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MIAMI NATURAL RADIOCARBON MEASUREMENTS I*

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INTRODUCTION

The construction of the dating apparatus started in the summer of 1960 and was completed one year later. The laboratory is located on the bottom floor of a three-story concrete-block building which has two thin concrete floors on concrete beams above the shield. The building is underlain by carbonate mud and coral rock. The geographic location is 25° 43.9′ N Lat, 80° 09.8′ W Long and only a few feet above sealevel. We use a proportional-counting tube with an active volume of 1 L, and a total sample volume of 1.30 L, filled with purified CO_2 to a pressure of 225 cm Hg (3 atm) at 25°C. The tube is made of copper with brass ends and quartz insulators. The shielding consists of 20 cm of iron, 10 cm of paraffin with boric acid, 2.5 cm of selected lead (Östlund, 1961), and cosmic ray guard counters. The room is air-conditioned but no additional precautions have been taken to exclude outdoor dust.

The counting tube gives 18.3 counts/min for 0.95x NBS standard above a background of 2.10 counts/min. The electronic circuits are partly standard commercial units, modified for our purposes, and partly homemade. The whole outfit is similar to the Stockholm C^{14} (Östlund, 1957) and tritium (Östlund, 1961) machines. The tube and inner lead shield was made at the Stockholm Laboratory by Lars Engstrand.

In the dating list below, all samples were measured twice with at least a 1000-min counting period each and a minimum of 14 days between counting periods. The ages are calculated as usual by comparison to the NBS standard, but in the case of marine carbonate material, we have taken into account the fact that sea-surface carbonate exhibits an apparent age of ca. 400 yr, or a Δ-value of $-50 \pm 12‰$ (where $\pm$ 12 is the standard deviation for a single sample). This figure was calculated from the results given by Fonselius and Östlund (1959) and Broecker and Olson (1961).

The NBS oxalic-acid standard and a series of carbonate samples from cores have been analyzed for C^{13} by Cesare Emiliani at this laboratory. The sample values obtained were related to the PDB Chicago C^{13} standard by using a gas standard which had been well calibrated previously against the PDB standard. The average δC^{13} value of the NBS standard is $-19.07 \pm 0.07‰$, obtained from a series of four analyses of samples prepared by direct combustion. The core carbonate C^{13} values are included in the comments. Where C^{13} analyses have not been made, we have assumed a value of $0 \pm 4.0‰$ (max error) and have included this in the probable error of the age. From the C^{13}-corrected age figures we have thus subtracted 400 yr to give the real C^{14} time elapsed from the moment the carbonate was formed in the sea until A.D. 1950.

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In the uncertainty of the age figures the standard deviation of this apparent age has not been included, not being an experimental uncertainty.

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SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES FROM DEEP-SEA CORES

All dates presented in this list are of deep-sea core samples collected from the Tongue of the Ocean, Bahamas, B.W.I. The material used for dating consisted of specific bulk calcilutite (silt- and clay-sized calcium carbonate) horizons which could provide four kinds of basic information: (1) rates of accumulation of bulk sediment, (2) periodicity of turbidite deposition, (3) estimates of the carbonate supply rate from the Bahama Banks to the Tongue of the Ocean, and (4) insight into the anomalous behaviour of Ra^{226} distribution in the sediments. In most cores, we have tried to date at least two horizons; an uppermost layer and another layer at some depth in the core. The uppermost layer provides a control from which relative rates of accumulation could be computed without the assumption of a zero age for the top of the core. However, where material was not available for dating the uppermost layer, we have had to assume a zero age for the top. This assumption may be invalid in some cases as exemplified by Core MG 60-14 (ML-17). In general, the rates of accumulation are highest on the bank slopes, as expected. Those deeper-water cores that show a relatively high rate of accumulation are from narrower sections of the basin, and therefore tend to show a thicker accumulation for a given volume of supplied sediment than is found in the broader reaches of the basin. Extensive evidence of turbidite layers suggests that the true age of any given horizon may be younger than reported, because of the possibility that older carbonate may have been mixed with younger material during deposition. All samples used for dating were collected by the Marine Laboratory staff and were submitted by G. A. Rusnak.

ML-12. Core MG 57-11, 60-65 cm **3700 ± 90**

Gravity core collected at the N end of the Tongue of the Ocean (24° 59′ N Lat, 77° 44′ W Long, water depth 2489 m). This core showed little evidence of turbidity current deposition and was supposed to provide an estimate of the accumulation rate unaffected by that complication.

ML-13. Core MG 57-18, 44.5-49 cm **4000 ± 100**

Gravity core collected from the center of the Cul de Sac (23° 40′ N Lat, 76° 52′ W Long, water depth 1253 m). Another core supposed to be largely

uninfluenced by turbidity current deposits. Analyses for Ra^{226} by B. Szabo show a relatively smooth distribution with the exception of a small minimum at the 6-to-8-cm level. It may thus be suspected that some of the finer material was derived from minor turbidity currents and therefore gives too great an age at certain levels.

