complex condensation products of the simple precursors are supplied. While the first layer will be formed in this manner, further building up will take place by covalent and hydrogen bond formation. This can proceed rather easily since both these bonds are relatively unspecific and consequently may have greater freedom with respect to the nature and sequence of the units. This is because the entropy of adsorption onto a specific surface is very large (and negative), whereas the entropy of hydrogen and covalent bonding is much smaller.

While adsorption is a spontaneous process, the building up of the main bulk of the structure requires the supply of free energy mainly for covalent bonding. If we assume that this is effected by coupling with free energy-yielding reactions, duplication may be triggered by conditions determining these reactions which may also be rate determining.

Once the process has started at one point, wherever that point may be, it may continue along the interface in a zipper-like fashion since the building up of the material will always result in an "open" portion just in front. The supply of the complementary precursors need not be strictly synchronous. It is seen that eventually two structures are obtained, one containing "old" protein and "new" nucleic acid, and other "new" protein and "old" nucleic acid, provided that no sister strand crossing over takes place. However, the two structures are identical as far as internal surface structure is concerned. The building up of the paracrystalline "carrier" will terminate when, for example, the surface

volume ratio reaches a critical value, possibly determined by such factors as surface energy or charge density or when the supply of some critical material is exhausted. This final size, however, will be influenced by factors of the environment such as temperature, concentration, hydration, pH, and so forth. It is also possible that the composition of the bulk material could vary within limits since strict specificity requirements are operating only in the surface layer. The supply of precursors, controlled by the system as a whole, may, however, be considerably buffered, tending to produce identical structures.

We thus have a mechanism whereby a solid structure is duplicated and at the same time a replication and preservation of a specific interface takes place. We may identify this structure with the chromosome, but the diagrammatic view of Fig. 1 is not meant to imply that the interface necessarily runs along the chromosome axis, nor that it is dimensionally correct, nor, indeed, that this is the only way adsorption complexes can be organized into one structure. Variations of the model could, for example, account for "discreteness" of the genetic material in the chromosome. (Chromomeres? see also, Mazia, 15).

The special conditions described here in some detail do not necessarily apply to all structures containing genetic material nor to all variations of a changing system of which it forms a part. Thus, for instance, the evidence that in certain systems (phage, transforming principle) the nucleic acid only is transferred is not incompatible with the idea

that the participation of this material in the host's cell economy results in the same type of structure as discussed here. Neither is the principle of the duplicating mechanism restricted to desoxyribose nucleic acid as one of the participants. The evidence that the plant viruses contain ribose nucleic acid only (where one definitely does not find base pairs) should serve as a reminder that genetic mechanisms should not be looked for in the properties of particular substances but in the way the whole system is organized (16, 17).

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- A discussion of these aspects and the problems connected with meiosis, mutations, and differentiation is in preparation.
- My thanks are due to my colleagues for help-ful criticism. The basic ideas underlying the 17. present approach were developed in discus-sions with Per Oftedal during his stay in this department in 1952.

black-carbon method during 1953 which are considered reliable and those obtained by the new carbon dioxide proportional-counting method.

Techniques, Assumptions, and Errors

The carbon dioxide proportional-counting system is superior to the black-carbon method for several reasons: (i) it has virtually 100-percent counting efficiency compared to 6-percent; (ii) it is free from air-borne fission product contamination; and (iii) it can be readily adapted to samples containing as little as 0.1 gram of carbon. The use of carbon dioxide is preferred over acetylene because of the absence of explosion hazards, the possibility of going to higher pressures with a consequent increase in sample/

Lamont Natural Radiocarbon Measurements III

W. S. Broecker, J. L. Kulp, C. S. Tucek

The previously published radiocarbon measurements from this laboratory (1, 2)were made in 1950-1952 with the blackcarbon method (3, 4). Subsequent to this period, the increasing frequency of atomic tests and, later, the larger shots which produced continuous long-term fallout, caused sufficient air contamination to render the black-carbon method unreliable unless elaborate precautions

were taken and multiple runs were employed. By the end of 1953, the pioneer work of de Vries and Barendsen (5, 6) with carbon dioxide and Suess (7) with acetylene had shown that proportional gas-counting methods have some distinct advantages. A gas proportional-counting system was then designed and constructed at Lamont Observatory (8). This paper (9) reports the results obtained by the

The authors are on the staff of the Lamont Geological Observatory, Columbia University.

background ratio, the absence of fractionation during preparation, and the ease of preserving the sample after counting. The carbon dioxide proportional system was selected for routine assay over the liquid scintillation technique because of the simplicity in sample preparation, the absence of fractionation, and the ease of reproducibility of background and counting efficiency.

The new technique involves the conversion of the carbon in the sample to very pure carbon dioxide, which is then placed in a large-volume (5-liter) proportional counter at a pressure of 1 to 2 atmospheres. Three counters have been in routine operation; the characteristics of each are given in Table 1. The small counter is used for samples containing less than 1 gram of carbon.

The ages given in this paper are given in carbon-14 years on the basis of a halflife of 5568 ± 40 years. If the integrated cosmic ray flux has been constant over the past 50,000 years (10), if the samples have not been subject to field contamination, and if the proper contemporary value for each sample type is selected, the carbon-14 ages will be in actual years. There was negligible isotopic fractionation in the preparation of these samples. Fractionation in nature appears quite limited (11) and would only produce detectable effects on nearmodern samples. The relative sequence of ages is independent of the half-life used and very insensitive to changes in the cosmic ray flux.

The error quoted for the ages is a combination of errors from three sources: statistical uncertainty, background fluctuations, and variations in efficiency. In most cases, the background fluctuations were no larger than those expected from statistical fluctuation alone, but during certain periods they exceeded this, introducing somewhat larger error in the determination. These variations can be correlated with extreme atmospheric pressure changes. The variations in efficiency are for the most part much less than 1 percent. This can be checked by the use of an external gamma-ray source. Two or more measurements were made on the majority of samples reported. In a few cases where only limited accuracy was necessary, the age quoted is based on only one determination.

The errors on a given measurement are calculated as follows:

$$E_{R_{i}} = R_{i} \sqrt{\left(\frac{E_{s_{i}}}{S}\right)^{2} + \left(\frac{E_{\widetilde{M}}}{\widetilde{M}}\right)^{2}}$$

where E_{B_i} is the error in the individual ratios of sample count rate to control count rate; E_{S_i} is the error in the sample count rate; $E_{\overline{M}}$ is the error in modern control count rate; S_i is the sample Table 1. Comparison of counter characteristics (counts per minute for background and modern wood). Counters 1 and 2 have an active volume of 4.9 liters; counter 3 has an active volume of 0.5 liter.

Gaund	1 :	2 atm			
Counto No.	Back-	Modern wood			
1 2 3	15.0 12.0	29.0 30.2	17.5 14.5 3.0	58.0 60.5 5.6	

count rate; \overline{M} is the average modern control count rate; and R_i equals S_i/\overline{M} (age computed directly from this ratio)

$$E_{s_i} = \sqrt{E_{T_i}^2 + E_{B_i}^2}$$

where E_{r_i} is the error in the total count rate and E_{r_i} is the error in the background count rate.

$$E_{\overline{M}} = \sqrt{\frac{(\overline{M}_i - \overline{M})^2}{n(n-1)}}$$

where \overline{M} is control count rate.

$$E_{T_i} = \sqrt{s_T^2 + e_{S_i}^2}$$

where s_T is the statistical error in total count (1σ) and e_{s_i} is the error due to uncertainty in efficiency.

The error in the background count rate (E_{R_i}) is estimated from the scatter of background values around the mean for a given period. Rarely does it exceed a factor of 2 times the statistical error for a given background measurement.

Minimum ages are given if the average net count lies within twice the error of zero activity. Therefore, only four or five in 100 given minimum ages should fall below the stated limit.

Results

The natural radiocarbon measurements are arranged in five tables (Tables 2 to 6) for convenience. The samples are grouped according to the primary field of interest—that is, geology or archeology—and by the method used in the assay. The data for the separate study on deep-sea cores are shown in Table 6.

Some comparison and calibration data should be noted. First, in most cases the ages obtained both by the carbon dioxide method and black-carbon method agree within the experimenal error (see Table 4, samples L-219, L-125, and L-214; and Table 5, samples L-115 and L-214; and Table 5, samples L-115 and L-116A). Evidence for fission-product contamination has been detected in some cases [Table 5, sample L-195; and Suess (12), samples W-76 and W-77, which were reruns by the acetylene method of samples L-117A and L-117S (1, 2), which had been measured earlier by the black-carbon method].

