21. RADIOCARBON DATING OF RECENT SEDIMENTS FROM LEG 64, GULF OF CALIFORNIA[1]

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ABSTRACT

Samples from Sites 474, 476–479, and 481 have been dated by the radiocarbon method to >40,000 y. Most of the late Wisconsinan to Holocene sedimentation rates were much greater than those estimated from biostratigraphy for Quaternary sediments deposited before 40,000 y. ago, being highest in the Guaymas Basin (rate at Site 477 > rate at Site 481 > rate at Site 478), intermediate at the mouth of the Gulf of California (rate at Site 476 > rate at Site 474), and lowest on the Guaymas slope.[3]

INTRODUCTION

Quaternary sediment accumulation rates in the Gulf of California were estimated from the biostratigraphic record (Curray et al., 1979). We were, therefore, interested in applying radiocarbon dating to the shallower sedimentary sequences to supplement the age data from biostratigraphy.

METHODS

Short sections of core material were sampled aboard ship, frozen in Kapak bags, and stored to await analysis. Depending on sample size and carbon content, radiocarbon measurements were performed on the carbonate fraction or the organic carbon fraction. The carbonate carbon was extracted by leaching with dilute HCl in a vacuum system. The residual sample material was filtered, washed, and dried. Next, the organic carbon was extracted by combustion in a vacuum. The ^{14}C activity was analyzed by the acetylene gas-counting method (modified from the method described by Suess, 1954) at the U.S. Geological Survey, Reston, Virginia. Sample activities have not been corrected for isotope fractionation by a ^{13}C measurement. If $\delta^{13}C$ values are assumed to be zero for the carbonate and $-21‰$ for the organic fractions, this correction would add approximately 412 y. to each date derived from carbonate carbon and 65 y. to each date derived from organic carbon. The true age, however, may be as much as 1000 y. younger than this corrected value, because reworked material may be incorporated in the samples and because of the marine-reservoir effect (the radiocarbon deficiency of ocean waters; Broecker et al., 1960). The dates given in Table 1 were calculated relative to the U.S. National Bureau of Standards oxalic-acid standard activity (Stuiver and Polach, 1977).

RESULTS AND DISCUSSION

The radiocarbon data for the organic and the carbonate carbon fractions of the samples are found in Table 1, and the results are plotted in Figure 1. We do not know why the ages of these two fractions appear to differ somewhat. Table 2 is a comparison of the approximate sedimentation rates for the upper section of each hole with data based on the biostratigraphic record described in the literature.

Table 1. Radiocarbon dating of sediments from the Gulf of California Leg 64.

Sample (interval in cm)	Sub-bottom Depth[a] (m)	Radiocarbon Dates (y. B.P. ± 1σ)[b] Organic Carbon	Carbonate Carbon
474-5-3, 115–120	34.65 (38.25)	34,200 ± 1500	26,400 ± 800
476-2-2, 73–79	11.23 (13.8)	>40,000	—
476-7-2, 113–117	59.13 (59.1)	—	30,650 ± 1200
477-3-1, 135–140	11.85 (19.15)	2,710 ± 110	—
477-4-1, 145–150	21.45 (29.2)	5,660 ± 80	8,020 ± 230
477-5-1, 115–120	30.65 (37 .0)	5,350 ± 100	—
477-17-1, 140–145	125.9 (131.3)	—	—
478-2-1, 7–18	3.57 (4.27)	3,420 ± 210	—
478-2-4, 102–113	9.02 (9.72)	—	—
478-2-5, 49–55	11.0 (11.7)	—	—
479-1-2, 37–42	1.87 (2.4)	4,540 ± 120	—
479-3-1, 67–74	13.17 (18.3)	16,820 ± 340	—
479-6-1, 16–25	41.16 (42.55)	—	—
481-3-2, 31–46	11.31 (11.65)	7,950 ± 100	—
481-10-2, 45–55	44.70 (44.7)	4,490 ± 110	—

Note: Dash indicates insufficient carbon for dating.
[a] Depth from top of core downward; figure in parentheses is the distance from core catcher upward.
[b] Dates are given as years before present, referenced to the year 1950.

Mouth of the Gulf

Only limited data are available for Sites 474 and 476, which are at the mouth of the Gulf. The average sedimentation rate calculated from radiocarbon ages for Site 474 is 120 cm/10^3 y.—about five times larger than the estimate from biostratigraphy. At Site 476, the shallow sample is anomalously old; possibly it contains recycled, geologically old organic matter. The average sedimentation rate calculated from radiocarbon ages is 192 cm/10^3 y. which is about double the biostratigraphic estimate.

