VOLUME 23 / NUMBER 1/ 1981

Radiocarbon

Published by THE AMERICAN JOURNAL OF SCIENCE

Kline Geology Laboratory
versity
en, Connecticut 06511

ISSN: 0033-8222

EDITORIAL STATEMENT TO CONTRIBUTORS

Since its inception, the basic purpose of Radiocarbon has been the publication of compilations of ^{14}C dates produced by various laboratories. These lists are extremely useful for the dissemination of basic ^{14}C information.

In recent years, Radiocarbon has also been publishing technical and interpretative articles on all aspects of ^{14}C. The editors and readers agree that this expansion is broadening the scope of the Journal. Last year, the editors published the Proceedings of the Tenth International Radiocarbon Conference that was held at Bern and Heidelberg, August 19-26,1979. Volume 22, Nos. 2 and 3, 1980 contained these proceedings. Volume 22 may be purchased at $80.00 for institutions and $60.00 for individuals. The special publications may also be ordered separately at $60.00. Volume 23, 1981 returns to its usual format of three numbers per volume.

As a result of publishing the proceedings, another section is added to our regular issues, "Notes and Comments". Authors are invited to extend discussions or raise pertinent questions to the results of scientific investigations that have appeared on our pages. The section includes short, technical notes to relay information concerning innovative sample preparation procedures. Laboratories may also seek assistance in technical aspects of radiocarbon dating.

All correspondence, manuscripts and orders should be sent to the Managing Editor, Radiocarbon, Kline Geology Laboratory, Yale University, 210 Whitney Ave, PO Box 6666, New Haven, Connecticut 06511.

The Editors

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1981

ANU RADIOCARBON DATE LIST VIII

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AUSTRALIAN GREAT BARRIER REEF EXPEDITION

The aims of the 1973 Great Barrier Reef Expedition's radiocarbon dating programs were: 1) to collect live specimens from various reef environments to serve as modern reference standards, 2) to evaluate suitability of materials from drilling, geomorphic, and sediment programs for dating purposes, and 3) to date appropriate samples related to those programs. Radiometric ages provide a time scale for evolution of reefs and reef islands, and the history of sea level in the area.

While a massive rise in level of sea (>100m) since the maximum of the last glaciation is universally accepted, there is little agreement as to when this transgressing sea first reached its present position in the Holocene, and directions and magnitudes of sea level change since that time; there is even conflict as to whether the most recent significant change has been a fall or rise in sea level. Detailed local studies, using a range of well controlled sea level criteria and dates, are required if Holocene time-sea level curves are to be accepted with any degree of confidence. Because reef areas possess an array of present and paleo-sea-level markers together with abundant datable materials they are particularly appropriate sites for investigating recent sea level changes. Nevertheless, serious problems in identifying changes based on reef data exist, although they are not always readily acknowledged. During the Royal Society – University of Queensland Expedition to North Great Barrier Reef in 1973 we became particularly conscious of both the utility of reef data and problems associated with its interpretation. This list presents evidence for a recent sea level history by utilizing data solely obtained from Expedition without recourse to earlier commentaries on this or adjacent areas of the Great Barrier Reef (Hopley, 1978), nor to sea level histories from other regions.

As part of the same Expedition an investigation of stratigraphy of several reef islands using shallow coring techniques was planned. Logistical difficulties limited drilling to two sites, Bewick (14° 26′ S, 144° 40′ E)

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and Stapleton Is (14° 19′ S, 144° 51′ E). The primary objective at these sites was to test the hypothesis that islands in this part of Great Barrier Reef have been formed by incremental addition of reef sediment during successive Quaternary marine transgressions. For this purpose drill performance was recorded in detail and all pieces of core were megascopically described.

Samples were obtained from various reef environments within 5° lat range between Raine (11° 36° S) and Low Is (16° 23′ S) on North Great Barrier Reef. However, nearly 90% of samples were coll within 1° band between Stapleton Island (14° 19′ S) and Three Isles (15° 07′ S).

1) *Live specimens.* Although a wide variety of corals and mollusks was collected dating was restricted to *Halimeda,* a calcified green algae growing on reef flats of many islands. Both organic carbon fraction (living plant tissue) and inorganic carbonate plates have been dated (ANU-1272A & B, ANU-1273A & B, Bewick Reef).

2) *Fossils, rocks, and sediments.* Limestone rocks included beach rocks, and various categories of rampart rocks varying from loosely cemented bassett edges, through more firmly cemented lower platform rocks to tough, firmly lithified rocks of higher platform. With rampart rocks, ages were desired on both skeletal materials and some cements. Where massive corals and tridacnids were present, they were cut out or broken from the matrix and prepared and examined by microscope.

