Volumetric θ/O_2 diagrams for the Mediterranean Sea

par

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Introduction

Volumetric diagrams have been made in terms of potential temperature and dissolved oxygen for the Mediterranean Sea. Previously, volumetric θ/S diagrams were presented*. These diagrams are an outcome of a continuing program. This program is designed to organize station data in terms of the physical properties and their attached volumes for each degree square. Montgomery did a similar study for the world oceans**.

Procedure

The first stage of this study was to measure the volume of each degree square using depth contoured charts. This then made it possible to give a volume for each observation; where there was more than one observation at a particular depth appropriate weighting was used. For example, if a certain 1º square contained N meters³ of water and was described by X_i (temperature) and Y_i (oxygen), another observation, with the same 1º square, of X_j and Y_j would split the volumetric allocation in two, so that the particular square would be described by $(N/2, X_i, Y_i)$ and $(N/2, X_j, Y_j)$. As the number of observations increases the volume is shared proportionately. Since observations within a particular square vary with depth, proportioning of volume will depend on the midpoints between observations. The end result is a series of volumetric numbers systematically assigned to observed θ/O_2 values. Relative importance of each observation is determined by the volumetric scale. With the addition of more and more observations some values will be reduced to insignificance while others will be substantiated by remaining high on the volumetric scale.

Discussion

For this presentation the various degree squares have been grouped into seven geographical areas; these are indicated by the shaded areas of the charts accompanying each three dimensional graph. Table 1 gives the statistical breakdown for the areas. 338 hydrographic stations were used, taken from 1959 to 1962. These stations occupied 120 of the 321 degree squares in the Mediterranean. The 120 degree squares with station data have a volume of $1.682 \times 10^6 km^3$; the total volume of the Mediterranean is $3.708 \times 10^6 km^3$. The small volumes not included in the graphs consist of shallow water subject to seasonal effects. It should be pointed out that in Table 1, column " Number of Stations " does not sum to the number of stations used in this study; some stations were used to describe two degree squares that were contiguous. These were instances in which a station was made on a line between two degree squares. Chart 1 shows the distribution of stations. It is apparent that for many degree squares there are no stations and that some areas have very few stations. The Western Mediterranean, Adriatic, Aegean and Cretan Sea have the best coverage, while the Central and Eastern Mediterranean have relatively few stations. Of course, this was due to the strategy of the investigations and the preliminary findings. Stations were concentrated in significant areas which were considered to be potentially important in the interaction between the air and sea, with subsequent production of deep and bottom water.
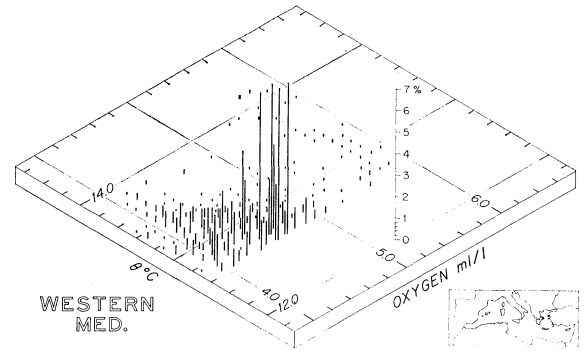

VOLUMETRIC POTENTIAL TEMPERATURE/OXYGEN DIAGRAMS
FOR THE MEDITERRANEAN SEA THREE DIMENSIONAL
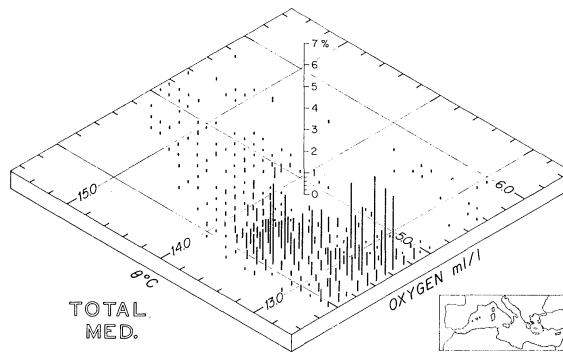
GRAPH. 1. — *Total Mediterranean :* This represents 92.9 per cent of the data for this area. 2.2 per cent of that not included is warmer than 15.5°C. 4.9 per cent is not included because it falls into intervals with less than 0.1 per cent of data.
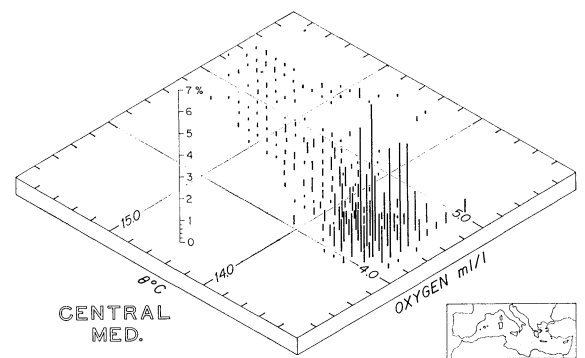