The relative accuracy of the carbon-14 dates is shown again in the detailed stratigraphic suite of samples from Nazca, Peru, shown in Table 5. Several interlaboratory calibrations are available-see samples L-167A in Table 2, L-214 in Table 4, L-182 in Table 5, Suess's sample W-40 (acetylene) (7) and Lamont's sample 103B(1). Other laboratories have concurred on the Two Creeks, Wis., date at about 11,500 years before the present, and several of the European laboratories have agreed on the Gröningen Church wood standard at about 1000 years before the present (13). Some of the early Chicago black-carbon dates appear to be too high-for example, the Gröningen Church was reported to date about 2200 years before the present (14). An additional instance of this can be seen in the comparison of sample L-214 (Table 4) for which three laboratories using two different techniques agreed on a date of 5200 years before the present, while Chicago obtained 6440 years before the present (14) (see also the discussion in Table 5 on samples L-115 and L-116A).

These new data also give several comparisons of different sample materials from the same site—that is, charcoal and shell (samples L-188C, L-201A, L-188A, and L-188D in Table 3), charcoal and wood (samples L-188B and L-188E in Table 3), and fresh and decayed wood (samples L-223A and L-223B in Table 2). The agreement in all cases is within the experimental error.

It is concluded that the errors stated are a reasonable index of the reproducibility of a measurement, that with the new techniques agreement between laboratories is excellent, and that there is no evidence of contamination in any of the measurements obtained by the gas-counting methods.

Studies of ocean-sediment cores made at the Core Laboratory of the Lamont Geological Observatory indicate that the transition from the Wisconsin glacial period to post-glacial time was marked by a rather sharp climatic change throughout the Atlantic Ocean and Caribbean Sea about 11,000 years ago. The lithologic and paleontologic data and a discussion of the implication of these results will be published separately (15). The carbon-14 dates on some of these cores are given in Table 6. All measurements were made on bulk core material. A value close to that of modern wood was used as an estimate of the initial carbon-14 activity of the carbonate in the sediments. Recent measurements on ocean water samples indicate that this assumption should introduce an error of no larger than 300 years.

Table 2. Radiocarbon dates obtained on geologic samples by the black-carbon method. All ages are given in radiocarbon years before the present.

	Description	Sample No.	Age		Description	Sample No.	Age	
. North Amer	ica				and silt in exposure 3 mi east of collect-			
A. Alaska	- f				ing site of sample L-137C.			
1. Cook Inl		x 1055	450 .		Hope Junction, Kenai Peninsula.	L-237F	$6800 \pm$	55
	Cenai Peninsula. Decom-		450 ± 100	200	Basal wood from 5-ft section of alter-			
	d bark from culture layer				nating sequence of peat and organic silt overlying glacial lake silts exposed in			
	in. of loess covering floor				road cut of Anchorage Highway near			
-	On the basis of dendro- d the radiocarbon date, it				Hope Junction. Collected by T. N. V.			
	hat the site was last occu-				Karlstrom in 1953.			
	250 and 350 yr ago. Other				Ingram Creek, Kenai Peninsula.	L-237G	4500 ±	45
	ence, both botanical and				Woody peat from base of alternating			
	est that the radiocarbon				peat and silt section 5 ft thick overlying			
	too young. It is not un-				till and bedrock exposed in road cut of			
	ne sample was contami-				Anchorage Highway near head of In- gram Creek. Collected by T. N. V. Karl-			
	ger carbon, for it was col- thin the root zone of the				strom in 1953.			
	tion mat. Collected by T.				Kenai, Kenai Peninsula. Lignitized	L-137D	> 24,0	იიი
	om, U.S. Geological Sur-				log at base of 50-ft section of iron-stained	L-137D	/ 27,0	000
	on, D.C., in 1951.				and flexured gravel overlying glaciola-			
	Point, Kenai Peninsula.				custrine or -estuarine deposits, 3 mi			
•	base of 18-ft-thick organic				north of Kenai in sea bluff.			
•	117O was taken 2 ft below							
	cted by T. N. V. Karl-				2. Seward Peninsula			
rom. lood fragmer	a ta	T 169D	8650-	450	Throughout the Seward Peninsula,			
Vood fragmei 'eat.	113.	L-163B L-117O	$8650 \pm 48200 \pm 9$		organic material can be obtained from			
	Point, Kenai Peninsula.		> 25,00		muck deposits that fill valleys of minor			
	m basal outwash exposed		/ 23,00	00	streams which are commonly underlain by blue-gray silt or by an older muck			
· · · · · · · · · · · · · · · · · · ·	rth of Boulder Point. Col-				that contains fossil remains such as ele-			
	. V. Karlstrom.				phant, horse, and bison, which are con-			
	g fragments under 6 ft of	L-137K	2250 ± 3	300	spicuously absent in the dated muck.			
	l landslide debris and 8 ft				Locally, the dated muck overlies thin			
	d till near Homer. Indi-				gravel containing remains of extinct			
	er Kachemak Bay was ice-				mammals. Until recently it has not been			
	re 2250 yr ago. Collected				possible to correlate these deposits with			
	ley, Alaska Division, U.S. vey, Washington, D.C., in				any known chronology, and their origin and climatic significance have been ob-			
950.					scure. These dates, coupled with previ-			
	Kenai Peninsula. Wood	L-137L	9600 ± 6	650	ously published dates for samples L-117C			
	0-ft peat section overlying				and L-117D (2), demonstrate that the			
	ed sand and gravel resting				muck has been accumulating more or less			
	he underlying gravel is in-				steadily from more than 10,200 yr ago to			
	annel gravel deposited on				less than 450 yr ago. The contained			
	ated to the Naptowne end				plant remains suggest that the muck has			
	Tustumena Lake. Dates of peat accumulation in				accumulated during periods when open forests of birch and poplar were pres-			
° ,	Vaptowne time. Collected				ent in the valleys as well as during			
y D. B. Krins					periods, such as the present, when trees			
	ession, Kenai Peninsula.				were lacking. Samples from zones con-			
	were collected from sepa-				taining remains of large birch and pop-			
	outside the boundaries of				lar trees not present in the area today			
	glaciation (Naptowne) as				suggest warmer periods, or at least peri-			
escribed from	n the Cook Inlet area				ods with warmer summers, centered			
	Péwé et al., 16) and from				about 3600 yr ago and from 8300 to			
	nilar stratigraphic zones. eement in age is striking				9500 yr ago. Buried beaver dams indi- cate beaver activity about 3600, 8350,			
	the validity of the radio-				and 9500 yr ago in an area which is from			
	in dating geologic events.				50 to 100 mi beyond the range of mod-			
	vere collected from buried				ern beavers. Finally, the fossil fauna of			
ganic deposit	s separated from underly-				the Pleistocene appears to have become			
	stratified-to-massive blue-				extinct on Seward Peninsula much more			
•	cattered pebbles and cob-				than 10,000 yr ago.			
	to be a glaciolacustrine				Peat overlain by 8 ft of muck; upper	L-137F	2750 ± 100	35
	to the Naptowne ad-				Coffee Creek, Bendeleben B-6 Quad-			
nce. Collecte 1951.	d by T. N. V. Karlstrom				rangle. Collected by R. S. Sigafoos,			
	d deformed peat at top of	L-137C	9500 ± 6	50	Alaska Division, U.S. Geological Survey, Washington, D.C., in 1950.			
÷	rlain by 15 ft of stratified	H-13/G	5500± 0		Wood overlain by 10 ft of frozen muck;	L-1970 1	0 200 ±	01
ganic silt ove						L-137G 1	.0,200±	00
	n cliff on south shore of				lower Cottee Creek. Bendelehen B-b			
					lower Coffee Creek, Bendeleben B-6 Quadrangle. Collected by R. S. Sigafoos			

