescue-feather-grass and desert (wormwood-fescue-feather grass) steppe belonging to the Trans-Volga-Kazakhstan steppe province of the Eurasian steppe region. The most important feature of the near-Elton and near-Baskunchak semi-desert steppes is the complexity of the vegetation cover due to the drainless depressions of the micro, meso-relief and macro-relief.

The vegetation of the shores of the lake is determined by the presence of solonetz and salt marshes. Therefore, the shores of Elton and Baskunchak are the "kingdoms" of saltworts, which have the ability to change their colour depending on the season (Fig. 3).

Bright green in spring, dark green in summer and yellow-orange in autumn, they picturesquely border the outskirts of salt marshes, contrasting with a white crust of dried salt. Often one can find salicornia here. Only in early spring, when the lakeside plain is saturated with the moisture of the desalinated waters, the domination of

Figure 3
Saltworts

Figure 4
Didier's tulip (*Tulipa gesneriana*), Schrenck's tulip (*Tulipa schrenkii*)

saltwort and wormwood recedes into the background, short-living annual ephemeral plants appear on the shores of the lake and rivers, as well as short-vegetative ephemeroid perennials: tulips, alliums, irises and gageas. Some of them are found in the Volgograd region only on Elton. Some representatives of the Elton flora are included in the lists of protected plants of our region. Among them there is a remarkable early-flowering two-flowered tulip (*Tulipa biflora*), Schrenck's tulip (*Tulipa schrenkii*) (Fig. 4), Taliyev's cornflower (*Centaurea taliewíi*), and some other species.

Of particular interest and value to botanists are plant species, first described from the vicinity of Elton and having their classic location here (Lavrenko 1980, Ilyin 1927). It is important to emphasize that the floristic complexes of Elton and Baskunchak can serve as a natural standard of arid ecosystems within the South-East of European Russia.

The fauna of these places is diverse and interesting. Animals are sensitive to human activities. Saiga antelopes, graceful pink flamingos, common in these places in the last century disappeared. The great bustard, little bustards, swans, sociable lapwings have become rare. But still, in the Trans-Volga steppes, there are still quite untouched habitats and the anthropogenic pressure is still not very large. Human "civilization" with its chemistry, intensive agriculture, industrialization and urbanization has not reached here yet. Therefore, there are such rare animal species in need of protection, such as the semi-desert marbled polecat, the steppe eagle, the long-legged buzzard, the demoiselle crane (Fig. 5).

For about a century in the village of Elton there has been a health resort based on the therapeutic mud of the lake, which in 1985 was recognized as a balneological monument of nature, as well as the Smorogdinsky mineral spring. Mud and brine from Elton are used in "Gornaya Polyana" mud bath in Volgograd. A well-equipped modern building of the health resort "Elton" has been built recently. For the purpose of rehabilitation of the population and the improvement of tourism,

Figure 5
Demoiselle crane *(Anthropoides virgo)*

the development of therapeutic and recreational areas and natural healing resources is carried out. Balneological resources are the most important component of the Elton region.

Years passed and in 1997, in accordance with a decree of the Government of the Russian Federation, the Bogdinsko-Baskunchaksky Reserve was founded, and the territory of Lake Elton was declared a state natural park in 2000.

Elton and Baskunchak are the most important natural attractions of the southeast of European Russia. How to combine their economic use and the need to preserve the unique arid natural complex of the Lower Volga region? We offer for the benefit of people a compromise environmental solution to this problem of the region (Brylev, Sagalaev 2000, Matlovičová, Husárová 2017, Amosov, Alexandrova, Safronov 2012).

CONCLUSION

The Elton-Baskunchak region claims to be included on the World Heritage List on at least two criteria:

1. On the one hand, it is a unique geological formation with the presence of a powerful Permian-Triassic salt complex and active salt tectonics, which can no longer be traced in any existing World Heritage site. On the other hand, the

Mount Bolshoye Bogdo is an important stratigraphic and paleontological object, illustrating the paleogeography of the Triassic period in the south of European Russia.

2. The Elton-Baskunchak Ecoregion is the especially valuable landscape of the semi-desert of the south-west of the Caspian lowland, that is unique not only within the Russian Federation, but in Europe also. It is also a natural industrial landscape which is rare for Europe. Here one can trace the stages of salt mining beginning from the 20-30s of the XX century from primitive salt processing to industrial production. Such modern objects are not yet on the list of the World Cultural Heritage.

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