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Recent Dissolved-oxygen Measurements in the Gulf of Mexico Deep Waters¹

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ABSTRACT

In 1963 it was suggested that rather large gradients in dissolved oxygen exist in the Gulf of Mexico below a sill depth of between 1500 m and 1900 m. However, measurements made on three cruises during 1966 and 1967 indicate that there is no clearly discernable horizontal variation in dissolved oxygen in these waters. Only slight vertical oxygen gradients exist below the sill depth; the mean value obtained is approximately 5.0 ml/l. The data obtained in 1966 and 1967 are compared with data obtained on seven previous cruises in 1935, 1958, 1959, 1962, and 1964.

Introduction. In a previous paper (McLellan and Nowlin 1963), based on data obtained in 1962 on cruise 62-H-3 of the *HIDALGO*, it was suggested that large oxygen gradients exist in the basin waters of the Gulf of Mexico below the controlling sill depth in the Yucatan Strait. From consideration of potential temperature data, this sill depth was determined to be somewhere between 1500 m and 1900 m. Judging by observations made in 1966 and 1967, however, it is highly probable that the oxygen data obtained in 1962 as well as in 1964 were based on faulty sampling or poor analytical techniques. Thus, the dissolved oxygen patterns presented earlier are subject to suspicion.

In this study, oxygen data obtained in 1966 and 1967 are compared with selected data obtained in 1935, 1958, 1959, 1962, and 1964, and it is shown that there is in fact no clearly discernable horizontal variation in dissolved oxygen in the basin waters of the Gulf.

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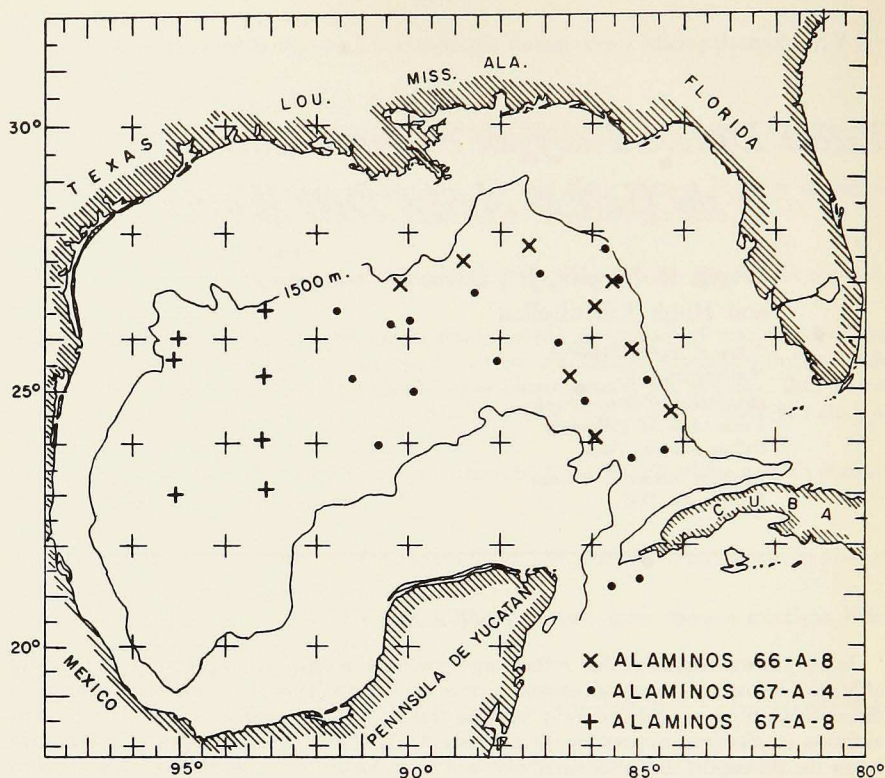


Figure 1. Locations of stations on ALAMINOS cruises 66-A-8 (1-24 June 1966), 67-A-4 (10 June-1 July 1967), and 67-A-8 (9-12 September 1967) from which data were utilized.

Data and Observations. The measurements employed here provide areal coverage of the entire Gulf Basin and were obtained on cruises by the ATLANTIS, the HIDALGO, and the ALAMINOS. The ATLANTIS in 1935 and the HIDALGO in 1958 (58-H-4) provided observations principally from the central eastern Gulf; observations were obtained from the western part on the HIDALGO in 1958 and 1959 (58-H-1, 59-H-2) and on the ALAMINOS in 1964 (64-A-2, 64-A-3); observations from the entire Gulf Basin were obtained on the HIDALGO in 1962 (62-H-3) and on the ALAMINOS in 1966 and 1967 (66-A-8, 67-A-4, 67-A-8); and observations in the Yucatan Basin were obtained on the ALAMINOS in 1967 (67-A-4). The ATLANTIS data are available from the Woods Hole Oceanographic Institution, the other data from the Department of Oceanography at Texas A & M University. Fig. 1 shows the locations of the 1966 and 1967 ALAMINOS stations from which oxygen data are presented.