SCIENCE, VOL. 124

Description	Sample No.	Age	Description	Sample No.	Age
Wood overlain by 15 ft of muck; Candle Greek, Bendeleben D-1 Quadrangle. Collected by D. M. Hopkins, Alaska Division, U.S. Geological Survey, Wash- ington, D.C., in 1949.	L-137N	9400 ± 750	ically similar horizons—that is, L157A and L158A. Submitted by T. L. Péwé, Alaska Geology Branch, U.S. Geologi- cal Survey, College, Alaska. Dome Creek. Series of samples in		
Wood from muck at head of Black Gulch, Bendeleben C-5 Quadrangle. Collected by D. M. Hopkins in 1948.	L-117E	8800 ± 1000	perennially frozen organic silt (muck) along Dome Creek, 10 mi north of Fair- banks. The stump (L-158A, in place)		
Wood from buried beaver dam on Mud Creek, Candle D-6 Quadrangle. Col- lected by D. M. Hopkins in 1949.	L-117E	3600 ± 500	and muck (L-158B) were closely asso- ciated; the wood (L-157B) and bison hide (L-127) (2) were slightly higher stratigraphically; and sample L-163H		
3. Bristol Bay area Nushagak Bay. Peat toward base of 6-ft organic section over stratified fine	L-137J	3600 ± 400	was still higher in the section but well within the permafrost zone. Submitted by T. L. Péwé.		
and, at mouth of abandoned slough west of Dillingham. Places a ceiling on a			Wood from upright stump at bottom of section.		> 30,000
evel of the sea several feet higher than at present, tentatively correlated with the "postglacial climatic optimum." Col- ected by E. H. Muller, Alaska Division,			Muck closely associated with L-158A. Wood 2 ft stratigraphically higher than L-158A but nearby. Total exposed per- mafrost section, 40 to 50 ft.		> 30,000 > 25,000
U.S. Geological Survey, Washington, D.C., in 1951. Naknek, Alaska Peninsula. Peat in	L-137I	> 30,000	Wood occurring 40 ft below surface in muck stratigraphically 10 ft above L-158B.		> 30,000
poorly stratified blue-gray silt overlain by 35 ft of stratified sand and silt. Be- low the peat, stratified silt contains striated cobbles and overlies till exposed at Cape Suworof, $\frac{1}{2}$ mi to the east. Places a ceiling on till at Cape Suworof,	1-1371	> 30,000	Eva Creek. Series of samples in a vertical 100-ft section along Eva Creek, 10 mi west of Fairbanks. Sample L-117H $(3750 \pm 200 \text{ yr})$ (2) was taken in the permafrost zone in the same vertical section at a depth of about 8 ft. Sub-		
 mplying a pre-Wisconsin age. Collected by E. H. Muller in 1951. Cape Greig, Alaska Peninsula. Peat 	ับ 1971	12 750 + 1100	mitted by T. L. Péwé. Wood taken 30 ft below surface in frozen muck.	L-163J	> 30,000
over till and underlying 35 ft of lacus- trine sand and silt. Dates an interval of	L-13/П	$12,750 \pm 1100$	Wood from 60 ft below surface in frozen muck.	L-157A	> 23,000
peat accumulation shortly after glacia- tion of Cape Greig. Coarse sand and			Wood from stump at bottom of section (100-ft depth) in frozen silt.	L-137X	> 28,000
gravel immediately above may be related to a moraine 8 mi to the east at Pilot Point, which is considered to be of Brooks Lake equivalence (Muller, in Péwé <i>et al.</i> , 16). Collected by E. H. Muller in 1951.			Eva Bench. Fragments of wood in permafrost 9 ft below surface in tan silt, 10 mi west of Fairbanks adjacent to Eva Creek. Submitted by T. L. Péwé.		10,500 ± 50
4. Other localities Chena River. Wood from 4- to 12-in. peat bed overlain by 5 ft of gray-brown silt and 1 ft of surface peat from bluff on south bank of abandoned channel of Chena River, ¼ mi from river, at long.	L-237A	8450 ± 700	advance of the ice in the lower Fraser Valley. Submitted by J. E. Armstrong and V. K. Prest, Geological Survey of Canada.		
146°43.3′W, lat. 64°52.3′N. Collected by J. R. Williams, Alaska Division, U.S. Geological Survey, Washington, D.C.,			Small stems and rootlets from Richmix Quarry, Sumas Mountain.		$11,500 \pm 110$
in 1950. Kobuk River. Samples collected by A. T. Fernald and D. R. Nichols, Alaska Division, U.S. Geological Survey,			Wood from station 252A, Mount Leh- man Road. Vancouver Island, British Columbia. Samples taken from 40-in. peat bed in Quadra group which lies beneath 50 ft		11,000 1 90
Washington, D.C., in 1952. Free trunk from organic zone overlying ill and overlain by 35 ft of stratified silt and sand.	L-237C	24 , 400 ± 4000	of Vashon till. This sequence has been traced from intermittent exposures for a 3-mi length of the sea cliff bordering Georgia Strait. The peat-bearing beds		
Silty peat from 35-ft section of sand and intermixed organic material overlain by 75 ft of dune sand.		> 24,000	are believed to correlate with similar de- posits found throughout the Georgia Basin. Submitted by J. G. Fyles, Geologi-		
Log from 15-ft depth in terrace sand and gravel in bluff near Shungnak.		2500 ± 300	cal Survey of Canada. Wood.	L-221A	> 26,000
Fairbanks. Wood from stump in for- est bed buried under approximately 50 ft of muck in Dawson cut, 8 mi north of Fairbanks. The stump lies at the base of the muck formation that is tentatively thought by the submitter to be Wiscon- sin in age and correlates well with sam-	L-137P	> 24,000	Peat. Lethbridge, Alberta. Sample consists of wood (black spruce) contained in 4 ft of limonitic sand and gravel that is underlain by 78 ft of till. Horberg in- cluded these materials in his "Lower Till" which he tentatively assigned to		> 24,000 > 26,000

157

L-223A

L-223B

L-228

L-227

L-155

L-150A

L-150B

L-167B

consin glaciation. Submitted by A. M. Stalker, Geological Survey of Canada.

C. United States

1. West

White River, Wash. Logs imbedded in volcanic mudflow deposit originating from the northeast side of Mount Rainier, then flowing down the valley of the White River some 40 mi to the west front of the Cascade range, then some 20 mi farther west into the Puget Sound lowland. Both hard fresh wood and badly decayed wood were run to check the possible alteration in the isotopic composition. Submitted by D. R. Crandell, U.S. Geological Survey, Washington, D.C. Fresh wood.

Decayed wood.

North Fork Newaukum River, Wash. Fossil wood (fir) in stream bed of river in SW 1/4 NW 1/4 sec. 35, T14N, R1W, W. M. Abundant, well-preserved limbs and trunks of fossil trees interbedded in sandstone and conglomerate beds of the Astoria formation of Miocene age.

San Francisco, Calif. Limb of juniper or red cedar, probably Juniperus californica, obtained from the west flank of Russian Hill during the excavation of Broadway Tunnel in a crossbedded, silty to clayey sand immediately above a bed of dark gray, sandy clay. This stratigraphic unit is probably part of an unnamed sand formation that underlies the widespread dune sands of the city and the recent muds and clays deposited in San Francisco Bay and that is extensively developed in the Lake Merced-Merced Valley area. It may be correlative with the Temescal formation and Merritt sand of Pleistocene age. Submitted by M. G. Bonilla and J. Schlocker, Engineering Geology Branch, U.S. Geological Survey, Washington, D.C.

Rozel Point, Box Elder County, Utah. Sample of asphalt that is believed to be one of the youngest natural oils in existence. Submitted by J. M. Hunt, Carter Oil Company, Tulsa, Okla.

Grand County Utah. Juniper roots penetrating the McCoy group of the Thompson district. Two separate samples. Collected by Helen Cannon, U.S. Geological Survey.

Juniper roots.

Juniper roots.

Ûnaweep Canyon, Colo. Charcoal obtained from a hearth in alluvium along East Creek, Unaweep Canyon. The hearth is 6 ft below the top of the alluvium, which is believed to be correlative with the Tsegi-Calamity-Piney Creek alluvial series. Estimated age: 2500 to 3500 yr before the present. Submitted by C. B. Hunt, U.S. Geological Survey.

2. Midwest

Stump Lake, N.D. Sample from tree L-239B stump along shore in SW1/4 sec. 32, T151N, R60W, Nelson County. Collected by S. Aronow, University of Wis-