ML-14. Core MG 58-6, 55-60.5 cm **6615 ± 130**

Silt-sized carbonate from a gravity core collected along the axial center of the Tongue of the Ocean (23° 58′ N Lat, 77° 18′ W Long, water depth 1369 m). This core had been analyzed previously by B. Szabo for Ra^{226} distribution and exhibited an erratic distribution in the upper 30 cm, which is explained by lithology indicating turbidite units, but deeper levels are undisturbed.

ML-15. Core MG 57-20, 54-59.5 cm **2630 ± 105**

Silt-sized carbonate from gravity core collected on the flat plain of the Cul de Sac (23° 32′ N Lat, 76° 56′ W Long, water depth 1281 m). Core is ca. 10 mi closer to the bank edge than MG 57-18 and shows a turbidite unit in the upper 32 cm demonstrated also by a minimum in the Ra^{226} distribution. Additional dates are needed but date shows undisturbed portion of this core to have accumulated twice as fast as Core MG 57-18; i.e. rate of accumulation is greater near the bank.

Core MG 60-14 series

Piston core taken along the axis of the Tongue of the Ocean due E of the southern tip of Andros Island (23° 49′ N Lat, 77° 14′ W Long, water depth 1345 m). Core appeared relatively undisturbed except for an obvious turbidite layer in the upper 10 cm. Age at top is not zero, probably because older material has been redeposited here by a turbidity current.

ML-17. MG 60-14, 0-5 cm **8275 ± 120**

ML-19. MG 60-14, 75-80 cm **12,810 ± 185**

ML-20. MG 60-14, 145-150.3 cm **21,040 ± 335**

Core MG 60-17 series

Samples from a piston core and pilot core taken at the approximate geographic center of the Tongue of the Ocean (24° 08′ N Lat, 77° 22′ W Long, water depth 1420 m). Core section: 0-26 cm, uniform calcilutite; 26-45 cm, two turbidite units grading from sands and silts at the bottom to fine calcilutite at the top; 45-50 cm, uniform calcilutite; 50-132 cm, four graded turbidite units; 132-137 cm, uniform calcilutite. Lower (undated) part shows many more turbidite units. Dates between 0 and 26 cm provide estimate of pelagic sedimentation rate. Dates below 26 cm provide estimates of frequency of turbidity flows, ranging here from one per 2500 yr to one per 3600 yr.

ML-21. MG 60-17, 0-10 cm **1515 ± 90**

Sample at top of pilot core.

ML-22. MG 60-17, 21-26 cm **8750 ± 115**

Piston core, above upper of two turbidite units. Bulk $CaCO_3$; $\delta C^{13} = +2.6$.

ML-23. MG 60-17, 45-50 cm **16,125 ± 215**

Piston core, between 2nd youngest and 3rd youngest turbidite units.

ML-24. MG 60-17, 132-137 cm **26,275 ± 570**

Piston core, below zone containing four turbidite units.

Core MG 60-20 series

Samples from a piston core and pilot core taken from the Tongue of the Ocean axis (24° 35′ N Lat, 77° 31′ W Long, water depth 1690 m). Core is similar to core MG 60-17, but lacks recognizable layers of fine-grained pelagic calcilutite. Samples for dating were therefore selected from below the sharp contacts of a few graded units. Contamination by reworked sediments cannot be excluded, but frequency of turbidity flows appears to range from one per 600 yr for the upper section to one per 6700 yr for the lower dated section.

ML-28. MG 60-20, 0-10 cm **2425 ± 70**

Sample at top of pilot core. Bulk $CaCO_3$; $\delta C^{13} = +2.8$.

ML-29. MG 60-20, 42.5-47.5 cm **4785 ± 75**

Piston core, below four youngest turbidite units. Bulk $CaCO_3$; $\delta C^{13} = +2.9$.

ML-30. MG 60-20, 72-77 cm **18,190 ± 265**

Piston core, below 5th and 6th turbidite units. Bulk $CaCO_3$; $\delta C^{13} = +1.1$.

Core MG 61-1 series

Gravity core collected on the bank-slope of the Cul de Sac (23° 38′ N Lat, 76° 32′ W Long, water depth 413 m). Core is relatively homogeneous calcilutite except for thin coarse layers of oolitic silt at 83.0 to 83.5 cm and 105 to 109 cm. Dates suggest that no important unconformities are present, and indicate rate of sedimentation to be ca. 575 g/cm²/1000 yr, the highest observed in the Tongue of the Ocean.

