THE STRAIT OF SICILY IN RELATION TO THE GENERAL CIRCULATION OF THE MEDITERRANEAN

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The following is a quick description of the Mediterranean related to the Strait of Sicily, in order to show the oceanographic importance of the Strait.

The Mediterranean is a typical example of what is called a concentration basin. This means that the amount of evaporated water exceeds the amount gained by the precipitation and river discharges.

Writing the continuity equation and the conservation of salt leads to:

$$\int_{\Sigma} \vec{u}\, d\sigma + B(t) = A \times \frac{dH}{dt} \qquad \text{[Eq. 1]}$$

$$\int_{\Sigma} \rho S \vec{u}\, d\sigma = \frac{d}{dt} \iiint_{V} \rho S\, dv \qquad \text{[Eq. 2]}$$

where:

Σ is the section of the strait

V, A are the volume and the surface of the basin

$\rho(t, M)$, $S(t, M)$, $\vec{u}(t, M)$ are respectively the density, the salinity, and the velocity of the fluid at time t at location M.

H(t) is the average level of the Basin

B(t) is the water budget defined as the rate of gain by precipitations and river discharge minus the rate of loss by evaporation.

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Dynamic calculations were made by Ovchimikov [Fig. 1] using the records of most expeditions during the last fifty years. According to his results the Atlantic water flows through the Strait of Gibraltar and the north African current carries it along the African coast to the east. On the way, some branches are deflected to the north and incorporated in cyclonal motions.

On the whole, the summer circulation of surface water maintains the same basic features as in winter. However the rate is reduced in the summer. This comes from the fact that the surface water movements are directly related to the wind field.

A 550 m [Fig. 1b] level of the Levantine water core one has a similar circulation in the eastern Mediterranean and in the central of the western Mediterranean where the water flow is incorporated to the surface circulation.

The main difference occurs from the Strait of Sicily to Gibraltar where it forms an undercurrent.

The Levantine water passes across the Strait of Sicily into the Tyrrhenian Sea where it flows counterclockwise to enter the Algerian and Provencal basin through the Sardinian Strait.

Then one branch continues westward to the Strait of Gibraltar, while another is deflected to the right, runs counterclockwise and joins the first branch near Gibraltar. The difference between winter and summer are clearly demonstrated in Fig. 2 showing the corresponding sections of salinity across the Levantine intermediate current.

The core of Levantine water is better defined in winter than in summer however, the main distribution of the salinity within the core layer remains the same.

According to Ovchimikov, the Levantine undercurrent has a stronger branch going northwards in summer than in winter. This is

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If the total amount of salt inside the basin and its level are constant over years it must exist a period T over which we have

$$\int_T \int_\Sigma \vec{u}\, d\sigma\, dt + \int_T B(t)\, dt = 0 \qquad \text{[Eq. 3]}$$

$$\int_T \int_\Sigma \rho S \vec{u}\, d\sigma\, dt = 0 \qquad \text{[Eq. 4]}$$

to be a concentration basin involves $\int_T B(t)\, dt < 0$.

Through the Strait of Gibraltar, the total flux varies according to Eq. 1.

To compensate the trend due to the loss in the water budget there is more water entering the strait than water flowing out over the period T [Eq. 3]. And in order to keep the amount of salt constant over the period T [Eq. 4], the amount of salt brought by the entering flow must be equal to that of the outlow over the period T.

The Atlantic flow of less saline and lighter water enters the Strait and under it, the Mediterranean water goes out, spreading in the Atlantic.

Now within the Mediterranean itself similar exchanges of water occur across the submarine ridge between Sicily and Tunisia.

This because this submarine ridge separates the Mediterranean into two main basins and the eastern basin is a concentration basin with respect to western Mediterranean.

A water of Atlantic origin enters the eastern Mediterranean in the surface layer while a more saline water flows in the lower layer to the western Mediterranean. This water in the lower layer is called the Levantine water.

corroborated by Fig. 3. General weakening of circulation in the surface and intermediate layers is a distinctive feature of the Mediterranean basin.

Spreading and mixing of Levantine water are now described by Fig. 4, by means of TS curves for winter and summer.

Point A corresponds to the characteristics of the water type of Levantine at its origin.

Along the curve one can follow the mixing of the Levantine water on its way to the west where salinity and temperature decrease along a density curve.