		~ 1.11		
Age	Description	Sample No.	Age	
	 consin, Water Resources Division, U.S. Geological Survey. Curtis, Neb. Charcoal from terrace on Dry Creek, NW¼ sec. 1, T7N, R26W. Collected by J. C. Brice, Washington University, for Water Resources Division, U.S. Geological Survey. White Pine, Mich. Log buried beneath 35 ft of clay, north of center of sec. 4, T50N, R42W. Collected by W. S. White, Mineral Deposits Branch, U.S. Geological Survey. 	L-239C L-239A	2200 ± 12,600 ± 1	
4800 ± 450 4950 ± 450 > 27,000	3. Mississippi Delta Mississippi Delta. Dated samples from the late Quaternary deltaic de- posits of the Mississippi can be used to interpret elevations of the sea at the time of sample deposition. The analyses of these samples provide information concerning elevations of the sea follow- ing the lowering of sea level in the late Wisconsin maximum. The detailed geol- ogy has been covered in a comprehen- sive report (17). The analysis of these			
> 27,000	dated samples indicates that 10,000 yr ago, the sea was about 100 ft lower than it is at present and that sea level was very nearly at its present level 5300 yr ago. Other geologic information (17) indicates that sea level has maintained its stand during the last 5000 yr. Sam- ples L-175D and L-175G, dated 1400 and 350 yr respectively, were laid down in depositional environments associated with standing sea level. In determining the elevation of the sea at the time each sample is deposited, it is necessary to consider the amount of postdepositional downwarping and the elevation of the environment with respect to the level of the sea at the time the sample was buried. The environments of deposi- tion of late Quaternary sediments from which these samples were taken and the amount of structural downwarping have been discussed by Fisk and McFarlan			
	 (18). Submitted by H. N. Fisk, Humble Oil and Refining Company, Houston, Tex. Marine pelecypod shells, surface, mouth of Mississippi River, Plaquemines Par- ish, La. Surface of mudlump 2000 ft off 	L-175 G	350 ±	250
< 200	North Pass. Large shells from 13-ft depth, Belle Chasse area, Plaquemines Parish Pump-		1400 ±	200
$< 200 \\ < 200 \\ 1350 \pm 200$	ing Station, T14S, R24E, sec. 89. Marine pelecypod shells from 69-ft		$5350 \pm$	500
1000 2 200	depth, same location as sample L-175D. Wood from 35- to 45-ft depth, Lake Felicity area, Terrebonne Parish, La.,	L-175F	6000 ±	550
	T20S, R20E, sec. 5. Wood from 120- to 135-ft depth, Duck Lake area, St. Martins Parish, La.,		9750 ±	550
	T15S, R11E, sec. 2. Wood from 80- to 120-ft depth, North Thibodaux area, Lafourche Parish, La.	L-175C	10,900 ±	100
	T14S, R16E, sec. 84. Marine pelecypod shells from 79- to 85-ft depth. University Place and Common	L-175A	> 30,0	000

4. East

 500 ± 400

Damariscotta, Me. Oyster shells

depth, University Place and Common

Street, Orleans Parish, La.

SCIENCE, VOL. 124

Description	Sample No.	Age		Description	Sample No.	Age
taken 1 ft above base in one of the largest shell heaps on the west bank of the Damariscotta River. Oysters are no longer abundant in this estuary, possibly				Brantley County, Ga. Organic ma- terial from soil samples from the Leon sand. Collected by R. S. Dyal and sub- mitted by L. Alexander, U.S. Depart- ment of Agriculture.		
suggesting a significant change in cli- mate. This material also afforded a test of the effects of surface contamination. The results suggest slight additions of old carbon to the bulk material, but the results are within stated errors. Collected by W. H. Bradley, U.S. Geological Sur-				Material from a depth of 17 to 20 in. Material from a depth of 88 to 133 in. South Florida. Mangrove peat from borings at the mouth of Shark River on the southwest coast. At this locality, the surface of which is covered by high tide, as much as 15 ft of autochthonous man-		1150 ± 350 23,000 ± 8000
vey. Selected, cleaned shells. Bulk material. <i>McDowell County, N.C.</i> Well-pre- served wood from North Muddy Creek at a point on the stream about 5.2 mi east of Marion, N.C., and 1.3 mi south of Nebo. This specimen is a fragment from a buried log that lies near the base		1600 ± 1900 ± 2680 ±	250	grove peat overlies a submerged rock surface. Because mangroves do not grow in water depths greater than a few feet, this occurrence of peat indicates rapid relative subsidence, and together with the evidence of still sand or uplift on the southeast coast, suggests a tilting of the Florida peninsula and submarine plateau.		
of a peaty blue-gray sandy clay at a total depth of 7 ft beneath the present surface of the flood plain. The log lies immedi- ately above a monazite-bearing gravel that forms the basal aggregate of the				The ages also suggest that tropical peats can accumulate very rapidly during sub- sidence—as much as 1 in. per 20 yr. Sub- mitted by Robert N. Ginsburg, Univer- sity of Miami.		
fluvial sediments on North Muddy Creek. The clay is overlain by 2 ft of brown sandy silt, which is overlain by 3				Peat at 35- to 50-in. depth. Peat at 84- to 94-in. depth.	L-162C L-162E	1500 ± 350 1700 ± 400
blown sandy sint, which is obtain by 5 ft of red-brown sandy silt. The log ap- pears to have been deposited at the same time as the clay. The upper 3 ft of red- brown sandy silt probably has been de- posited since farming began in Mc- Dowell County about 150 yr ago. [This sample (W-7) was also dated by Suess at 2270 ± 200 yr (12).] Submitted by W. C. Overstreet, U.S. Geological Survey.				II. Pacific Ocean Rapa Island, South Pacific Ocean. Lignite sample from Rapa Island in the Australian group, Polynesia, assigned a late Tertiary age. The isolation of this lignite and its possible young age were the reasons for the analysis. Submitted by J. M. Schopf, U.S. Geological Sur- vey.	L-150C	> 26,000

Table 3. Radiocarbon dates obtained on archeological samples by the black-carbon method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age	Description	Sample No.	Age	
I. North America			Charcoal.	L-159A	1400 ±	250
San Francisco Bay, Calif. Samples			Charcoal.	L-159B	$550 \pm$	200
from burials and midden at University			Charcoal.	L-159C	$500 \pm$	250
Village site (14-S Ma-77). On the basis			Baluchistan (Pakistan). The dating	·		
of cross-dating with the Early horizon of			of prehistoric Indian and Baluchi chro-			
the Sacramento-Delta region, this site is			nologies is still in a very early stage be-			
judged to be the earliest known evidence			cause there has been so little evidence			
of human occupation in the San Fran-			for gaging a time datum. It is known			
cisco Bay region. Estimated date 1000 to			that the Harappan cultures of the Indus			
2000 B.C. Submitted by B. Gerow, Stan-	er a		Valley were flourishing after 2200 B.c.			
ford University.			because evidence in Mesopotamian sites			
Charcoal from burials with major cul-	L-187A	2700 ± 350	of that period has been recovered. The			
tural association.	T 1077		assumption that can then be made is			
Charcoal from both burials and midden.	L-18/B	3150 ± 300	that the pre-Harappan Amri ware can			
II. Asia			probably be dated in the period between			
			2800 and 2500 B.C. In Baluchistan the			
Saudi Arabia. Three samples of char- coal from an ancient mining site in			evidence is very scanty, and dating can			
southwestern Saudi Arabia near the			be made only on the basis of comparison			
northwestern corner of the Rub al Khali.			with the Harappan period. The Baluchi			
The ages indicate that the veins were			sites stand midway between the Indus			
mined for gold during at least two peri-			Valley and Iran, and their dating would			
ods and will doubtless be of value for			be indicative of the period when the Near East was influencing India. A basis			
studies of desiccation in the Arabian			for comparison with known Mesopo-			
desert. Samples submitted by W. D.			tamian sites is necessary; C^{14} dating of			
Johnston, Jr., Foreign Geology Branch,			the Quetta sequence makes this possible.			
U.S. Geological Survey.			The Quetta Valley sequence has been			
U.S. Geological Survey.			Ine Quetta valley sequence has been			

worked out by stratigraphic excavation, and five assemblages have been defined, running from a preceramic horizon (Neolithic?) to an elaborate ceremonial and agricultural society. Each of these assemblages contains elements directly comparable to other assemblages known in Baluchistan and the Indus Valley. The preceramic culture (KGM) is of maximum importance because its dating will go far in demonstrating whether the Indian area was so peripheral to Near Eastern culture centers that it has been an area of considerable lag, or whether contacts were more frequent and development was more immediately responsive to the West. On the basis of presentday evidence, the following approximate dates have been postulated for the Indus-Quetta cultures:

Indus Valley	Quetta Valley	Date (B.C)
Harappan	Damb Sadaat III	2000
	Damb Sadaat II	2300
Amri	Damb Sadaat I	2500-2800
	KGM IV	
	KGM III	3000
	KGM II	
	KGM I	4000

L-180A

L-180B

 5300 ± 500

 4150 ± 350

The samples were selected from the stratigraphic levels in the order of sequence from preceramic to the elaborate Quetta culture in order to present a series of sequential dates. The assumption was made that if any sample was contaminated, its date would be out of line with the archeological data. The series of dates resulting is, however, valid in terms of the archeology. If this series of dates can be taken as a reliable indication of the chronology of the Indus River-Baluchistan area, it is clear that, unless considerable cultural lag is postulated, the dates determined by other means for the prehistoric village cultures of both Iran and Iraq to which there is frequent close stylistic comparison with the Baluchistan cultures particularly, must be revised down and in some cases quite considerably.

Charcoal from Kili Ghul Mohammad I site in Quetta Valley, in the base of Room I in the mound. There is no previous date for a preceramic level in the Indian area. The nearest area in which such comparable levels have been dated with reasonable accuracy is in Iraq (Jarmo). In comparison, there appears to be at least a 1000-yr lag in the Quetta area. However, since this sample is taken from the upper levels of the preceramic horizon, it is entirely possible that a date from the lowest levels (3.5 m below) may close the time gap.

