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THE ROLE OF DRIFTING ICE IN BUILDING THE BOTTOM LANDSCAPE AND SEDIMENT COMPOSITION IN THE SHALLOW WATERS OF NORTH CASPIAN SEA

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ABSTRACT

Shifts and the ice drift in the shallow northern part of the Caspian Sea can have a significant impact on economic activities. The revitalization of the oil companies in Russia and Kazakhstan, with its foreign partners for exploration of hydrocarbons in the North Caspian shelf, requires serious scientific, environmental and technical support of these activities. In this paper we present the results of joint research in ice.

The predominant type of modern sediments in the northern Caspian Sea is silt (sandy mud, mud). Thick deposits of soft mud in a river are areas that form sediments of rivers. In all soils there is an admixture of broken and whole shells, and in some areas it is the main part of the bottom sediments. It is represented by the following forms: Cardium edule, Didacna trigonoides, Didacna barbot-de-marnyi, Adacna plicata, Monodacna edentula, Dreissensia polymorpha, Dreissensia distincta, Theodoxus pallasi, Zagrabica brusiaiana, Caspiella eichwaldi. On the surface sediments are more enriched with muddy material, which is accumulated by the decomposition of algae dying and Zostera, silty sediments of aeolian origin. According to B.I. Koshechkin (1958), the percentage of coarse fractions in soils (the size of shell fragments is more than 1 mm) from 6 to 19.2%. In some areas at the bottom of a small (less than 10cm) layer of recent sediments lies an ancient breed - khvalynskaya clay. Numerous underwater banks and some islands of the Caspian Sea (for example, Little Pearl Island) consist almost entirely of whole and broken shells.

Figure 1. Shell fragments entirely predominate in these soil samples.

It is believed that the main cause of the destruction of the dead shells of mollusks is the sea swell. However, due to extreme shallow marine delta of the Volga region and the entire eastern part of the North Caspian, the storm does not develop a strong emotion. The frequency of wave height of 0.5 m is 58.6% [3]. The maximum wave height is no more than 1.0 m This is clearly not enough for rather solid shells Didacna trigonoides or Didacna barbot-de-marnyi to be crushed. Rather, they will slowly fray and eventually become thinner, such as it occurs in the surf zone of Dagestan coast.

In our opinion, the main cause of mechanical damage to shells is drifting ice. For the first time the impact of drifting ice in the bottom of shallow waters of the North Caspian was studied and described in the works of the Laboratory of aerial methods AS of the USSR. [2]

In subsequent years, this work has been continued. The studies found that gauging furrows present long, often straight furrow with the length from a few tens of meters to several kilometers.

The furrows are formed under the influence of hummocky pack ice the bottom. They are oriented in the direction of prevailing during these periods eastern, south-eastern and north-westerly winds and present vectors of ice drift, drawn along the bottom.

Figure 2. Gauging furrows on the bottom of the North Caspian. The view from the helicopter.

Furrow width varies from a few up to 50-100 m and over. There are grooves, gradually widening in the direction of ice movement. Some are crooked or broken lines, indicating a gradual or sudden change in direction of the drift ice. All furrows end with shafts, that are formed with furrowed ground. The height of some of them is more than the depth of the sea, and they come to the surface in the form of small islands.

Bright gauging furrows on the darker bottom background can be visible from the plane. A large number of furrows is observed in spring, after clearing rom the ice, when the water is not puddle with spring storms, in the area of Chapurenok, Chistaya Banka islands, Seal Isles Archipelago as well as in the shallow waters of the northern and eastern coasts, where their density reaches 20-50, and sometimes 100 or more furrows at 1 km route. The timeline of furrows in the muddy soils comprises 2-3 years. In sand furrows are smeared with seaways in a single season.

Figure 3. Typical gauging furrows on the bottom of the North Caspian Sea. Underwater picture.

The ploughing effect of drifting ice is also characteristic of the coastal zone. Drifting ice from the sea, arriving on shore, plow topsoil out, leaving traces of ploughing with the depth of 0.5 m and length of several kilometers. On the islands of the North Caspian Sea during heavy ice drift along the coast strong piles of ice are formed. Fragments of ice, thus penetrating into the soil to a depth of 1 m, retain up to the end of May. There has been a case, when the wellhead in the Volga seaside on an island a house has been moved from the basement with the drifting ice.

Figure 4. Typical Caspian "winter" grounded ice.

When landing ridges on the ground there is further accumulation of ice as a result of ridging under the influence of movement and drift. As a result, hummocks can penetrate into the soil to a depth of several meters. The depth of their penetration into the soil depends on physical properties of soil, hummock mass, contact area and the depth of the sea.

More than 50% of the Northern Caspian is subject to ice ploughing (pack ice interaction with the seabed). These processes are of massive (albeit seasonal) nature, and therefore play an important role in the ecology of the Caspian Sea. Due to mechanical impact of drifting ice, there is not only movement of huge amount of bottom soil. At the same time shells if dead clams are damaged on the bottom. [1]

As a result of intense ice movements, there are cases of destruction and loss of pressurization of plugged exploratory wells in the offshore eastern (Kazakh) sector of the North Caspian Sea. A large number of these wells were on the sea coast, but were flooded during the rise of the Caspian Sea (1976-1996).

Similar processes occur in Russian sector of the North Caspian Sea. Production and environmental monitoring, which the Russian company Lukoil has carried out for many years over muted exploration wells, which are located in the license areas of the bottom at a depth of 6 to 28 meters, has not revealed significant changes. However, the concrete cap of the well, located at a depth of 6 m, was partially damaged, which suggests the effect of drifting ice on it. In addition, around the well, the divers observed broken shells, which were not found near the other wells, located on the bottom in deep water.

Toroses and hammocks formed can easily force in or break through underwater facilities located on the bottom or at inadequate sea bottom. The result is catastrophical consequences for the Caspian sea ecosystem.In the last two decades in the North Caspian there has been intense work on the development of the local hydrocarbons, accompanied by the design and construction of fixed platforms, subsea pipelines and other oil and gas infrastructure. Therefore, the evaluation of the intensity of ice impacts related to hazardous natural processes is a key element to ensure geotechnical safety of oil and gas facilities and environmental security in the area.

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