VOLUMETRIC T-S DIAGRAMS
FOR THE MEDITERRANEAN SEA

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The volume of the Mediterranean Sea has been determined by using a planimeter on contoured charts for each degree square. The Sea of Marmara or Black Sea were not included. This is similar but more discrete that Montgomery's paper[1] on the world ocean.

MEDITERRANEAN HYDROGRAPHIC STATIONS
OCCUPIED BY VESSELS OF
WOODS HOLE OCEANOGRAPHIC INSTITUTION
1961 – 1962

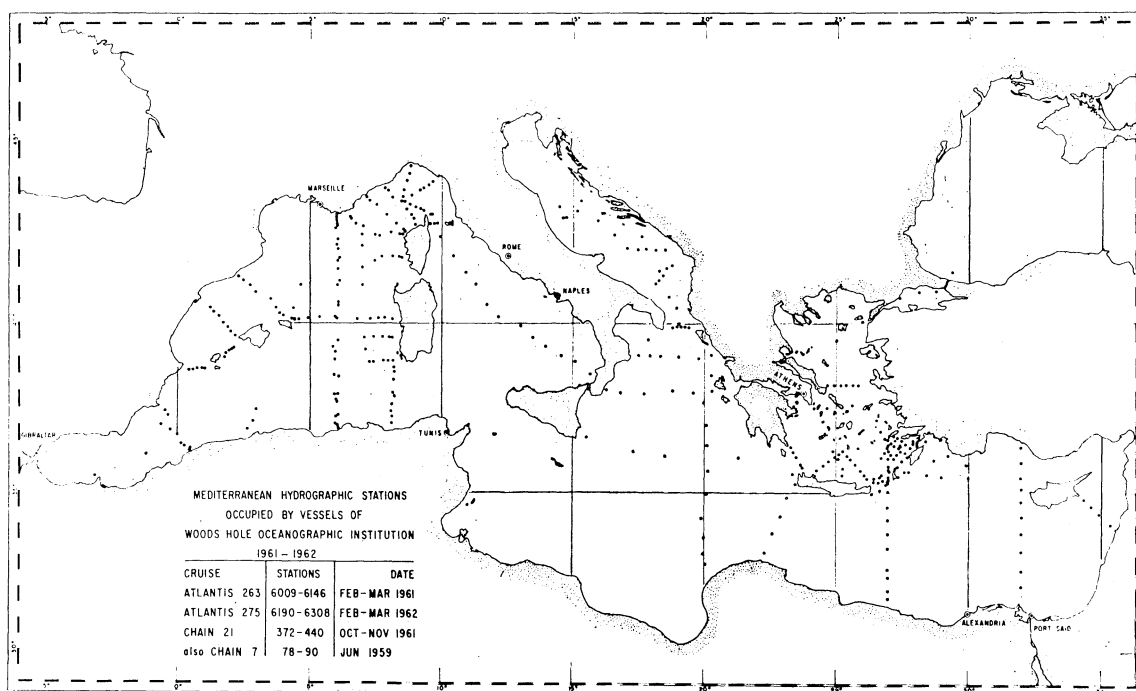| CRUISE	STATIONS	DATE
ATLANTIS 263	6009-6146	FEB-MAR 1961
ATLANTIS 275	6190-6308	FEB-MAR 1962
CHAIN 21	372-440	OCT-NOV 1961
also CHAIN 7	78-90	JUN 1959

FIGURE I

Method.

Each degree, of which there are 321, was planimetered twice and averaged. These were put on punch cards and an area and volume calculated. Later the cards were used to allocate volumes to the station observations. Next the Woods Hole station observations were punched on cards for « Atlantis » Cruises 263 and 275 and « Chain » cruises 7 and 21, totaling 352 stations. Each station was sampled from the surface to bottom, averaging 20 observations per station; fourteen bottles were used on the first cast down to 600 m and 6 bottles to the bottom on the second cast. Degree squares were assigned stations, then the volume card was matched