Charcoal from Mian Ghundai (Damb Sadaat I) Quetta Valley, in rubble fill. The relationships of these levels to the Amri assemblages of Sind are very strong. In view of this fact and of the evidence for dating the Amri of Sind to the period prior to 2300 B.c., and more exactly to 2500 B.c., it appears that the date of 24150 B.c. is too late. In view, however, of the range allowance, it is likely that a date of 2400–2300 B.c. for

Description Sample No. the Amri of the Quetta Valley (Kechi Beg) is more fitting. Charcoal from Mian Ghundai (Damb L-180C Sadaat II) in a hearth from wall C of Room 2. The archeological evidence for contemporaneity of the Quetta culture with the Harappan civilization indicates that this date falls well within the time expectancy of that culture. Charcoal from Mian Ghundai (Damb L-180E Sadaat II) from Room 3, north wall complex. This sample belongs to the Quetta culture, as does L-180C. However, it was collected 3 m below L-180C and was separated from it by at least two floor levels. This sample is, therefore, somewhat earlier than L-180C. It is favorable to that of L-180C in stressing the date of 2000 B.C. for the Quetta culture. Hoifung, South China. Charcoal L-188C

Hoifung, South China. Charcoal from TAS site in Hong Kong area. This site is believed to belong to the very end of the Neolithic, which is characterized by the first appearance of "glaze" pottery and dark stoneware. The site is thought to be not older than 2000 B.c. or younger than 500 B.c. Submitted by H. L. Movius, Jr., Harvard University; collected by the late Father Maglioni, Catholic Mission, Hong Kong.

Hoifung, South China. Shells from L-201A coastal Neolithic site in the SOS locality. Sample seems to mark the beginning of "net" decoration, and its typical adzes seem to be ancestors of the rectangular type. Predicted age: between 2500 and 500 B.C. Conch shells growing at present in the area were used as a control. Their activity was 2 percent higher than the average value for modern wood. Collected by the late Father Maglioni and submitted by H. L. Movius, Jr.

III. Europe

Cave of La Madeleine, near Montpellier (Herault) southern France. Carbonized wheat and shells found between two stratified late Neolithic hearths associated with typical pottery of West European or Chasseyian type. The age was estimated as 2500 to 200 B.C. Collected by J. Arnal, submitted by H. L. Movius,

Jr. Carbonized wheat.

Shells (average modern wood value assumed for control).

Cave of Suquet-Coucoliere, near Montpellier (Herault), southern France. Samples associated with pottery and artifacts of early Bronze Age type found in level 3 of this site. The overlying horizon yielded materials of the early Middle Bronze Age and late Neolithic material occurred immediately below. The date was estimated as 1900 B.C. The fact that the two C14 dates agree indicates that the difference between the predicted and the C14 ages is not due to contamination either in the laboratory or in the field. Collected by P. Ponnaux and C. Ponnaux. Submitted by H. L. Movius, Jr. Charcoal. Wood.

L-188C 2950 ± 400

Age

 4050 ± 400

 4050 ± 350

 $201A \quad 3100 \pm 150$

L-188A 4200 ± 500 L-188D 4700 ± 400

L-188B L-188E	1700 ± 1750 ±	
SCIEN	ICE, VOL	. 124

Table 4. Radiocarbon dates obtained on geologic samples by the carbon dioxide method. All ages are given in radiocarbon years before the present.

A Attach and Canada United Without Section 2. Submitted by Boston University Physical Research Laboratories. Attack 1, 2 to 4.6 ft from surface, in L-277D 5600 ± 170 Habre search during the control of birch pollen zone. Attack 1, 2 to 4.6 ft from surface, in L-277D 5600 ± 170 Habre search during the control of birch pollen zone. Attack 1, 2 to 4.6 ft from surface, in L-277D 5600 ± 170 Habre search during the control of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger at top 0 direct bottom of birch pollen zone. In this surger top 0 direct bottom of birch pollen zone. In this surger top 0 direct bottom of birch pollen zone. In this surger top 0 direct bottom of birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In this surger top 0 direct birch pollen zone. In thi	Description	Sample No	. Age		Description	Sample No.	Age
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nd woody material taken in small val- grading the second structure of the se	A. Alaska and Canada						
$ \begin{aligned} y_1 ht. 6i^2 223, long. 152^2 10^{\circ} W, 3 mi \\ exc arch 4 long arch 4 U mish. Pollea analyse have east carrelated with peat from the harder Lake are 30 mi to south which we have have have have have have have hav$							
drift of Umint' Poline analyse' haveeen correlated with peat from thehandler Lake area 90 mi to south. $J=1251 > 39.0$ $drift and the target of t$							
cerr correlated with gear from is outh, handler Lake area 90 mi to south, ubmitted by Boston University Physi- al Research Lake Mich pollen zone. Alterial 4.2 to 4.6 ft from surface, in laterial 4.4 to 4.6 ft from surface, in laterial 4.4 to 4.5 ft from surface, in laterial 4.2 to 250 ft from surface; <i>L</i> -277D 580 ± 170 sar bottom of hirch pollen zone. <i>James Bar, Quebe,</i> Peat from hor- lappis and to 250 ft from surface; <i>L</i> -278B 800 ± 270 sin peat zone. <i>James Bar, Quebe,</i> Peat from hor- sin evel of a long near Small, 173 it above milevel of a long near Small, 173 it above y the black carbon method at 2350 ± 200 the Wisconsin glacitation. This sample statement of James Bar, 173 it above y the black carbon method at 2350 ± 200 the Submitted by H. N. Fisk. <i>Submitted by J. E. Pottger,</i> Butter problem was to define whether these ce- tracts were moders in origin or merely states were moders in origin or merely states were moders in origin or merely to this laboratory. State in mediately southying blue char rates. <i>With States</i> and the uphase of stati- rates. <i>Submitted by J. E. Pottger,</i> Butter problem was to define whether these ce- tracts were moders in origin or merely states were moders in origin to state samples are inpad to the composed at least in per origin or moder in origin were internation to a local states were aborts of states states were inform in the local states states were inform in the local states states were internation in the local states states were inform in the local states states were inform in the local states states were inform in the local states states were intere						T 195T	> 20.000
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Jaccrial 42016.2775809170this tree grew in place, it must have lived after the sea level was lowered to at least this extent during the onset of the Wisconin glaciaton.Jacrial 42.00.215.0 ft from surface, it. 22777539 ± 150the sea level was lowered to at least this extent during the onset of the Wisconin glaciaton.James By, Qubse, Peat from hoto- large By, Qubse, Peat from hoto- method accupation by forests as previously dated at this laboratory which has been subjected to the dating procedure in this laboratory.2430 ± 100James By, Qubse, Peat from hoto- large By, Qubse, Peat form hoto- ming of the upland occupation by forests as previously dated at this laboratory. which has been subjected to the dating procedure in this laboratory. Sample 243B is the smallest sample which has been subjected to the dating procedure in this laboratory. The total mersity of Montreal.Juried State Must Lake, Wath. Samples of sedi- entrary part from bog located in 535, 220N, RT about 3.5 milet at 511 contant at depth of 21.75 ft below trace. Covington, Wath. Samples of sedi- entrary substring books layer of hovin collicity, Samples of sedi- entrary best from bog located in 535, 1200 ± 2001.269A11,000 ± 200 total state 1200 ± 200Covington, Wath. Samples of sedi- entrary sed from bog located in sa55, 220N, RTak. antary part from bog located bootty at at adepth of 32.57 below trace. Covington, Wath. Sample of sedi- stratary part from bog located bootty at at adepth of 32.57 below wrfac.1.269A11,000 ± 200 total state from savely. Covington, Wath. Samples of sedi- stratary part from bog located in sas56, total state from bog located boo							
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Larrie 200 to 215 it from surfaces. Learner bottom of brich pollen near surfaces. is no or of horebaceous pollen below sain pare toway. James Bay, 715 it above sain pare toway. Inter and accuration by forest in stample dates the begin ments in two Wiscomis Lakes. These samples are hydrocarbon extracts from recent sedi- ments in two Wiscomis Lakes. These sample 243B us the sample dates the begin ments in two Wiscomis Lakes. These sample dates the begin ments in two Wiscomis Lakes. These sample are hold an older the sca. It wiscomis Lakes. These samples are hydrocarbon extracts from recent sedi- ments in two Wiscomis Lakes. These sample 243B us the sample date of the lating procedure in this laboratory. The total weight of carbon is sample was to define whether these ea- tracts were modern in ongin or merely sample 243B is the sample are hydrocarbon extracts from recent sedi- ments in the sen subjected to the dating procedure in this laboratory. The total weight of carbon is sample was to define whether these ea- tracts were modern in ongin or merely sample 243B was 0.225 g. Despite the large error, the sample date of 13 fr from bog urface. Coving(on Mark, Samples of sedi- entare date date of 13 fr theover tracts were multion in S2, 7122, 728, RE. ubmitted by G. B. Rigg and H. R. L-269D 10,200 \pm 500 the bog urface. This sam and and gravel i the adding date date of 13 fr theover at an depth of 13 fr theover the date of the sea. I L-269D 10,200 \pm 500 the bog urface. This sam and and gravel i the bottom of his 27. The sea of the se		L-277D	J090 1	170			
arear journ of hirch pollen zone. L-2778 13002 270 distrain 24.0 to 25.0 ft from surface; L-2778 12002 270 arear large, Quebe, Pear from bot- large and pear conception performs the sea. L-219 2430 ± 100 James Bay, Quebe, Pear from bot- large and pear conception performs the sea. L-219 2430 ± 100 Large and pear conception performs the sea. L-219 2430 ± 100 Large and pear conception pear conception pear conception and pear conception currants in two Wisconsin Lakes. The problem was to define whether these ex- tracts were modern in origin or merearly containation by old hydrocarbons. as previously dated at this laboratory the blackster Hear and the problem was to define whether these ex- tracts were modern in origin or merearly containation by old hydrocarbons. All United States Description the laboratory. Samples are judged to be composed at least in part of recently formed hydro- carbon submitted by G. B. Rigg and H. R. containmediately one pear million. Sample run was hydro- carbon curract. 2-243A 5250 ± 100 Could, University of Markey above failed at the form bog stated on the carter. L-243B 1800 ± 1000 ± 1000 per contain and per contains with and perform bog stated on the carter. L-243B 1800 ± 1000 ± 1000 per contains and perform bog state on the carter. Could, University of Washington. L-269D 11,900 ± 1000 ± 100 per (100 by S. 200 yr (100 by S. 200 yr (100 by S. 200 yr		1-277C	7530 +	150			
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is in zone of herbaccous pollen below and per section method as older than 30,000 yr. Submitted by H. N. File. Submitted		L-277B	8300 +	270			
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James Bay, Quebec, Peat from bot network JulisL-219 $2430 \pm$ 100Wisconsin Lakes. These samples are hydrocarbon extracts from recent sedi- ments in two Wisconsin Lakes. The problem was to define whether these ex- tracts were modern in origin on merely containation by oil bydrocarbons. Sample 243B is the smallest sample which has been subjected to the dating procedure in this laboratory. The total wright of carbon in sample 243B was 0.025 g. Despite the large error, the sample dats the large error, the sample dats the day of 14 if from bog urface. Could, University of Wahington. Leages Tomob 12.75 ft below wright out at depth of 14.75 ft below wright out a depth of 12.75 ft below wright out at depth of 14.75 ft below wright out a depth of 14.75 ft below wright out at depth of 14.75 ft below wright out at depth of 14.75 ft below wright out a depth of 14.55 ft below wright out about a depth of 14.55 ft below wright out a depth of 14.55 ft below wr							
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bly pre-Wisconsin. Submitted by P. C.compressed peat, perforated by pholads, contained in the purpura haemastoma, s. sp. Consul Beach, at from -12 to -26 m of Torre Del Lago. Peat contains the remains of a forest of Pinus dominating						T 040	10.050
Drr, Santa Barbara Museum of Naturalcontained in the purpura haemastoma, s. sp. Consul Beach, at from -12 to -26 m of Torre Del Lago. Peat contains the remains of a forest of Pinus dominating						L-246	$18,350 \pm 4$
Istory, Santa Barbara, Calif.s. sp. Consul Beach, at from -12 to -26Central California Coast. Rock-bor- ng mollusks that once lived in the sur-L-285> 37,000model control c							
Central California Coast. Rock-bor- L-285 > 37,000 m of Torre Del Lago. Peat contains the remains of a forest of Pinus dominating							
ng mollusks that once lived in the sur- remains of a forest of <i>Pinus</i> dominating		T 005	< 07 0	00			
		L- 285	> 37,0	UU			
aut of a wayt-out platform. this plat-							
on nows, need, and Dennia, the inguest	face of a wave-cut platform; this plat-				on Abies, Picea, and Betula, the highest		