Oxygen determinations on cruise 66-A-8 were made by the Winkler method,

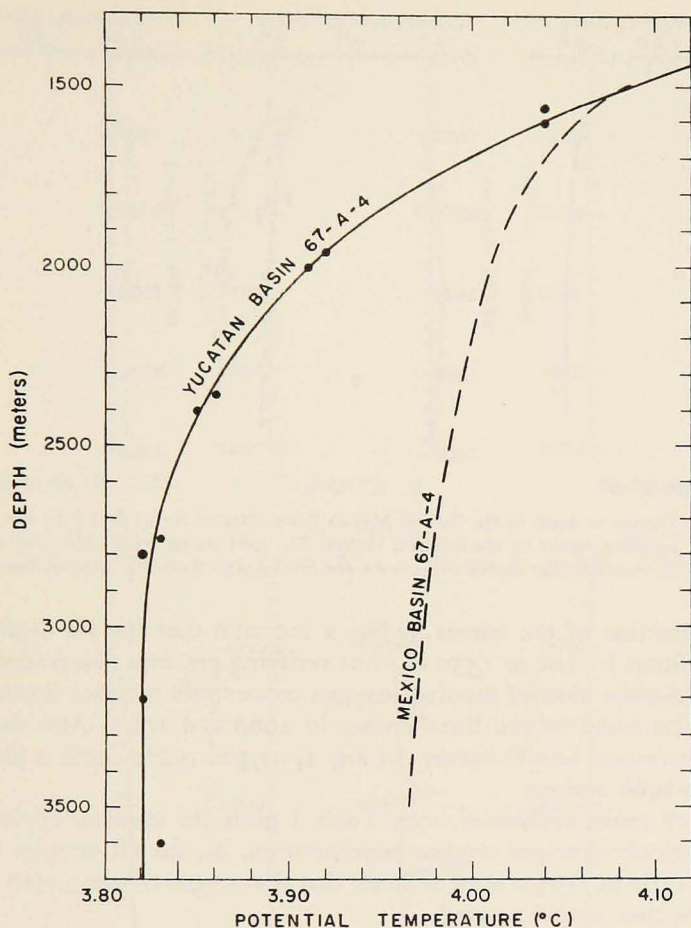


Figure 2. Potential temperature vs depth in the Yucatan and Gulf of Mexico basins as observed on ALAMINOS cruise 67-A-4. The dashed curve was selected by eye to best fit the 62 data points below the 1400-m depth.

using potassium biniodate as the standard; oxygen data on 67-A-4 and 67-A-8 were determined by the Chesapeake Bay Institute technique for the Winkler method described by Carpenter (1965); and all oxygen determinations for the cruises prior to 1966 were made with modifications of the Winkler method.

Results. In Fig. 2, potential temperature versus depth is plotted for both the Yucatan and Mexico basins, using data from cruise 67-A-4. Values of adiabatic cooling that were applied to *in situ* temperatures in order to determine potential temperatures were based on data presented by Cox and Smith (1959).

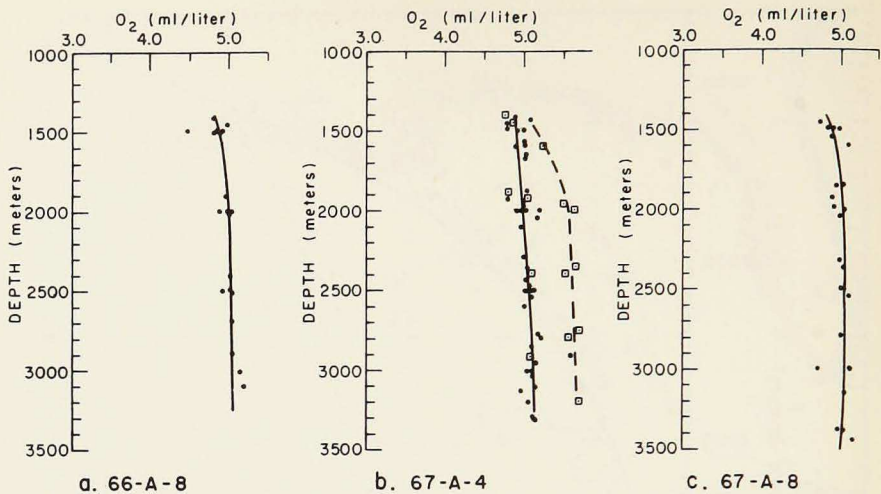


Figure 3. Oxygen vs depth in the Gulf of Mexico Basin. Plotted are all data from the ≥ 1400 -m sampling depths on the indicated cruises. The solid curves were selected by eye to best fit the data. The dashed curve is for the 67-A-4 data from the Yucatan Basin.

The intersection of the curves in Fig. 2 indicates that the sill depth in the Yucatan Strait is close to 1550 m, thus verifying previous observations.

Fig. 3 displays plots of dissolved-oxygen concentration versus depth for the basin waters based on the three cruises in 1966 and 1967. Also shown are visibly determined best-fit curves. In Fig. 4, oxygen versus depth is plotted for seven pre-1966 cruises.

