THE D18O VARIABILITY OF SOUTHEAST MEDITERRANEAN WATER MASSES (OFF THE ISRAELI COAST)

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Abstract

The annual and seasonal variability of salinity, temperature and oxygen isotopic composition ($\delta^{18}O$) of the southeastern Mediterranean water-masses (off the coast of Israel) was studied during two consecutive years (June'96 – May'98). The $\delta^{18}O$ values of the Levantine Surface Water varied between 1.3 and 1.7‰VSMOW, without a distinct seasonal pattern. The variability in $\delta^{18}O$ values during summer is due to changes in evaporation rates. While during winter, the combined effect of winter overturn and evaporation rates, as well as rainfall and its $\delta^{18}O$ signal, modify the surface-water $\delta^{18}O$ values. The intermediate and deeper waters have nearly constant values of ~1.5‰ and ~1.3‰ respectively throughout the year.

Key-words: oxygen isotope composition, water masses, southeastern Mediterranean

Introduction

The Mediterranean is a semi-enclosed sea characterized by an anti-estuarine thermohaline circulation resulting from the excess of evaporation over precipitation plus river runoff. North Atlantic surface water that enters the Mediterranean moves eastward and spreads from Sicily Straits through the southeastern Mediterranean (SEM) undergoing progressive modifications due to air-sea interaction. The water becomes warmer and saltier and reaches the EM as Modified Atlantic Water (MAW) (1-3). During the summer, a shallow ephemeral water-layer, defined as the Levantine Surface Water (LSW) is formed (4,5). The surface water layer displays a high annual-interannual variability related mainly to the position of atmospheric pressure cells (6). Recent studies (2,6-8), have shown that the EM thermohaline circulation has changed considerably since'87. Until `87 the Levantine Intermediate Water (LIW) was formed in the Rhodes Gyre and the Deep Water (DW) originated in the south Adriatic Sea. After that, and due to changes in large scale freshwater balance, the Cretan/South Aegean Sea became an additional source of DW.

Because of the sensitivity of the EM to large amplitude interannual variability (6) we initiated this study that aims to determine the $\delta^{18}O$ seasonal and annual variability of SEM water-masses as well as their temperature and salinity characteristics.

Sampling and Methodology

Water samples were taken during twelve consecutive bi-monthly cruises (June`96 May`98) on board of the R/V *Shikmona*. The upper 700 m were sampled at a permanent station (32°28.23'N; 34°36.61'E), ~30 km off the Israeli coast. During each cruise, continuous vertical profiles of T, S and O_2 concentration were measured by a Sea-Bird SBE 9 + electronic CTD. Water sample were taken from 1.7-liter Niskin bottles mounted on a General Oceanics Rosette and were stored in darkness at ~4°C for the $\delta^{18}O$ analyses. The $\delta^{18}O$ measurements were carried out using a VG SIRA-II mass spectrometer. The values are reported in ‰VSMOW. The analytical precision is 0.01‰, and the reproducibility is better than 0.1‰.

Results and Discussion

$\delta^{18}O$ variability in surface water

The results show that the $\delta^{18}O$ values of the LSW varied repeatedly between 1.3 and 1.7‰VSMOW, without a distinct seasonal pattern. The stable isotope signal of the surface layer is very sensitive to local and short-scale climatic events of days and weeks. During summer, the $\delta^{18}O$ variability is influenced mainly by the evaporation rate. During winter, the system is more complex and the variability is the result of the combined effect of evaporation rate, rainfall $\delta^{18}O$ value and rainfall amount, as well as the winter overturn rate (thickness of the mixed layer). During rain/snow storms, the $\delta^{18}O$ values of the LSW dropped to ~1.4‰. In other winter events, higher $\delta^{18}O$ values of ~1.6‰ resulted from the overturn and mixing of the surface layer with the denser underlying LIW.

The seasonal and interannual d18O variations with depth

Unlike the frequent variability of the surface-water $\delta^{18}O$ values, the LIW and DW had nearly constant values of ~1.5 and ~1.3‰, respectively, that generally correspond to the salinity and temperature profiles (Fig. 1). Between October and December `96, exceptionally high $\delta^{18}O$LIW values of up to ~1.8‰ occurred between ~200-400 m water depth, probably reflecting an extreme formation event of intermediate water at the northern part of the Levantine basin. This $\delta^{18}O$ increase indicates a change in the freshwater forcing or a redistribution of salinity in the northern EM similar to the dry climatic event that occurred between `87 and `95 (3,7,8).

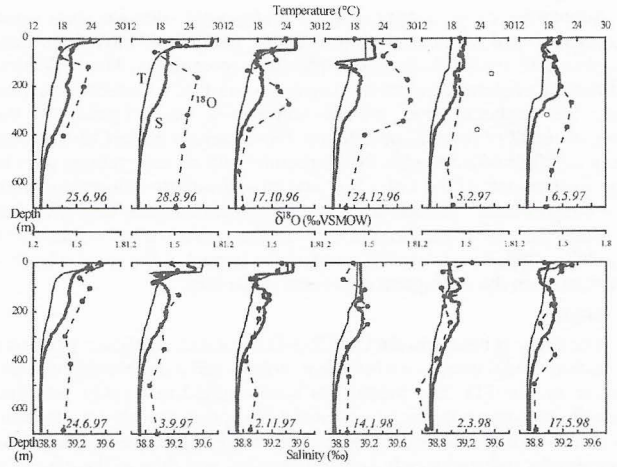

Fig. 1. d18O, temperature and salinity variations during the studied period.

Conclusions

The eastern Mediterranean water-masses (off the Israeli coast) have a distinct oxygen isotopic signature controlled simultaneously by several physical processes related to the atmospheric forcing. The $\delta^{18}O$ variations of the surface water results from local and short-scale climatic events of days and weeks. Changes in evaporation rates, rainfall amount and its $\delta^{18}O$ value, and the winter overturn rate may play an important role in shaping the $\delta^{18}O$ signal during the winter. Because the LIW and DW masses originate in the northern EM, abrupt evaporation/precipitation changes in the surface waters at the source area could be detected by the $\delta^{18}O$ values of these water masses.

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