Description	Sample No	o. Age	Description	Sample No.	Age	
forest formation of the present Alps.			shore areas which yield climatological			
Presumably Epi-Wurm II or Epi-			information bearing on the origin and			
Wurm III stage of the last glaciation			history of arctic ice shelves. The lack			
20). Collected and submitted by A. C.			of any source area within several hun-			
Blanc, Istituto Italiano Di Paleontologia			dred miles indicates that the wood prob-			
Jmana, Rome, Italy.			ably drifted to its present location on			
II Basifa Oscar			the shore. Samples numbered 254 may indicate times when the shelf was ab-			
II. Pacific Ocean Raroia Atoll. Samples bearing on			sent; however, a moat between the shelf			
sustatic or local fluctuation in the South			and the shore has been reported (22)			
Pacific Ocean. It is concluded that			that might allow access even during the			
Raroia coral atoll had attained roughly			presence of a shelf. The L-266 series was			
he present form and dimensions by a			submitted by Hattersley-Smith; the			
late 2500 yr ago. Subsequently, eleva-			L-261, L-254, L-248, and L-284 series			
ion of 15 to 20 cm or eustatic drop in			were submitted by A. P. Crary, Air			
ea level by this amount resulted in onset			Force Cambridge Research Center,			
of considerable erosion of the reef mar-			Cambridge, Mass.			
in by storms and upgrowth of islands			Wood from hill immediately east of	L-266A	> 25,0	000
y deposition of the coarse rubble of			Sanding Lake, Prince Patrick Island.			
orals. These changes seem to have oc-			Collected by E. T. Tozer.	I OCCD	> 22 (001
urred about 2000 yr ago. Collected by J. Newell, Columbia University.			Wood from 6 mi north of Salmon Point, Intrepid Inlet, Prince Patrick Island.	T-700B	> 33,0	500
ragment of reef thrown up on erosion	L-258A	2680 ± 90	Collected by E. T. Tozer.			
emnant of old reef flat, presumably by a	ц- 238А	2000 ± 90	Wood from top of gravelly ridge about	L-266C	> 33,0	00
surricane. The date of the limestone of			10 mi inland from Canyon Fiord. Col-	~ 2000	,	50
his block provides a rough maximum			lected by P. F. Bruggeman.			
ate by which the atoll had reached its			Large fragment of spruce believed to	L-261A	980 ±	1
resent form and a maximum date for			be drift wood found near Richardson			
ne elevated reef platform on which the			Depot Point. Collected by A. P. Crary.			
lock rests.			Small fragment of spruce from Depot	L-261B	$2190 \pm$	1
Iumic soil from a depth of 4 to 5 ft	L-258B	900 ± 130	Island in Markham Inlet. Collected by			
hich corresponds closely to the time			A. P. Crary.	• • • • • •		
f change from fine to coarse sedimen-			Small fragments of tamarack from	L-261C	6050 ±	2
ation. The sample is thought to be in-			Sheridan River terrace. Collected by			
icative of the maximum age of the			A. P. Crary. Samples of driftwood from the northern	T-254A	3400 ±	1
rincipal island of the atoll. This hori- on overlies coarse gravel probably			shore of Ellesmere Island behind the	L-254B	$5740 \pm$	
quivalent in age to the reef block of			present ice shelf. Collected by A. P.		$6120 \pm$	
ample L-258A.			Crary.	L-254D	3000 ±	
lieces of coral separated from the	⁻ L-258C	1740 ± 230	,	L-248A	7200 ±	
umic soil of sample 258B.			Ward Hunt Island. Shells from			
-			raised beach (140 ft) on Ward Hunt			
V. Soil studies			Island, a small piece of land projecting			
This group of samples was submitted			through the ice shelf on the northern			
y the Soil Survey, Soil Conservation			shore of Ellesmere Island.			
ervice, U.S. Department of Agriculture,			McClintock Bay. Shells from raised	L-248B	7200 ±	2
eltsville, Md. (21)			beach near glacier face.	H-210D	1200 -	-
odzol from Bennekom, Netherlands	L-251A	940 ± 20		- 004	100 .	
B_{21} horizon, 15 to 20 cm)	T 051D	010 . 100	Ward Hunt Island. Sponges on the	L-28 4	400 ±	1
resco-Kenyon intergrade from Howard	L-251B	210 ± 130	surface of ice shelf near west end of			
ounty, Iowa, 300 ft west and 150 ft orth of SE corner NE1/4 sec. 33,			island. May have been trapped by sea			
100N, R13W (A_{11} horizon, 0 to 4 in.).			ice below shelf and subsequently have been brought to surface through melting.			
resco-Kenyon intergrade from Howard	L-251C	< 100	Collected by A. P. Crary.			
ounty, Iowa, 300 ft west and 150 ft	L-25 1C	< 100	T-3 Ice Island. Samples were chosen			
orth of SE corner NE $1/4$ sec. 33, T100			in order to determine the origins of an			
, R13W (A_{12} horizon, 4 to 8 in.).			11- by 5-mi ice island floating in the			
dina silt loam, near NW corner,	L-251D	410 ± 100	Arctic Ocean. The significance of the			
W1/4 sec. 10, T68N, R21W, Wayne			dates obtained has been discussed in a			
ounty, Iowa $(A_1 horizon, 0 to 6 in.)$			separate publication (22). Submitted by			
dina silt loam, near NW corner,	L-251E	840 ± 200	A. P. Crary.			
W1/4sec. 10, T68N, R21W (A ₂ hori-			Surface dirt in bottom of drainage lake.	L-192B	5730 ±	3
on, 8 to 12 in.).			Represents a combination of all dirt lay-			
larion, A11, 0 to 6 in., Pocahontas	L-256A	440 ± 120	ers with possibility that much of the top			
ounty, Iowa.	T A -	0.40	material had been washed away.		4-0	~
ebster, A ₁₁ , 0 to 6 in., Pocahontas	L-256B	270 ± 120	Surface grass and debris. Represents top	L-192E	450 ±	2
ounty, Iowa.	TOFOR	050 . 105	layer in area of much floral material but			
arnes loan, 0 to 4 in., Cavalier	L-256D	350 ± 120	may not be representative of organic			
			matter in top dirt layer.			
ounty, N. D.	I 9560	2000 ± 2000		I_912D	3050 -	0
ounty, N. D.	L-256C	30,000 ± 8000	Bottom layer of dirt near outcrop. Un-	L-213D	3050 ±	20
	L-256C	30,000 ± 8000		L-213D	3050 ±	2