GRAPH. 2. — *Western Mediterranean :* This represents 98.1 per cent of the data for this area. 0.7 per cent is not included because it is warmer than 14.7°C. 1.2 per cent is not included because it falls into intervals with less than 0.1 per cent of data.
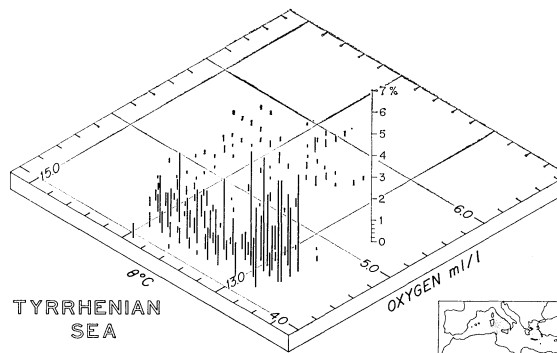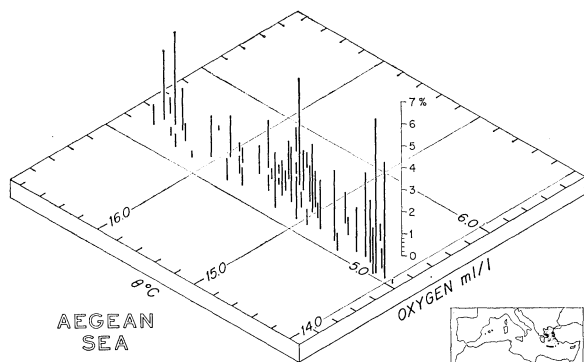

GRAPH. 3. — *Tyrrhenian Sea :* This represents 99.9 per cent of the data for this area. 0.1 per cent is not included because it falls into intervals with less than 0.1 per cent of data.
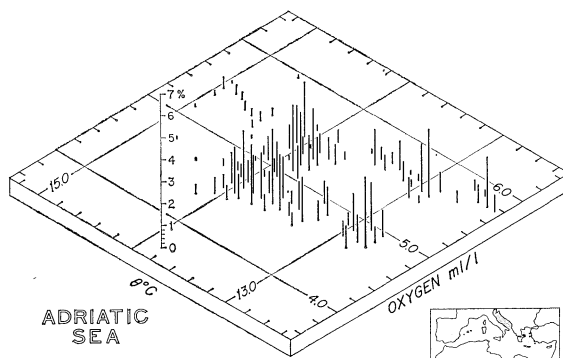

GRAPH. 4. — *Adriatic Sea :* This represents 99.8 per cent of the data in this area. 0.2 per cent of the data is colder than 12. 3°C.


GRAPH. 5. — *Central Mediterranean :* This represents 96.6 per cent of the data for this area. 0.2 per cent is colder than 13.0° C, and 1.6 per cent is warmer than 16.0° C. 1.6 per cent falls into intervals with less than 0.1 per cent of data.

GRAPH. 6. — *Aegean Sea :* This represents 89.9 per cent of the data for this area. 10.1 per cent is warmer than 16.9° C.
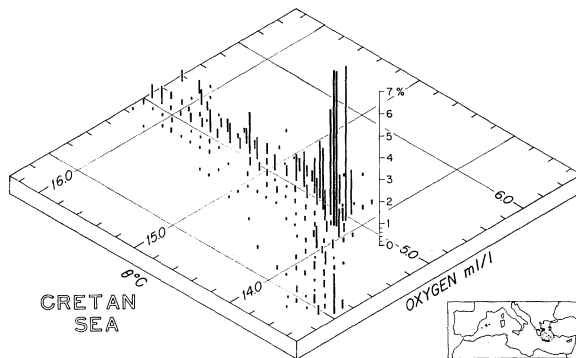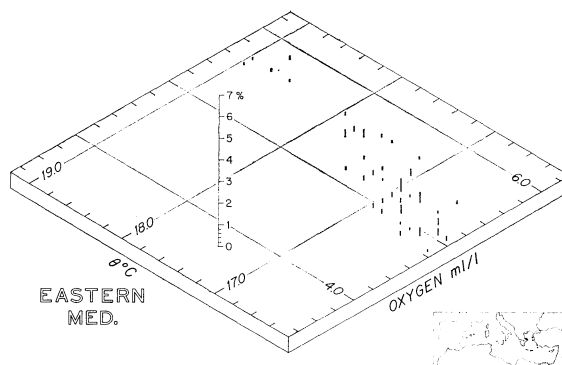

