THE MAIN ENERGETICALLY ACTIVE ZONES OF THE BLACK SEA

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The intensive vertical water exchange between the deep and surface waters takes place in the middle of large-scale quasi-stationary cyclonic gyres in the central part of the Black Sea. The rising of deep waters results from a kinematic effect. Their average perennial volume is equal about 3000 km /year. In winter, when the cyclonic circulation becomes more active, the upper boundary of the deep waters in the centres of cyclonic gyres may rise to the depth of 25-30 m. With the deep waters biogenous elements and hydrogen sulfide surplus produced in the water column, rise into the surface layer where H_2S is oxidized. In such a way the biological productivity of the upper layer and the dynamical balance between the processes of producing and oxidation of H_2S are maintained. The deep water rising forms a vast central divergence zone (CDZ) passing through the centres of cyclonic gyres (OVCHINNIKOV *et al.*, 1993).

In the centres of cyclonic gyres where the thickness of the upper active layer and its heat reserve are minimal (due to deep water rising), during the autumn-winter cooling (thermohalinic convection) the intensive mixing and sinking of surface waters down to the pycnocline dome occurs. In the process of their interaction with the deep waters (5/1 or 6/1) the waters of cold intermediate layer (CIL) are formed, and at the same time the oxigen for the rising H_2S oxidation is supplied. This process is accompanied by the intensive energy exchange between the sea and atmosphere, that gives the reason to consider these regions to be the Black Sea energetically active zone (OVCHINNIKOV *et al.*, 1993).

The internal waves with mesoscale periods which are actively developed on the main pycnocline domes, contribute to the most energetic interaction between the surface and deep waters.

In the nearshore zone, between the midstream of the Rim Cyclonic Current (RCC) and the shore, there is a quasi-stationary system of nearshore anticyclonic eddies (NAE) covering the whole sea coast along its perimeter (OVCHINNIKOV, TITOV, 1990; OGUZ *et al.*, 1992). They are formed owing to anticyclonic vorticity of the current field at the expense of the lateral shear (horizontal gradient) of velocity between the RCC midstream and the steep nearshore slope of the bottom. The nearshore convergence zone (NCZ) where the kinematic sinking of water takes place, is passing through the centres of the NAE having convergence properties. On the other hand, the nearshore area is a periphery of quasi-stationary cyclonic gyres where the kinematic sinking of water occurs. The superposition of NCZ upon this area stipulates the intensive sinking of the nearshore waters there (OVCHINNIKOV, TITOV, 1990).

The regions of deep water rising in the CDZ and surface water sinking in the NCZ are communicated and form a single closed system of the transverse circulation. In this system of circulation the water rising in the CDZ is compensated by the water sinking in the NCZ. Yet the compensation of rising waters is not carried out by their direct transport from the region of sinking, but through a complex lateral turbulent exchange in the system of eddies of various size.

The fundamental importance of the transverse circulation system for the ecology of the Black Sea consists in the following. If the extent of the anthropogenous contamination does not exceed the natural capability of the sea to the self-purification, the contaminated waters, sinking in the nearshore zone, are purificated gradually during their moving to the centre of the Basin and improve the ecological conditions of waters in the region of their rising. If the extent of the anthropogenous contamination exceeds the natural potential of self-purification, then the sinking contaminated waters having passed through the system of transverse circulation, will close the cycle of the whole sea contamination including its deep waters, that may lead to the irreversible ecological catastrophe of the Black sea (OVCHINNIKOV, TITOV, 1990; TITOV, 1992).

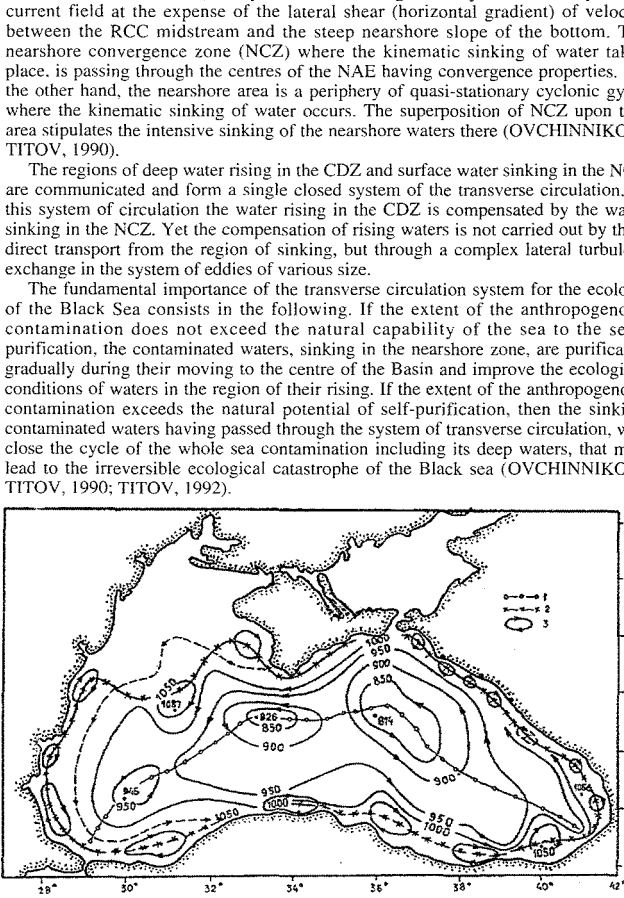

Figure: Dynamical topography of the Black sea surface relative to 200 dbar depth and its main energetically active zones: the central divergence zone (1), the nearshore convergence zone (2) and the nearshore anticyclonic eddies (3).

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