For each cruise considered here, Table I gives the standard deviation and the numerically-averaged oxygen concentration, \bar{O}_2 , for all samples taken at or below 1500 m. There is no evidence that the oxygen concentration changed during the time period covered.

Table I.

Cruise	Standard deviation (ml/l)	\bar{O}_2 (ml/l)	Number of stations ($z \geq 1500$ m)	Number of data points ($z \geq 1500$ m)
ATLANTIS 1935	0.134	4.96	9	23
58-H-1	0.124	5.08	6	19
58-H-4	0.054	4.87	4	7
59-H-2	0.055	5.01	5	17
62-H-3	0.280	4.62	52	114
64-A-2 and 3	0.482	4.58	19	67
66-A-8	0.048	4.99	7	19
67-A-4:				
Mexico Basin	0.077	5.03	16	55
Yucatan Basin	0.099	5.61	2	11
67-A-8	0.111	5.01	9	21

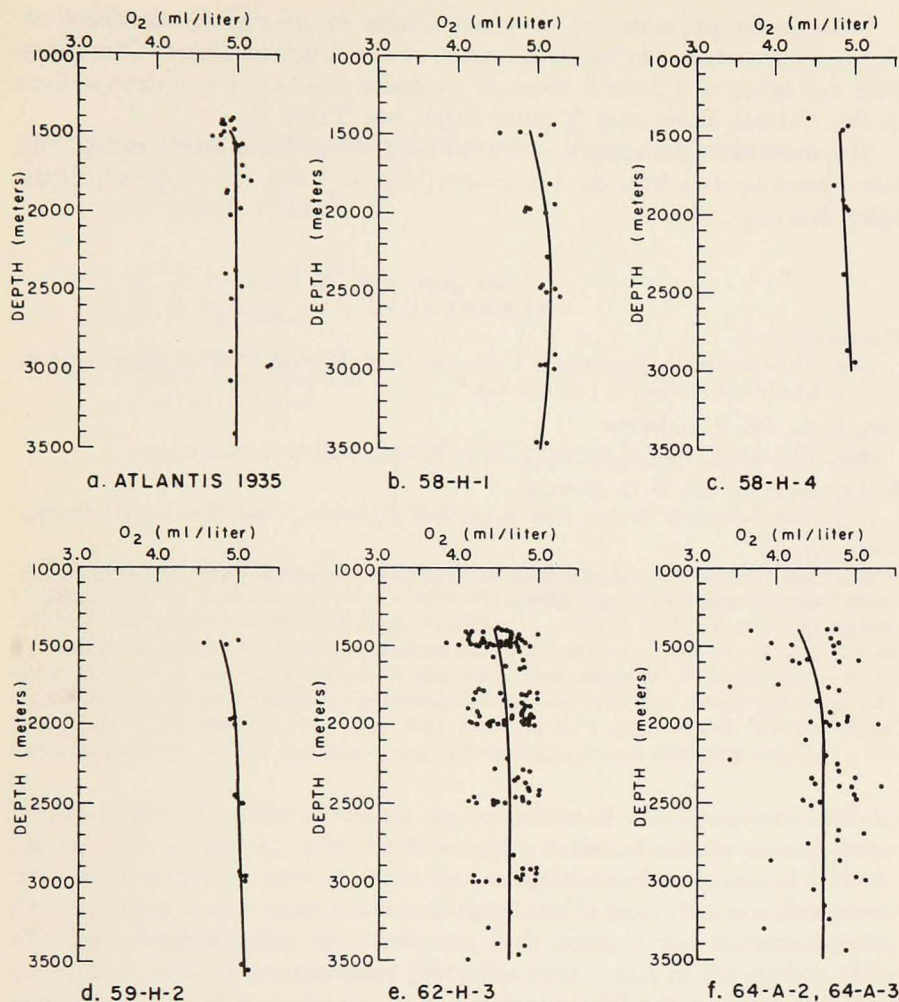


Figure 4. Oxygen vs depth in the Gulf of Mexico Basin. Plotted are all the data from the ≥ 1400 -m sampling depths on the indicated cruises. The solid curves were selected by eye to best fit the data.

Discussion. The oxygen data collected on the 1962 and 1964 cruises show much more scatter at any given depth than do the oxygen data presented from the other cruises. As noted, it is very probable that this scatter resulted from poor sampling or inaccurate analysis. Moreover, horizontally uniform oxygen concentrations are consistent with the horizontal uniformity of salinity and potential temperature documented by McLellan and Nowlin for the basin waters (1963). Horizontal uniformity of temperature and salinity were observed again on the 1966 and 1967 cruises.

Wüst (1964:45, table 15) has given a value of 5.6 ml/l for the dissolved-oxygen concentration in the deep waters of the Yucatan Basin. This agrees with our value of 5.61 ml/l obtained on cruise 67-A-4 at two deep stations in the Yucatan Basin near Yucatan Strait (see Table I).

Our mean value for oxygen in the Gulf of Mexico Basin waters is 4.91 ml/l when based on data from the ten cruises listed in Table I, or 4.99 ml/l if the 1962 data are excluded.

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