GRAPH. 7. — *Cretan Sea :* Shows the colder water and represents 82.3 per cent of the data for this area.
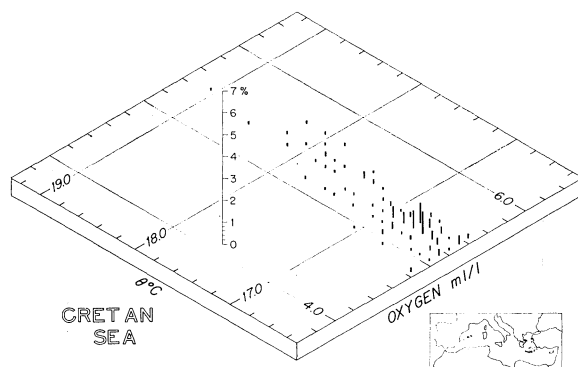
GRAPH. 8. — *Cretan Sea :* Shows the warmer water and represents 12.1 per cent of the data for this area. 5.1 per cent is warmer than 19.3° C. 0.3 per cent of the data is not included because it falls into intervals with less than 0.1 per cent of data.
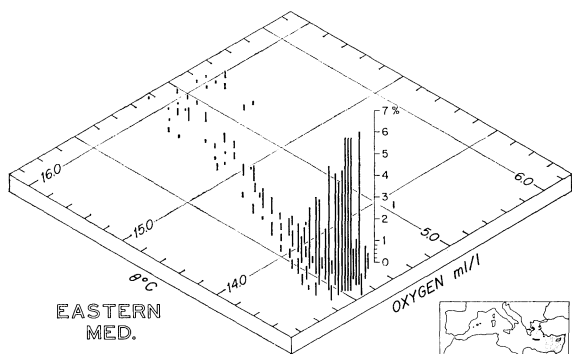
GRAPH. 9. — *Eastern Mediterranean :* Shows the colder water and represents 90.9 per cent of the data in this area.

GRAPH. 10. — *Eastern Mediterranean :* Shows the warmer water and represents 7.3 per cent of the data for this area. 1.8 per cent is not included because it is warmer than 19.2° C.

Volumetric analysis is useful in evaluating data. In Graph 2 for the Western Mediterranean a small parcel of water has oxygen of 3.8 ml/1; we would not expect to find this in the west because this is the area into which relatively high oxygen water from the Atlantic is introduced through the Strait of Gibraltar. In looking further it was discovered that these oxygens were collected on R/V Chain, Cruise 7 and are 0.15 ml/1 lower than the other data in this area. Therefore, we would reject these oxygens.

Conclusions

The dissolved oxygen in the Mediterranean Sea ranges from 3.88 to 6.58 ml/1. The lowest values are found in the Cretan Sea and the Eastern Mediterranean, the highest values in the Western Mediterranean and Tyrrhenian Sea. The total measured volume of the Mediterranean is $3.708 \times 10^6 km^3$.

TABLE 1

Statistics of Geographical Areas

Sections	Number of Degree Squares for which there are stations*	Number of Stations	Volume Rep. by data . x $10^6 km^3$
West. Med.	44	160	0.703
Tyrrhenian	8	18	0.124
Adriatic	9	21	0.018
Central	32	61	0.595
Aegean	8	55	0.018
Cretan	7	13	0.049
East. Med.	12	24	0.175
	120		1.682

* Mediterranean Sea occupies 321 degree squares

TABLE 2

Parameters of the Study*

Average Depth of Stations	Area	Volume
1429 m	$2.523 \times 10^6 km^2$	$3.708 \times 10^6 km^3$

* The Black Sea is not included.

References

[1] MILLER (A.R.) & STANLEY (R.J.), 1965. — Volumetric T-S diagrams for the Mediterranean Sea. *Rapp. Comm. int. Mer Médit.*, **18**, 3, pp. 755-759.

[2] MONTGOMERY (R.B.), 1958. — Water characteristics of Atlantic Ocean and of world ocean. *Deep-Sea Res.*, **5**, 2, pp. 134-148.