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(1) MONTGOMERY (R.B.), 1958. — Water characteristics of Atlantic Ocean and of world oceans. — Deep-Sea Research, 5 : 134-148.
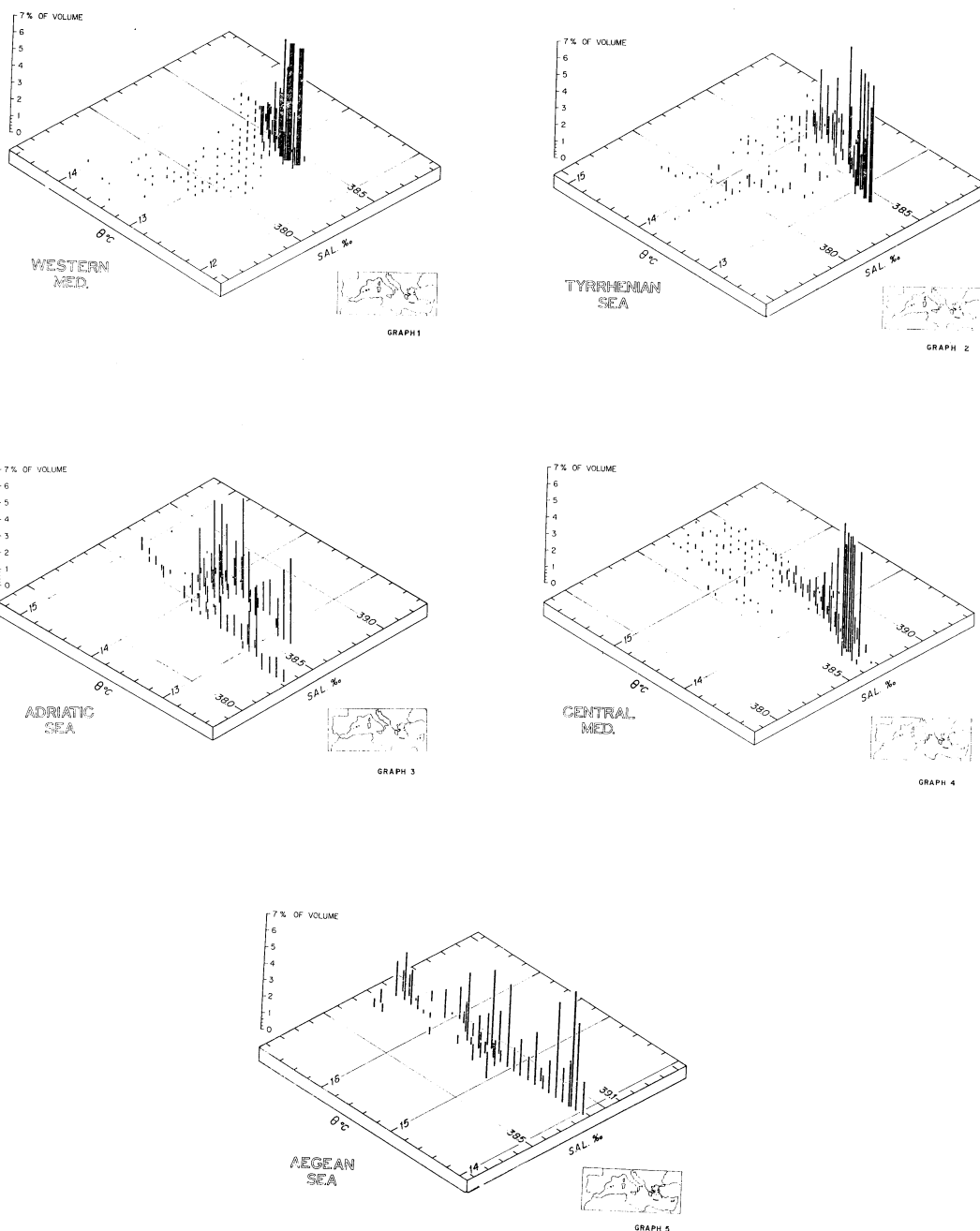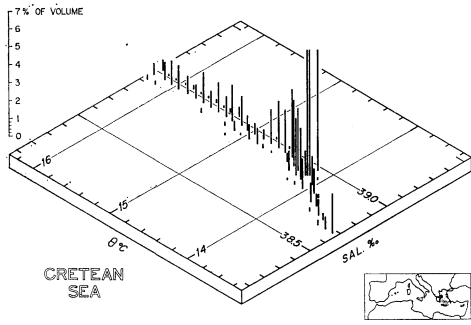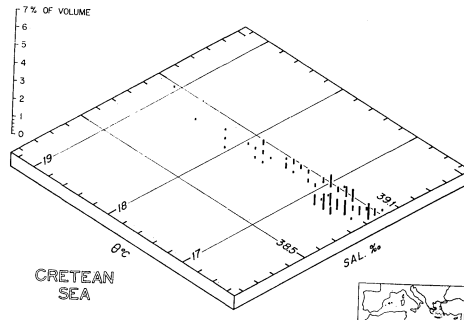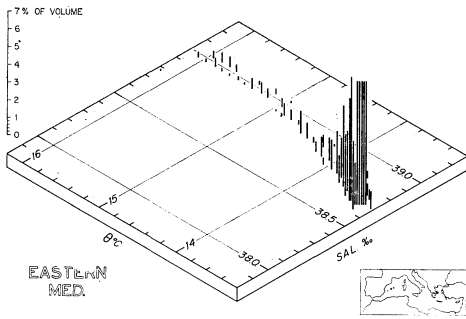
Fig. 2. — Graph 1 : *Western Mediterranean :* represents 87 % of data. Of the 13.0 % not included, 0.7 % is fresher than 37.45 °/oo, 0.7 % is warmer than 14.7°C, and 11.6 % falls into scale intervals with less than 0.1 % of the data. Graph 2 : *Tyrrhenian Sea :* represents 91.1 % of the data. The 8.9 % not included falls in scale intervals with less than 0.1 % of the data. Graph 3 : *Adriatic Sea :* represents 99.0 % of the data. Of the 1.0 % not included, 0.2 % is colder than 12.3°C and 0.8 % represents intervals with less than 0.1 % of the data. Graph 4 : *Central Mediterranean including Ionian Sea :* represents 92.6 % of the data. Of the 7.4 % not included, 0.2 % is cooler than 13.0°C, 1.6 % is warmer than 16.0°C, and 5.6 % falls into scale intervals with less than 0.1 % of the data. Graph 5 : *Aegean Sea :* represents 89.7 % of data. 10.3 % is warmer than 16.9°C.
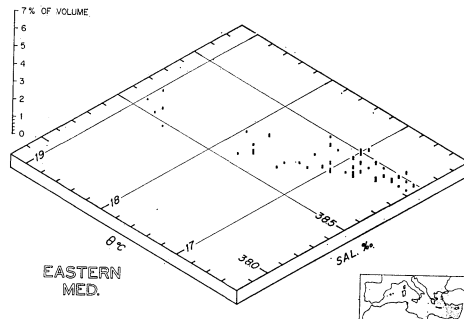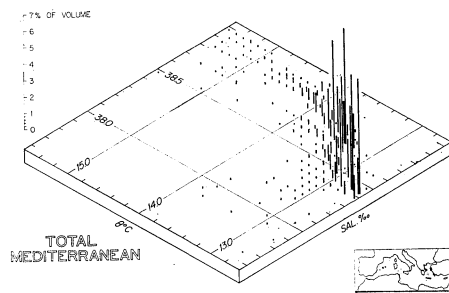
GRAPH 6