SCIENCE, VOL. 124

Table 5. Radiocarbon dates obtained on archeological samples by the carbon dioxide method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age		Description	Sample No.	Age	
I. North America Apponaug, R.I. Oyster shells used as a roof to protect grave food offering by		800 ±	90	cient Nazca sites collected in 1952–53 (25). Submitted by W. D. Strong, Co- lumbia University.		000	50
early Indians. Possibly marks the tran- sition between first- and second-period pottery making in New England. Sub- mitted by W. S. Foular, New England				Site N-1 (Estaqueria)—Strata Cut I (catalog No. 134) from burned end of stake at 0.65-m level; charcoal. Huaca del Loro phase, Fusional Epoch.		900 ±	70
mitted by W. S. Fowler, Narragansett Archeological Society of Rhode Island. <i>Poverty Point, La.</i> This site (NE1/4 of NE1/4 sec. 19, T19N, R10E, West				Site NTu-8 (Huaca del Loro); Temple Fill from first floor of round temple structure (catalog No. 104); charcoal. Huaca del Loro phase, Fusional Epoch.		970 ±	70
Carrol Parish) represents the end of the Eastern Archaic Stage and the beginning of the Burial Mound Building Stage. It is the same cultural complex as the Laboratory site in Ministeriori (22) dotted				Site NTu-8 (Huaca del Loro); Whale Bone Room (catalog No. 103); char- coal. Huaca del Loro phase, Fusional Epoch.	· ·	1200 ±	80
Jaketown site in Mississippi (23) dated by the black-carbon method (1) as 2350 ± 200 yr. These archeological sites provide an excellent opportunity for charling the characters after				Section of post removed from small mound at the intersection of lines in the San Jose Pampa; wood. Middle Nazca phase, Florescent Epoch.		1430 ±	80
checking the chronology of stream chan- nel positions in the alluvial valley of the Mississippi River which was worked out by H. N. Fisk (24). The cultural de- posits at Jaketown were made on an				Site N-4 (Cahuachi); Strata Cut I-SW, 3.00- to 3.25-m level (catalog No. 192) from fireplace in southwest face of cut) charcoal. Proto-Nazca phase, Formative Epoch 1.	;	1460 ±	80
island in the active channel of the Ohio River of Fisk's C-1 stage. The Poverty Point village appears to have been es- tablished beside the Mississippi River Channel of C-1 stage and the site par-				Site N-4 (Cahuachi); Strata Cut 7, 4.00- to 4.25-m level (catalog No. 311); char- coal. Proto-Nazca phase, Formative Epoch.	•	1630 ±	80
tially destroyed by an Arkansas River Channel of stage H. Submitted by J. A. Ford, American Museum of Natural History.				Site N-4 (Cahuachi); Strata Cut I, 3.50- to 3.75-m level (catalog No. 139); charcoal. Late Paracas phase, Forma- tive Epoch.	;	1710 ±	80
Charcoal from fireplace 18 in below surface in Midden Area, trench A. Charcoal from extensive layer exposed beneath southern portion of mound B	L- 272	2860 ± 2660 ±	90 80	Site N-4 (Cahuachi); Strata Cut I, 3.75- to 4.00-m level (catalog No. 140); charcoal. Late Paracas phase, Forma- tive Epoch.	;	1840 ±	80
antedating the construction of this part of the mound. Winnemucca Lake, Nev. Juniper roots and stalks taken from lowest oc- cupation level in wave-cut Fishbone cave 250 ft above the floor of dry Lake Winnemucca, which was once a part of pluvial Lake Lahonton. The climatic conditions in this desert region per- mitted the preservation of perishable materials not ordinarily found in such old archeological sites. Excellent speci- mens of basketry, netting, wooden tools, along with bones of horse, camel, and man are found in the lower levels of the cave. Clear evidence of human occupa- tion occurs in the lower level, which was dated by this sample. The site was occupied by man very shortly after the lake waters fell below the cave floor. Submitted by P. C. Orr, Western Speleo- logical Institute. Santa Rosa Island, Calif. Abalone shells taken from upper part of trun- cated alluvial fan on coast of Santa Rosa Island. Their presence in this type deposit 50 ft above the present sea level indicates that man occupied this alluvial fan during at least the late stages of its formation. Submitted by P. C. Orr, Santa Barbara Museum of Natural His- tory, Santa Barbara, Calif.	L-245 L-257	11,200 ± 6820 ±		Paracas, Peru. Prehistoric cottom cloth, mummy 114 (Bundle B 1946–14, American Museum of Natural History) Paracas Necropolis Period, Peru. This specimen is of the same age as Libby's sample 271 (14) which gave $2257 \pm$ 200 yr. Previously dated at Lamont by black-carbon method as 1700 ± 200 yr. (1). This figure would place the Necrop- olis phase of Paracas as contemporary with such important ceramic types as W. D. Strong's incised, slip-painted early Nazca and the Cavernas negative ware. Neither of these has been reported from Necropolis graves. Although perplexing, this observation does not rule out the acceptance of the 1750 \pm 100 yr figure, and by some would be taken as support- ing evidence. Submitted by Junius Bird, American Museum of Natural History. Huaca Prieta, Chicama Valley, Peru. Charcoal from two separate samples of firepit at bottom of Test 2, the oldest surviving portion of this midden. Its age should indicate the start of the prece- ramic, agricultural culture which ulti- mately produced this midden. Previously dated by the black-carbon method at the Lamont Observatory at 3650 ± 400 yr and by the University of Chicago (sam- ple C-598, at 4298 ± 230 yr (14). Col- lected by C. Larco; submitted by Junius Bird.		1750 ±	90
II. South America Nazca, Peru. Key horizons from an-				Bird. Charcoal. Charcoal.	L-116A L-116B	3780 ± 3860 ±	

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I)e	scri	nti	nn	

Sample No. Age

Amazon Basin. These samples represent an attempt to date pottery from the small organic content which is present in the binding material. The prehistoric ceramics in the Amazon basin were made with the aid of burned bark of the Caraipe tree and/or fresh water sponges as tempering agent. The samples were gathered in two sites of so-called "black earth" on the floodplain at the confluence of Negro and Solimoes (Amazon) rivers in the upper layer (30-cm depth). In addition to defining an age for the ceramics, the samples would date the minimum time since the alluvial deposits were layed down by the Parana do Careiro as it shifted to its present course. This knowledge is of practical value in assessing the degree of permanency of the alluvial stream pattern downstream from Manaus. The dates were calculated on the basis of the assumption that the organic matter was dominantly plant matter, probably caraipe bark, although there was evidence of sponge spicules. The organic matter from living sponges in the same area give a specific activity only 70 percent of that of normal modern wood. Thus the ages are maximal and would be lowered in proportion to the ratio of sponge-plant contribution to the tempering material. The samples were collected by H. O'Reilly Sternberg, Centro de Pesquisas de Geografia do Brasil, who, in the course of his investigation of the geomorphology of this area, conceived the idea of using the tempering agent of the sherds as a carbon source. The project was supported by a grant from the Conselho Nacional de Pesquisas, of Brazil.