REFERENCES

1. Ovchinnikov, I.M. (1966). "Circulation in the surface and intermediate layers of the Mediterranean Sea, Okeanologiya, 6, 62-75.

2. Wüst, Georg (1961). "On the vertical Circulation of the Mediterranean Sea. J. Geophys. Res., 66, 3261-3271.

(Fig. 1 after Ref. 1, Fig. 3 after Ref. 2, Fig. 4 after Ref. 2)

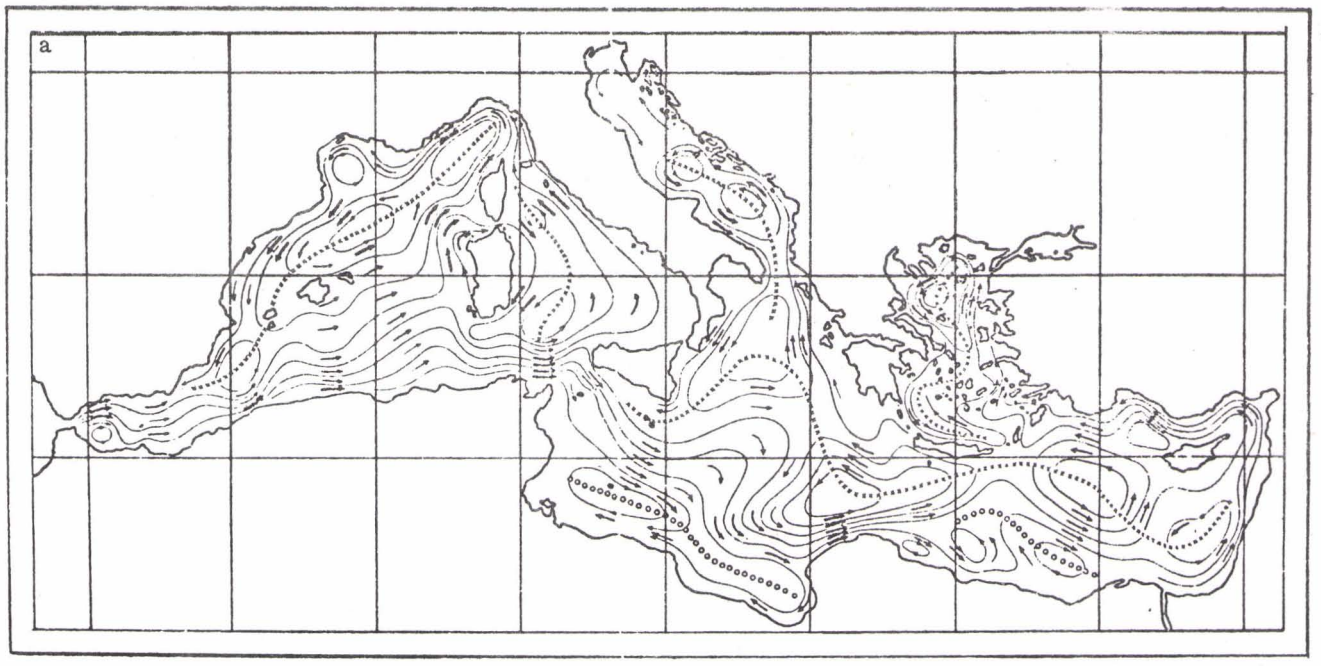


FIG. 1

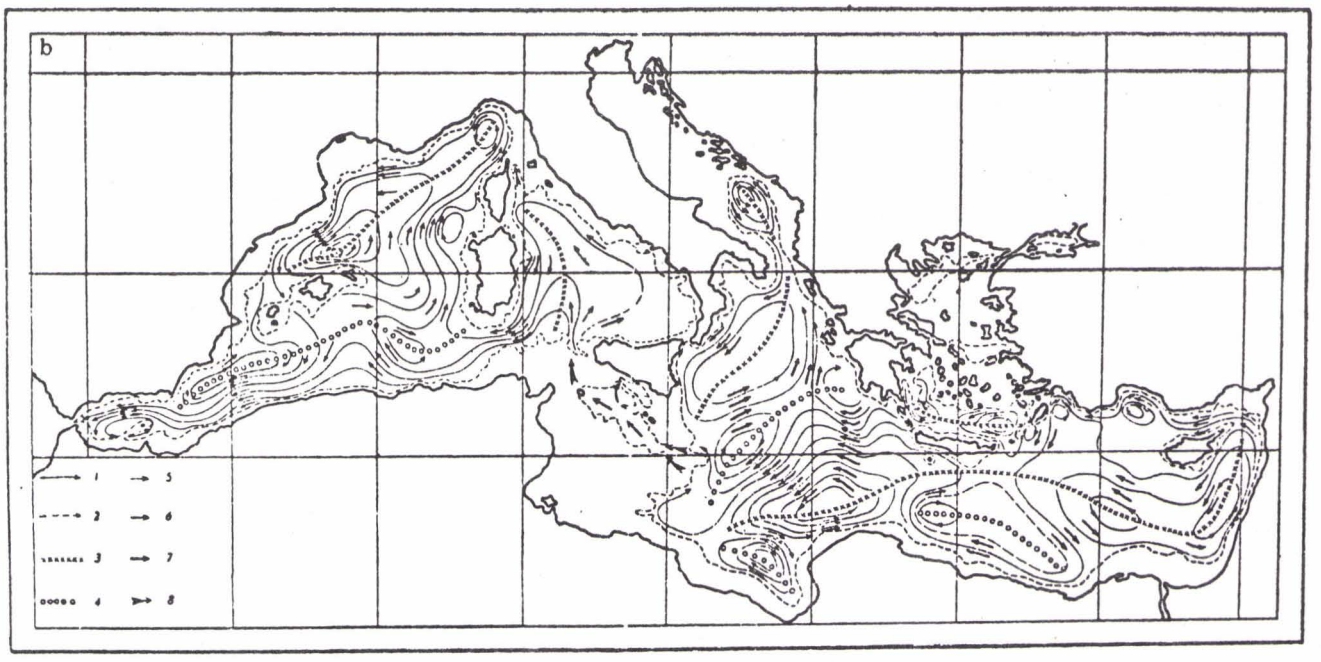
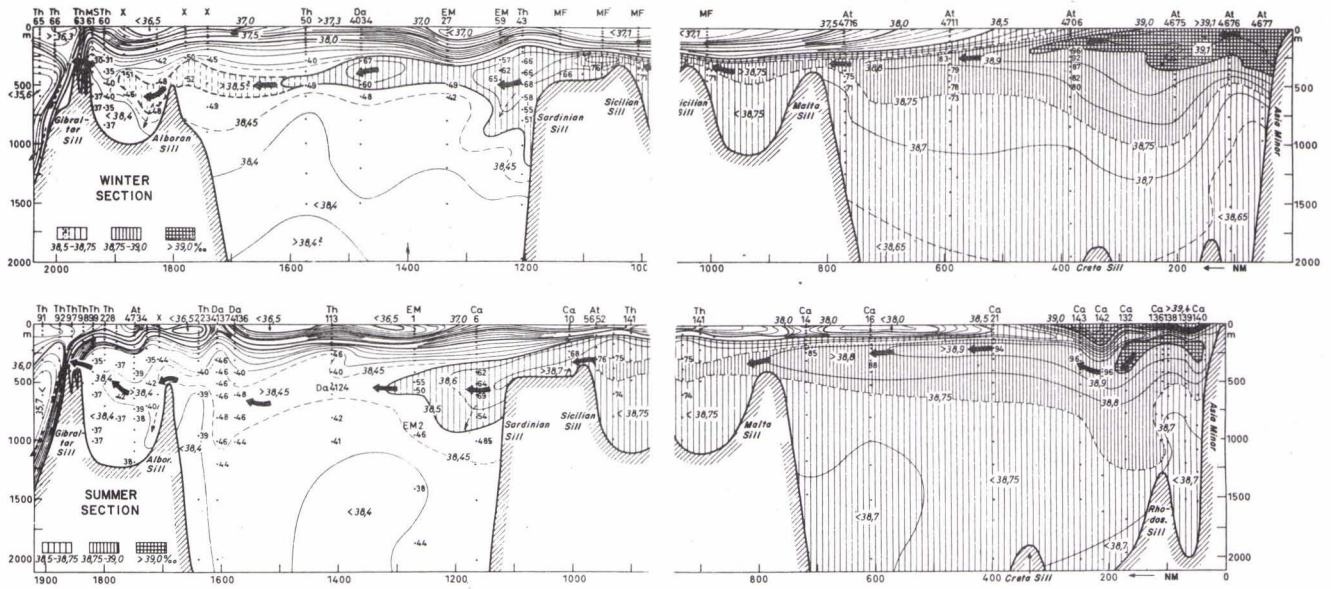