GRAPH 7

GRAPH 8

GRAPH 9

GRAPH 10

FIG. 3. — GRAPH 6 and 7 : *Cretean Sea :* represents 95.1 % of the data. 4.5 % is warmer than 19.3°C and 0.4 % falls into intervals with less than 0.1 % of the data. GRAPH 8 and 9 : *Eastern Mediterranean :* represents 97.8 % of the data. 2.2 % of the data not included is warmer than 19.2°C. GRAPH 10: *Total Mediterranean:* represents 91.5 % of the data, 2.2 % of that not included is warmer water and 6.5 % is not included because it falls into intervals with less than 0.1 % of data.
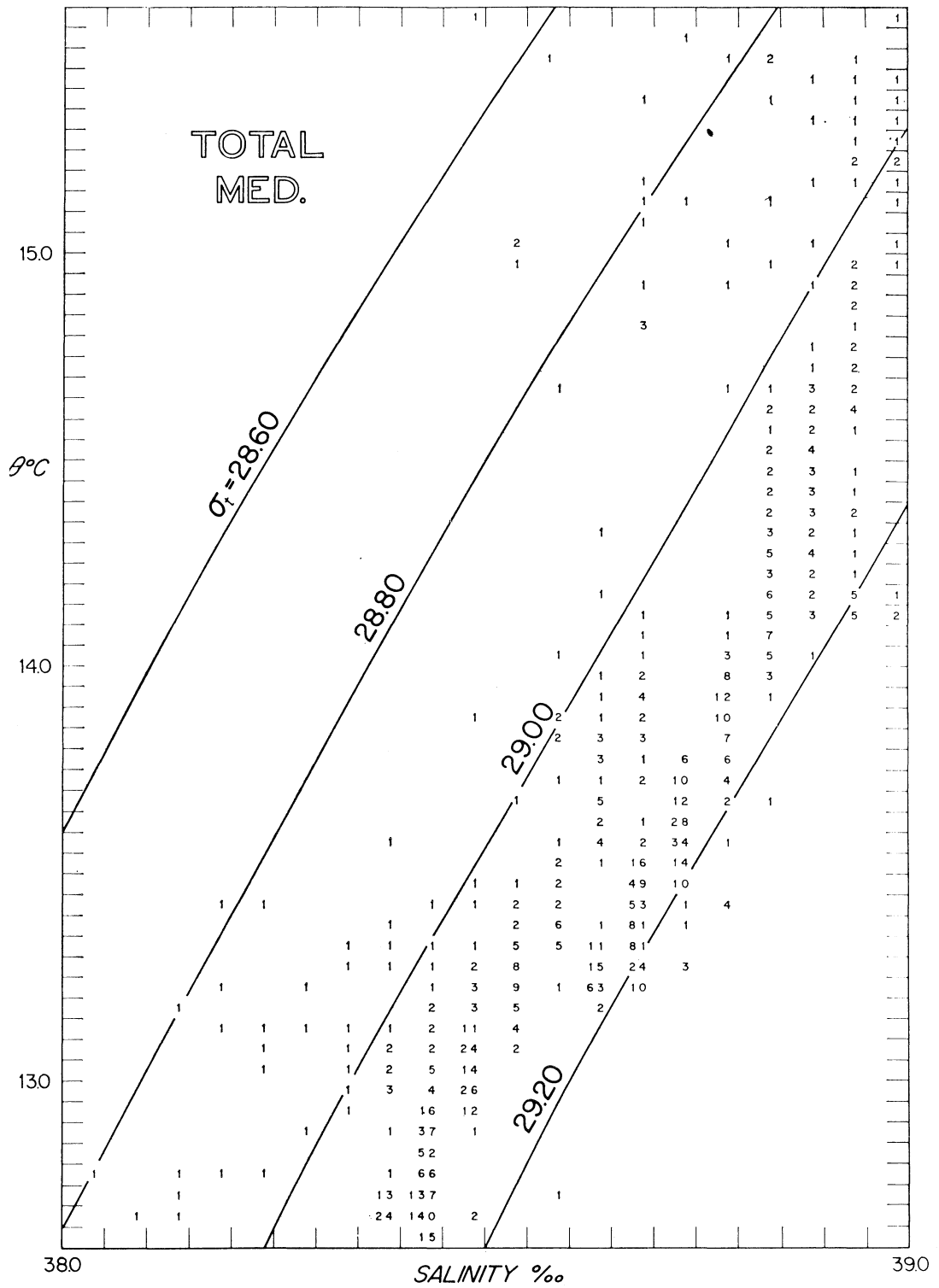
TOTAL
MED.