Rims and decorated sherds from Fazenda "Bom Successo.' Sherds from Fazenda "Alencorne."

L-198A

L-198C

L-182

L-271A

2050 ± 120

 1100 ± 130

 9500 ± 200

 7200 ± 230

> 35,000

III. Asia

Hotu Man, Iran. Charcoal from hearth under and associated with Hotu skeletons No. 2 and No. 3. The University of Pennsylvania laboratory obtained an age of 9190 ± 590 yr on same material by black-carbon method (26). Submitted by C. S. Coon, University of Pennsylvania.

IV. Africa

Khanguet-el-Mouhaad (Department L-240B of Constantine), Algeria. This site is important in that it is the first Upper Capsian site in which human remains have been found to be dated by the C14 method. The burial is being studied by L. Cabot Briggs at the Bardo Museum in Algiers. Charcoal was found associated with the skeleton at depth of 90 to 100 cm below the surface of midden deposit. Collected by M. Jean Morel of Bone. Submitted by H. L. Movius, Jr.

Kalambo Falls, Northern Rhodesia. Wood from tree trunk found in Lower Paleolithic site. Presumably this horizon belongs to the very end of the third Interpluvial (Kanjeran-Gamblian) or the very beginning of the Gamblian Pluvial Period-that is, of third interglacial or early fourth glacial age. Excavated by J. D. Clark, Rhodes-Livingstone Museum,

Description

Livingstone, Northern Rhodesia. Submitted by H. L. Movius, Jr.

Florisbad, near Bloemfontein, Orange Free State. The Florisbad Skull (Homo or Africanthropus helmei) was discovered in association with many stone implements and fossil bones of numerous extinct species of animals in the lowest of three peat layers at this site. Samples from the three layers were measured by Libby (14), who obtained the following ages: (i) sample C-850, Peat layer No. I, older than 41,000 yr; sample C-851 Peat layer No. II, 9104 ± 420 yr; sample C-852 Peat layer No. III, 6700 ± 500 yr. A. C. Hoffman, director of the National Museum in Bloemfontein, who collected these samples, felt that the date for the middle peat (Peat II; sample L-271-C) was definitely too low, since remains of extinct animals were found in association with it. Further investigation revealed that this layer had been penetrated by the roots of gum trees, and, accordingly, a whole new set of carefully collected and cleaned specimens was chosen. Submitted by H. L. Movius, Jr.

Peat layer No. I	L-271B	> 35,000
Peat layer No. II	L-271C	$28,450 \pm 2200$
Peat layer No. III	L-271D	$19,530 \pm 650$

V. Pacific Ocean

Masbate Island, Philippines. Char- L-274 coal from depth of 12 to 18 in. in a "late Neolithic" dry cave site. Date tests H. O. Beyer's prehistoric sequence for Northern Malaysia. Collected by W. G. Solheim, II, University of Arizona. Submitted by H. C. Conklin, Columbia University.

Murray Valley, South Australia. These two samples provide the basis for the archeological sequence in all of Australia. Shells of living mollusks collected in the Tartanga Lagoon on the Murray River were used as modern control for these samples and were found to be approximately 1 percent greater than our modern wood standard. Collected by N. B. Tindale, South Australian Museum, Adelaide. Submitted by H. L. Movius, Jr. Large Unio protovittatus shells from Layer C at the Tartanga site referred to as Mid-Recent and believed to have been occupied prior to the deposition of the 10-ft terrace of the River Murray. Possibly as old as 9000 yr. Layer C represents approximately the midpoint in the sequence at this site. Tindale estimates that the earliest occupation (Layer A) may go back as a minimum to 8000 years before the present. Shells from Layer IX at Devon Downs L-271G which provide a figure for the middle stage in the development of the Pirrian culture, of which Devon Downs is the type site. There is no geologic basis for dating this horizon, although it is believed to be younger than the time of formation of the 10-ft terrace of the Murray and hence as old as 4500 years before the present. In any case, at the time Devon Downs was occupied, the climate in South Australia was definitely more moist than it is at present.

0 0

 2710 ± 100

 6030 ± 120 L-271E

4290 ± 140

SCIENCE, VOL. 124

Table 6. Radiocarbon dates obtained on Atlantic deep-sea cores by the carbon dioxide method. All ages are given in radiocarbon years before the present.

Description	Sample No	. Age		Description	Sample No.	Age	
Core A-180-74. Collected from 3330-m depth at lat. 0°03'S; long. 24°10'W. Core consisted of uniform foraminiferal lutite with no obvious evi- dence of turbidity currents, erosion,				ing or turbidity currents. The normal sediment consists of lutite. Depth 218 to 228 cm <i>Core A179-15</i> . Taken at 3110-m depth at lat. 24°48'N, long. 75°55'W	L-279A	1 0, 860 ±	18
slumping, or reworked older sediments. The excellent agreement in lithology between this core and three others taken on a 400-km traverse across the mid- Atlantic ridge in the equatorial region ndicates that this core represents an undisturbed and uninterrupted record of sedimentation.				off Eleuthera Island, Bahamas, from a steep slope. Core consisted mainly of calcilutite with a layer of calcareous silt near the base of the section. Depth 94 to 99 cm Depth 110 to 113 cm <i>Core A180-48.</i> Taken from Fosse de Cayar submarine canyon in the conti-	L-279B L-279E	7600 ± 10,700 ±	
Depth 0 to 5 cm Depth 18 to 21 cm Depth 38 to 41 cm Depth 57 to 64 cm Depth 77 to 83 cm Depth 97 to 103 cm Depth 114 to 125 cm <i>Core R10-10.</i> Collected from 4755-m	L-295A L-295B L-295C L-295D L-295E L-295F L-295G	$3630 \pm 11,260 \pm 15,000 \pm 18,910 \pm 23,000 \pm 26,700 \pm 37,500 \pm$	460 500 680 1100 1800	nental shelf near Dakar, French West Africa, at a depth of 1450 m at lat. 15°19'N, long. 18°06'W. The core was taken from canyon wall 100 fathoms above the canyon floor. Material con- sists of dark green clay very uniform throughout except for silt partings and lenses.			
depth at lat. 41°24'N, long. 40°06'W. Core consisted of lutite taken from basin east of the Mid-Ocean Canyon in New- foundland Basin. The lower part of the core contains some glacial marine de- posits. The date of the material in the				Depth 190 to 210 cm Depth 440 to 455 cm Depth 490 to 510 cm <i>Core A164-62</i> . Taken at lat. 39°45'N, long. 68°53'W at 2270-m depth. The upper 250 cm of the core consists of	L-279D	10,480 ± 11,380 ± 15,300 ±	390
first 7 cm in the core is somewhat older than expected. Whether this is due to mixing of the top of the core in collec- tion, inclusion of carbonate from preex- tising sediments, or loss of the top of the core in collection is not clear. Depth 0 to 7 cm Depth 35 to 39 cm	L-212G L-212H	4160 ± 4360 ±		graded micaceous glauconitic gray sand. Below the sand, the deposition appears to be normal and the purpose of the measurement was to determine the ex- tent of erosion at the time of sand depo- sition. The date indicates that at most, only a small amount of post-Wisconsin sediment was removed.			
Depth 50 to 50 cm Depth 90 to 100 cm Depth 90 to 100 cm Depth 112 to 120 cm Depth 120 to 125 cm Depth 165 to 175 cm Depth 255 to 275 cm <i>Core A179-8.</i> Taken at 4060-m depth at lat. 20°28'N, long. 72°49'W, northwest of the Island of Hispaniola on the Caicos-Hispaniola abyssal plain. The core contains numerous layers of	L-212H L-202 L-212A L-212C L-212D L-212F L-212E	4300 ± 8100 ± 10,680 ± 10,550 ± 11,800 ± 15,820 ± 20,300 ±	120 180 420 480 600	bepth 468 to 488 cm Core A180-1. Taken at 5120-m depth at lat. 39°07'N, long. 54°32'W. The upper 130 cm of the core consists of sands that were probably deposited by the Grand Bank's earthquake turbidity current of 1929 (27, 28). The age of 5200 yr indicates that there was only limited erosion at the time of the sand deposition and confirms recency of the event.	L-279C	6990 ±	140
calcareous sand probably due to slump-				Depth 140 to 170 cm	L-212B	5130 ±	13

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- Is Lamont Geological Observatory contribution No. 197.
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A man who has committed a mistake and doesn't correct it is committing another mistake.—Confucius.