FIG. 1b

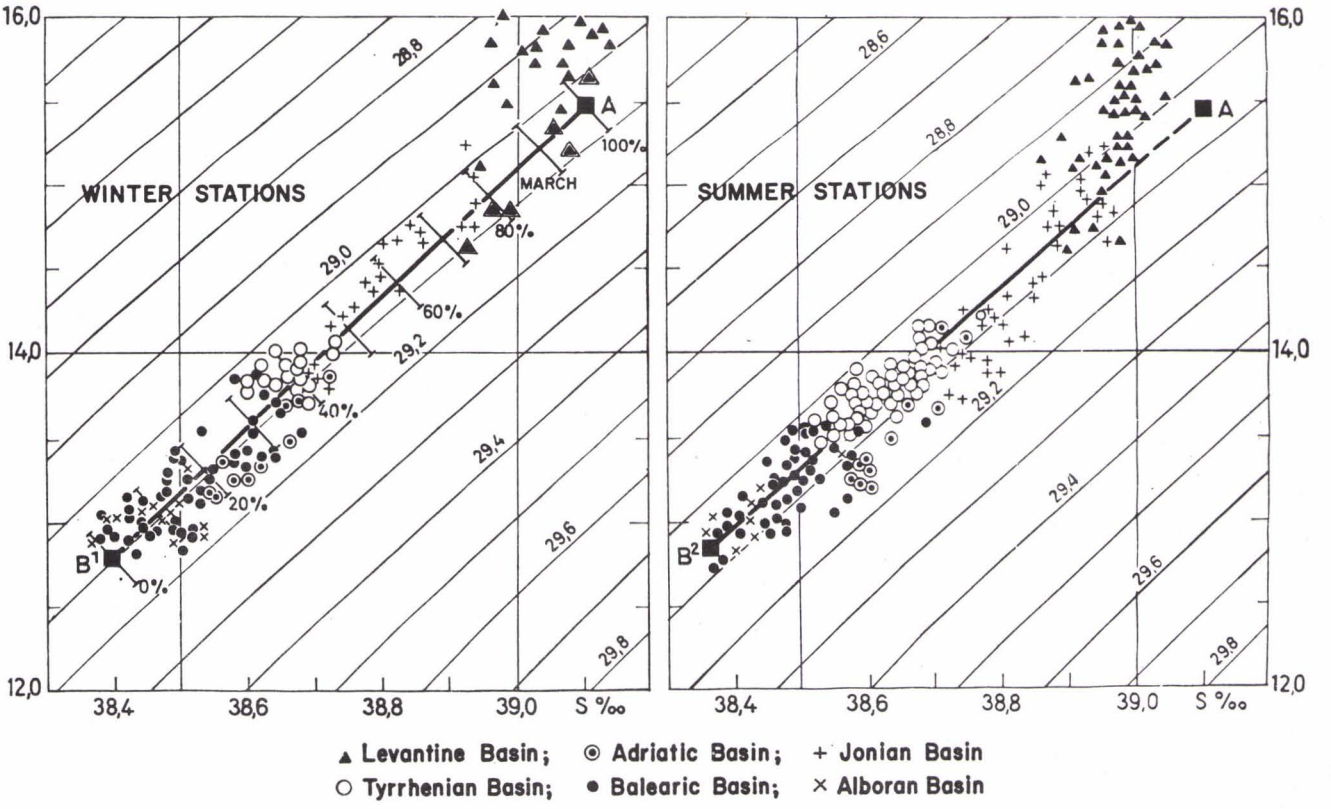
Geostrophic components of Mediterranean currents in the winter.

a) at the surface, b) at 500 m. Dynamic contour lines for the intervals: 1-5 and 2-2.5 conventional dynamic centimeters. Lines: 3) divergences, 4) convergences. Velocities of the geostrophic component of the current (cm/sec): 5-1-10, 6-10-25, 7-25-50; 8) direction of water movements across sills.



Longitudinal sections of salinity along the axis of the Levantine intermediate current for winter and summer.

FIG. 3



T/S diagram for the core layer of the Levantine intermediate water in winter and summer.

FIG. 4