Guaymas Basin

The ^{14}C data for the Guaymas Basin sites (477, 478, 481) are limited yet complicated (Table 1). The complex

[1] Curray, J. R., Moore, D. G., et al., *Init. Repts. DSDP*, 64: Washington (U.S. Govt. Printing Office).
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[3] After submission of this manuscript, all estimates of rates of accumulation were revised from those of the *Geotimes* article (Curray et al., 1979) by addition of new data. See site chapters (this volume, Pt. 1), Aubry et al. (this volume, Pt. 2), and Curray et al. (this volume, Pt. 2). The conclusion is, however, the same, that radiocarbon dating yields much higher estimates of rates of accumulation than biostratigraphic data.

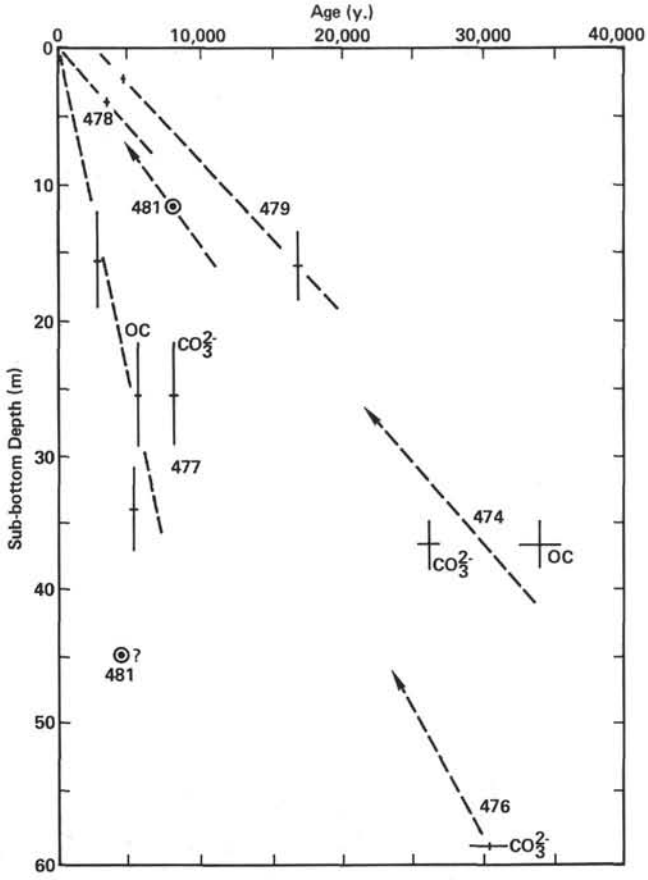

Figure 1. Radiocarbon age versus sub-bottom depth for core samples from Leg 64 Sites 474, 476–479, and 481. (OC = organic carbon; CO_3^{2-} = carbonate carbon).

Table 2. Comparative sedimentation rates.

Site	Sedimentation Rates (cm/10^3y.) Based on Radiocarbon Ages	Biostratigraphic Record and Literature
474	120	24[b]
476	192	80[b]
477	480	>120[b]
		100[c]
478	92	>120[b]
479	112 (96)[a]	50[b]
481	144	>120[b]

[a] Value in parentheses calculated by assuming that the data line intercepts the origin (Fig. 1) as do the lines for the other sites.
[b] From Curray et al. (1979).
[c] From Calvert (1966) and van Andel (1964).

tectonic history of the basin may account for the younger material below the older material at Sites 477 and 481, possibly brought in by slumping. The average sedimentation rates calculated from radiocarbon ages are 480 cm/10^3 y. for Site 477 and 144 cm/10^3 y. for Site 481. The rate for Site 477 is as much as five times the estimate derived from biostratigraphy. At Site 478, the two sedimentation-rate estimates are in relatively good agreement—approximately 100 cm/10^3 y.

Guaymas Slope

Only two values could be obtained from the Guaymas Slope samples (Site 479; Table 1), and the intercept of the extrapolation to the seabed yields an apparent age of about 2600 y. for the organic matter. Similarly apparent ages (about 2500 y.) for seabed organic matter have been observed in the Southern California Bight (Emery and Bray, 1962). These old seabed ages are probably explained by sediment mixing and the incorporation of older, reworked carbon. The average sedimentation rate calculated from radiocarbon dates is 112 cm/10^3 y., which is about double the estimate from biostratigraphy.

The sedimentation rates calculated from radiocarbon ages for Sites 474, 476–479, and 481 (Table 2) are greater than the Cariaco Trench mean rate of 50 cm/10^3 y. (Spiker and Simoneit, 1980).

CONCLUSIONS

Samples from Sites 474, 476–479, and 481 have been dated by the radiocarbon method to >40,000 y. at sub-bottom depths to about 60 meters. Most of the sedimentation rates calculated from radiocarbon ages were much greater than those estimated from the biostratigraphic record, suggesting that either the rates have increased significantly in the late Pleistocene or Holocene or that the samples are contaminated with young carbon. The apparent rates of accumulation are highest in the Guaymas Basin (rate at Site 477 > rate at Site 481 > rate at Site 478), are intermediate at the Mouth of the Gulf (rate at Sites 476 > rate at Site 474), and are lowest on the Guaymas Slope.

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