15.0

$\vartheta°C$

14.0

13.0

$\sigma_t = 28.60$

28.80

29.00

29.20

38.0

SALINITY ‰

39.0

GRAPH 11

FIG. 4. — GRAPH 11 : *Numbers are volumes* × 10³ *km³ this represents* 90.0 % *of the data.* 2.0 % is fresher than 38.0 ⁰/oo, 0.1 % is saltier than 39.0 ⁰/oo, 3.4 % is warmer than 15.6°C, and 4.5 % is not included because it falls in scale intervals with less than 0.1 % of the data.

to the observations. All observed temperatures were converted to potential temperatures using Fofonoff's formula ([1]). Each observation was assigned a volume : for the mean depth midway between observations above and below, for the area each observation was waited according to the number of stations to that observed depth, and these two numbers were multiplied giving the volume represented by that particular temperature and salinity. Finally,

Sections	Number of Degree Squares	Number of Stations	Volume Rep. by Data. x 10^3km^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
Cretean	7	13	0.049
East. Med.	12	24	0.175

TABLE I

degree squares were combined into appropriate sections and the observations sorted so that potential temperature, salinity, volume, and percent of volume were given. This is the data from which the graphs were made.

Discussion.

The volume of the Mediterranean was found to be 3,708 × 10^3 km^3, it's area 2,523 × 10^3 km^2. (Kossina's volume for the Mediterranean including the Black Sea is 4,238 × 10^3 km^2 ([2]). The graphs represent observations from 352 stations, taken in 120 of the 321 degree squares, see chart. The degree squares with stations account for 1,683 × 10^3 of the total volume. For the three dimensional graphs (fig. 2 et 3) volumes of o. 1 % and greater are shown in the vertical : the squares with greater than 7 % volume have vertical bars placed side by side and the temperatures are in o. 1°C, and salinity 0.05 ‰ intervals, except for graphs of the Cretean Sea and Eastern Mediterranean, these graphs do not include warm water : the scale is limited to three degrees centigrade and one and half a part per thousand salinity. The two dimensional graph gives the volume × 10^3 km^3 for the total Mediterranean (fig. 4).

(1) FOFONOFF (N.P.), 1962. — Physical properties of sea-water. — The Sea, Edit. M.N. HILL, Interscience Pub., London, p. 3-30.

(2) KOSSINNA (E.), 1921. — Die Tiefen des Welt meeres. — Berlin Univ., Institute f. Meereskunde, Veroff., N.F., A. Georg. — Naturwiss. Reihe, Heft 9, p. 7. Cited in SVERDRUP (H.U.), JOHNSON (M.W.), and FLEMING (R.H.), 1942. — The Oceans. — Prentice-Hall Co., N. Y., table 4., p. 15.