ML-32. MG 61-1, 0-5 cm **910 ± 65**

Bulk $CaCO_3$; $\delta C^{13} = +4.0$.

ML-33. MG 61-1, 147-152 cm **1145 ± 70**

Bulk $CaCO_3$; $\delta C^{13} = +4.9$.

ML-35. Core MG 60-13, 36.5-41.5 cm **5200 ± 85**

A gravity core collected from the SW side of the Tongue of the Ocean (23° 45′ N Lat, 77° 18′ W Long, water depth 1250 m). Another relatively undisturbed calcilutite core except for a poorly graded sandy silt at 34.5 to

41.5 cm. Dating of the bottom section of this short core was tried because accumulation-rate data are otherwise lacking for the surrounding area. Bulk $CaCO_3$; $\delta C^{13} = +3.2$.

Core MG 61-2 series

Calcilutite from a gravity core taken along the E side of the Cul de Sac (23° 46′ N Lat, 76° 38′ W Long, water depth 1089 m). Graded sandy-silt turbidite layers occur at 13 to 21 cm, 22.5 to 43 cm, 48 to 57 cm, 70 to 81 cm, 103 to 117 cm, and 123 to 128 cm, separated by poorly graded calcilutites. Incorporation of older carbonate cannot be excluded, but frequency of turbidity flows is ca. one per 550 yr.

ML-37. MG 61-2, 0-5 cm **790 ± 65**

Bulk $CaCO_3$; $\delta C^{13} = +4.9$.

ML-34. MG 61-2, 129-134 cm **3350 ± 75**

Bulk $CaCO_3$; $\delta C^{13} = +2.5$.

ML-36. Core MG 60-11, 106-111 cm **3685 ± 80**

Bottom section of a gravity core collected from the S end of the Cul de Sac (23° 30′ N Lat, 76° 46′ W Long, water depth 1270 m). Core exhibits a large number of graded beds. Assuming zero age for the top, frequency of turbidity flows is one per 460 yr. Bulk $CaCO_3$; $\delta C^{13} = +3.8$.

Core MG 60-4 series

Gravity core taken in axis of the Tongue of the Ocean in NW Providence Channel N of Nassau (25° 14′ N Lat, 77° 44′ W Long, water depth 2750 m). Calcilutite core with one very well-graded turbidite layer at 46 to 55 cm, and thinner ones at 67.5 to 68 cm, 104 to 104.2 cm, and 119 to 121.5 cm. Turbidity flows apparently occurred at the relatively low rate of one per 6000 to one per 10,000 yr in this area, where pelagic sedimentation is also slow. ML-39 and ML-40 directly above and below the main sand layer, prove to be approximately synchronous; as old material is incorporated in a turbidite, the underlying sample, presumably pelagic, may date the turbidity flow more reliably.

ML-38. MG 60-4, 0-5 cm **1770 ± 65**

Bulk $CaCO_3$; $\delta C^{13} = +4.0$.

ML-39. MG 60-4, 39-44 cm **6770 ± 110**

Just above sand layer.

ML-40. MG 60-4, 56-61 cm **5965 ± 90**

Just below sand layer. Bulk $CaCO_3$; $\delta C^{13} = +2.5$.

ML-41. MG 60-4, 140.5 to 145.5 cm **29,120 ± 850**

Below 3 thin sand layers. Bulk $CaCO_3$; $\delta C^{13} = +2.3$.

Core MG 60-18 series

A gravity core collected from the E side of the Tongue of the Ocean (24° 10′ N Lat, 77° 17′ W Long, water depth 1380 m). Sand layers occur at the

following depths in the core: 0-1.5 cm, 7-8 cm, 10-12 cm, 14-20 cm, 27-27.5 cm, 36.5-38 cm, 41-41.5 cm, 58-61 cm, 86-89 cm, 92-92.5 cm, and 144.5-145 cm. ML-50 and ML-51, like the paired samples ML-39 and ML-40 in MG 60-4, prove that sediment directly above a graded sand layer is older than the underlying lutite. Turbidite frequency is ca. one per 470 yr.

ML-48. MG 60-18, 1.5-6.5 cm **1520 ± 65**

Just below sand layer. Bulk $CaCO_3$; $\delta C^{13} = +2.6$.

ML-49. MG 60-18, 20-25 cm **2285 ± 65**

Just below sand layer. Bulk $CaCO_3$; $\delta C^{13} = +3.3$.

ML-50. MG 60-18, 81-86 cm **7285 ± 95**

Just above sand layer. Bulk $CaCO_3$; $\delta C^{13} = +5.1$.

ML-51. MG 60-18, 89-92 cm **4715 ± 80**

Just below sand layer and above thin sand "pocket." Bulk $CaCO_3$; $\delta C^{13} = +3.8$.

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