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YALE UNIVERSITY GEOLOGY AND GEOPHYSICS RADIOCARBON DATES I

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INTRODUCTION

A radiocarbon dating system has been established at the Department of Geology and Geophysics, Yale University. Liquid-scintillation counting of benzene described by Noakes *et al* (1965) and Polach and Stipp (1967) is used. The operation of the original Yale Radiocarbon Laboratory, based on counting CO_2 gas, was suspended in 1969. The present facility is operated as part of the geochemical laboratories of the Department of Geology and Geophysics. The operation is small, geared to solving geochemical problems, through the use of radiocarbon as a dating tool and as a natural tracer in combination with other geochemical parameters. The facility will collaborate on significant archaeologic and geologic problems. However, it will not be a facility to which samples are submitted routinely. We believe that commercial facilities and other laboratories dedicated to such kinds of operation are better suited to handling such diversity and volume of samples.

Our procedure follows those used by the authors cited, with subsequent refinements incorporated. Lithium metal pellets (American Lithium Corporation, dry pack) visually inspected to identify and remove white pellets, were used in the formation of Li_2C_2, at temperatures above 800°C. Conversion of the cooled Li_2C_2 to acetylene is effected with the slow addition of deionized water; this results in yields $> 95\%$.

An activated chromium catalyst (KC-Perlkator, Kalichemie, Hannover, West Germany) is used to trimerize the acetylene to benzene. The overall yield from CO_2 to benzene is $> 80\%$. The actual synthesis yield is higher since the yield calculation is based on measurements after liquid transfer to the counting vials.

The recovered benzene, ca 2ml, is brought up to 3ml volume by adding petroleum-derived benzene. To this is added 1 ml of scintillating solution, 0.35% PPO* and 0.01% dimethyl POPOP* in a petroleum-derived mixture of 3 parts benzene to 1 part toluene. Counting is done in a Packard Tri-Carb Model 3003 liquid-scintillation spectrometer.

Both quartz vials and low-potassium glass counting vials (Packard Instruments) were tested for blank level. As both proved the same the low-potassium glass was chosen for our work.

Counter stability is monitored by an internal hot (~ 2000cpm) ^{14}C standard. Background determined using petroleum-derived benzene (spectroscopic grade) is ca 7.5cpm. Multiple analyses of a ^{14}C-free limestone

* PPO = 2, 5, Diphenyloxazole; POPOP = p-Bis [2-(5-phenyloxazolyl)]-benzene. Both reagents from New England Nuclear.

and a contemporary coral (Table 1) show that the errors are compatible with the counting errors for each sample. The ^{14}C-free limestone data indicate that the blank due to sample preparation is negligible. The activity of 0.95 NBS oxalic acid, used as the contemporary standard, is 7.5cpm/g carbon.

The first ages measured by this method were made on deep-sea cores rich in calcium carbonate. $\delta^{13}C$ was not measured in these samples but will be measured in samples that require it.

The ^{14}C half-life of 5568 years is used in conformity with the style of the journal. The errors, in years, are 1σ counting errors which include the combined counting uncertainties of sample, background, and standard.

TABLE 1

Replicate analyses of (A) a modern coral and (B) a ^{14}C-free limestone

	Cpm per gram carbon	% Deviation from 0.95 NBS oxalic acid
A. Modern Coral		
Siderastrea siderea?	8.29 ± 0.09	$+11.3 \pm 1.1$
Discovery Bay, Jamaica	8.24 ± 0.08	$+10.7 \pm 1.1$
(5- to 6-yr old coral	8.33 ± 0.10	$+11.9 \pm 1.3$
coll live March 1973	8.28 ± 0.09	$+11.3 \pm 1.1$
from 24m depth, by R C Aller)		
B. Limestone		
Bayport Limestone (Mississippian)	0.03 ± 0.06	
Bellevue, Michigan coll by	0.06 ± 0.05	
L K Benninger	-0.01 ± 0.05	
	0.00 ± 0.04	
	0.02 ± 0.04	
	0.01 ± 0.04	

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We would like to dedicate this paper to the late Richard Foster Flint who followed the re-establishment of a radiocarbon facility at Yale again with interest, advised us on the writing of this date list, and, with his characteristic thoroughness, critiqued it after submission. His wisdom and even-handedness will be missed.

SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES

Atlantic Ocean

Mid-Atlantic Ridge, Project FAMOUS

Two cores raised by the research submersible *Alvin,* under the guidance of George Keller, in conjunction with Project FAMOUS in Sept 1974, were measured for ^{14}C to determine rates of sediment accumulation and of sediment mobility on the crest of the Mid-Atlantic Ridge.

FAMOUS 527-3 (36° 48.59′ N, 33° 15.32′ W) 2705m water depth, was 24cm long. The core is calcareous ooze with volcanic debris. The top 8cm of this core is homogenized relative to ^{14}C age because of bioturbation. A rate of accumulation of 2.9cm/1000yr is determined from the deeper parts of the core.

FAMOUS 530-4 (36° 48.54′ N, 33° 16.53′ W) 2687m water depth, was 17cm long. The core is calcareous ooze with volcanic debris. The old, probably constant, dates over the length of this core indicate that it is the result of physical disturbance. A realistic accumulation rate cannot be calculated for this core.

Ya-1.	FAMOUS 527-3: 0 to 3cm, 65.5% $CaCO_3$	2000 ± 150 50 BC
Ya-2.	FAMOUS 527-3: 3 to 6cm, 74.1% $CaCO_3$	2620 ± 100 670 BC
Ya-3.	FAMOUS 527-3: 6 to 9cm, 77.8% $CaCO_3$	2420 ± 100 470 BC
Ya-4.	FAMOUS 527-3: 9 to 12cm, 77.3% $CaCO_3$	3180 ± 110 1230 BC
Ya-5.	FAMOUS 527-3: 13 to 15cm, 74.6% $CaCO_3$	4420 ± 150 2470 BC
Ya-6.	FAMOUS 527-3: 15 to 18cm, 71.8% $CaCO_3$	4920 ± 200 2970 BC
Ya-7.	FAMOUS 527-3: 18 to 20cm, 60.8% $CaCO_3$	5990 ± 200 4040 BC
Ya-8.	FAMOUS 527-3: 20 to 23cm, 57.5% $CaCO_3$	7050 ± 180 5100 BC
Ya-9.	FAMOUS 530-4: 0 to 2cm, 53.9% $CaCO_3$	12,600 ± 1600 10,650 BC

Ya-10. FAMOUS 530-4: 4 to 6cm, 49.6% $CaCO_3$ — 16,400 ± 1100; 14,450 BC

Ya-11. FAMOUS 530-4: 8 to 10cm, 47.7% $CaCO_3$ — 17,000 ± 1500; 15,050 BC

Ya-12. FAMOUS 530-4: 14 to 17cm, 43.2% $CaCO_3$ — 18,090 ± 740; 16,140 BC

References

Noakes, J E, Kim, S M, and Stipp, J J, 1965, Chemical and counting advances in liquid scintillation age dating: 6th internatl conf radiocarbon and tritium dating Proc, Pullman, Washington, June 7-11, 1965, p 68-92.

Polach, H A and Stipp, J J, 1967, Improved synthesis technique for methane and benzene radiocarbon dating: Internatl Jour Appl Radiation & Isotopes, v 18, p 359-364.