Oceanographic problems of the Mediterranean

by

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Steady state conditions require that approximately $45 \times 10^3 km^3$ of 38. 5 p.1000 water be formed each year within the Mediterranean Sea. This is based on the premise that the influx of Atlantic water is about 36.5 p. 1000 and the excess of evaporation over precipitation and runoff is sufficient to account for the increased salinity. The quantitative figure also represents the Mediterranean contribution to the deep circulation of the Atlantic Ocean. The volume of the Mediterranean, $3.7 \times 10^6 km^3$, is about 80 times this annual production and suggests an average turnover of only 80 years.

With such a short turnover time the Mediterranean circulation is probably unique in the World Ocean. In the first place, variability may be characteristic of deep circulation as well as surface circulation since the control is meteorological and the density structure is produced by air-sea interactions. Further, geological forms such as sills and channels control geographic distributions. The Strait of Sicily effectively separates east from west : the mean salinity of the Eastern Mediterranean is 38.7 p. 1000 and the Western Mediterranean is 38.4 p. 1000. In the north the meteorological control is most effective and results in the production of dense water, particularly in the NW Algero-Provencal Basin, the Adriatic, and the Aegean Seas.

Thus the Mediterranean Sea presents itself as a laboratory for the study of many phenomena relative to problems of circulation. The following problems are worth noting for study.

1. Bottom waters — what is the process of formation and the rate at which it is formed? Can we detect seasonal changes with present techniques?

2. Outflow of Intermediate and Deep water — is the outflow an upwelling process drawing contributions of both Intermediate and Deep water, or, is there some process which determines their relative contributions.

3. Wind-driven circulation — how rapid is the circulatory response to wind force? The deep homogeneity of Mediterranean waters in winter is characteristic, suggesting that they are stirred by energy derived from the wind.

4. Deep Aegean circulation — wind-stirring is effective to what depth? In the deep water oxygen values are high, 4.9 - 5.0, suggesting strong aeration in contrast to values south of the Cretan island chain, 4.0 to 4.3 ml/l .

5. Outflow of Aegean water — there are indications of a flow of Aegean water passing over the Scarpanto sill and sinking to a depth of 1200 meters. The slight instability at this depth suggests a dynamic and sporadic flow.

This raises questions as to circulation over sills in general as to the degree of turbulence, the dissipation of energy, and the mechanism of mixing.

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6. Oxygen minimum layer — in the Eastern Mediterranean the oxygen minima are poorly defined. Minima are clearly defined in most parts of the Western Mediterranean. Original oxygen sources are from surface absorption or brought in with Atlantic water. Therefore, the problem of formation of oxygen minima in the Mediterranean Sea may be a fruitful study.

7. Life of nutrients — relative to the Atlantic Ocean the nutrient content of Mediterranean water is poor. Yet the narrow density range suggests an efficient use of the nutrients. The nutrient cycle deserves study from a dynamic and physical viewpoint.

8. Sea level versus salinity — drastic changes in Atlantic sea level would most certainly affect the salinity content of Mediterranean water. As more knowledge is gained about Mediterranean circulation, there should be a growing emphasis on paleo-oceanography. Circulation of past ages may be reflected in the bottom sediments. Reconstruction of past events may help in the control of the future.

9. Contribution of the Adriatic — outflow of the Adriatic to the Ionian Sea is clearly the major portion of deep water content in the Eastern Mediterranean. It is difficult to estimate the size of this contribution and it remains a problem.