Salt fingering processes and the distribution of the density ratio in the Southeastern off the Egyptian Coast

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Temperature and salinity (T-S) finestructure on vertical scales of 10 db and larger is examined in a 215 km by 110 km grid located southeastern Mediterranean off the Egyptian coast. The convergence of several water masses within the grid dominated by the Levantine Intermediate Water leads to a variety of T-S finestructure which unstable to double diffusive processes. The data used in this study were collected during the joint Soviet-Egyptian expedition on the Russian RV Akademic Levrentyev which took place from 20 to 26 December 1988.

Vertical profiles of temperature, salinity, density and density ratio Rp for a number of stations in the experimental area are selected to identify the salt fingering regions. Vertical profiles from a selected station located at the western boundary of the area are shown in Fig.1. A profile of the stability angle Tù taken from Washburn and Käse (1987) defined as :

$$\text{Tù} = \tan^{-1} \frac{\alpha Tz - \beta Sz}{\alpha Tz - \beta Sz}$$

where α is the coefficient of thermal expansion (α >O), β the coefficient of haline contraction, and Tz and Sz the vertical in situ temperature and salinity gradients. The vertical distribution of Tù allows portions of the profile to be grouped into four stability regimes : S denotes a stable region of the profile, U a region with density inversions, SF a region diffusively unstable to salt fingering, and DL a region unstable to double diffusive layering.

To quantify the frequency of occurrence of Tù in the various stability regimes, all Tù estimate from all stations were sorted into a histogram which is shown in Fig.2. By forming histograms of the density ratio Rp, a fundamental parameter in controlling double diffusive processes, it is found that 66 % of the volume is unstable to salt fingering while the unstable gradients are found in the 11 % of the profiles. In about 23 % of the volume, Rp is less than 2 in the salt fingering sense and at these low values salt fingers grow rapidly. SCHMITT (1979) has developed a similarity theory which describes the initial growth rates for salt fingers and found that for Rp ≤ 2, salt fingers grow rapidly.

One primary salt fingering region is found from about 300 to 1000 db with a modal Rp of 2.0. A horizontal map of Rp in the salt fingering region showed that the strong horizontal Rp gradients underlie relatively high salinity regions and vica versa.

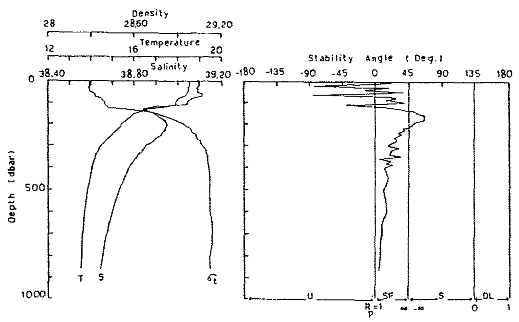

Fig .1.- Profiles of water temperature, salinity and density for station 2056. Profile of the stability angle is shown in panel at right

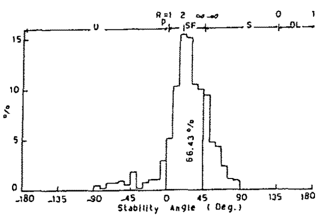

Fig. 2.- Histogram of stability angle from all stations. Stability regions and Rp scale are shown at top of figure.

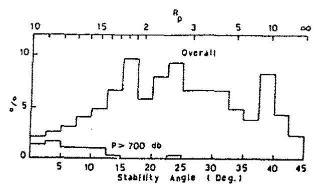

Fig. 3.- Higher resolution histogram of stability angle for salt fingering portion of the histogram of Fig 2.

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Water fluxes induced from the wind stress over the Northern Red Sea and the Gulf of Suez

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The expected controlling factor in driving the circulation of the upper surface layer in the longitudinal direction along the main axis of the Red Sea is the wind stress (GERGES & SOLIMAN, 1987). The variation of the wind stress with time over the northern region of the Red Sea is thought to be one of the main controls on that of the surface transport. Consequently, the aim of the present work is to examine the relationships of the variabilities of the surface flux with those of the wind stress over the northern Red Sea off the Egyptian coast and the Gulf of Suez.

Zonal and meridional components of the wind stress (Fig.1) over the northern Red Sea and the Gulf of Suez were calculated from each station wind observation through the bulk formulas. The data used in this study were collected during the joint Soviet-Egyptian expedition on the RV Professor Bogorov which took place during the period 1-6 March 1990.

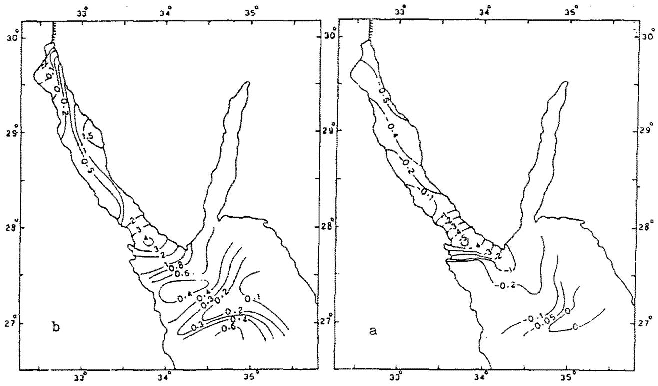

Fig.1. Zonal (a) and meridional (b) components of the wind stress in gm/cm/sec^2.

For the zonal component of the wind stress, the high energy area corresponds to the southern part of the Gulf, where the westward wind stress is dominant and decreases northward and southward. The highest energy area for the meridional stress is found around 27° 30'N and 33° 30'E which is the same position as that for the zonal stress.

Based or the wind stress components, the zonal and meridional components of the Ekman flux for the upper 50m layer (Fig.2) were computed. Zonal fluxes were in the eastward direction. The magnitude of the eastward flux was larger in the Gulf (8.84 $m^2.sec^{-1}$) than those through the northern region of the Red Sea (7.82 $m^2.sec^{-1}$). The meridional Ekman fluxes were northward, i.e. against the wind direction. This is in agreement with the Barlow's (1934) results.

Summations of the Ekman fluxes through the southern boundaries of the study area were about 13.13 $m^2.sec^{-1}$, of them 9.35 $m^2.sec^{-1}$ through the Gulf of Suez.

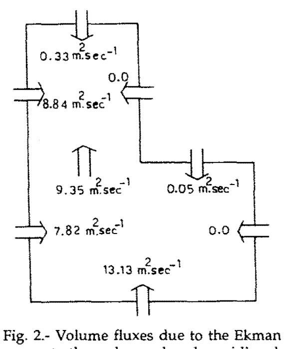

Fig. 2.- Volume fluxes due to the Ekman currents through zonal and meridional boundaries of the study area

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