Separation of smaller branching corals and mollusks from the cementing matrix, and removal and isolation of cement from within coral pores, proved much more difficult. Tiny slabs of coral and cement were cut and examined microscopically, and contaminants (either coral or cement) removed by saw and/or dentist's drill. Examination of thin sections of these samples suggests that it is unlikely that all contamination was removed, and therefore ages, notably ANU-1208 (coral), ANU-1380 (coral), ANU-1381 (matrix), ANU-1601 (matrix), ANU-1602 (matrix) must be interpreted accordingly.

Only three beach rocks were dated. Two contained *Tridacna* valves (ANU-1386, -1591) on the surface, which were prized out, cut, and examined in the usual manner. The third (ANU-1596) was a bulk sample; thin-section examination indicated the presence of acicular aragonite cement. In this case, no attempt was made to separate allochems and cement. Dated samples from limestone rocks included 6 corals, 12 *Tridacnids,* 4 matrix cements, and 1 bulk calcarenite.

Samples of loose sediments from individual horizons and sediment units contained three types: sand (17 samples), coral fragments (4 samples), and mud (1 sample). Cay sands were sieved at 0.5F intervals and a split of total detritus falling between medium to very coarse sand (2 to −1F units) was submitted for bulk age determination. Thin-section examination indicated a variety of skeletal constituents, mainly Foraminifera, *Halimeda,* other calcareous algae, and molluscan and coral fragments, the proportion of each constituent varying between samples.

In a number of instances secondary material was present in intraskeletal voids and chambers, but not in sufficient quantities to affect significantly validity of ages.

Four samples of sandy-gravels from the reef islands were dated. Between 5 and 15 stick coral fragments in −1 to −4F size range were selected from each sample and physically cleaned of surface contaminants. Interior void sediment and borehole linings were not removed; but such contaminants were estimated to compose less than 3% of total sample mass.

3) *Drill cores.* The drilling program yielded both consolidated and unconsolidated material suitable for dating. For drilling technique and sampling method, see Thom (1978). Sample size was limited by 35.5mm internal diam core barrel and highly variable lithologies with depth. Quantity of material submitted for dating was barely adequate, inhibiting further treatment (Thom, Orme, and Polach, 1978).

Selection of samples, based on stratigraphic and geomorphologic criteria and physical pretreatment was carried out by the collector in consultation with the ANU Radiocarbon Laboratory and samples dated as submitted, without further physical or chemical pretreatment.

Ages are reported as *conventional radiocarbon ages* BP (Olsson, 1970, p 17) using, however, the *ANU Sucrose* contemporary radiocarbon dating standard (Polach, 1979; Currie and Polach, 1980) as a frequent cross check of our 0.95 NBS Oxalic value. The *conventional radiocarbon ages* BP are corrected for isotopic fractionation based on either an estimated $d^{13}C$ value (Polach, 1976; Stuiver and Polach, 1977) with an uncertainty of estimate never smaller than ± 2‰, or measured $d^{13}C$ value with an error of measurement never larger than ± 0.2‰. The $d^{13}C$ values are expressed wrt to PDB; the error of estimate or measurement is incorporated in the age ± error calculation. The calculations, presentation, and annotations follow the suggestions made by Stuiver and Polach (1977). Thus, $D^{14}C$ is the relative difference between the ^{13}C corrected sample activity (count rate) and the measured and ^{13}C corrected oxalic acid activity (count rate). The *conventional radiocarbon age* (t) is, thus, defined as

$$t = -8033 \ln \left(1 + \frac{D^{14}C}{1000} \right)$$

All $d^{13}C$ measurements are estimated 0.0 ± 2.0‰ except where noted. Samples were submitted by Dept Biogeography and Geomorphology, Australian National University.

ACKNOWLEDGMENTS

We wish to acknowledge the support of J Golson, Head, Department of Prehistory, RSPacS, who is administratively responsible for the ANU Radiocarbon Dating Research Laboratory. The excellent work of the laboratory's senior staff, John Head and John Gower, made this report possible.

SAMPLE DESCRIPTIONS

Samples are listed on island-by-island basis starting from Raine Island in N to Low Isles in S.

Raine Island

ANU-1591. **$D^{14}C = -136.4 \pm 7.0‰$** **1180 ± 70**

Tridacna shell from surface of beach rock near beacon at E end of Raine I. (11° 35′ S, 144° 02′ E). Beach rock overlain by guano rock. Coll by D Hopley.

Fisher Island

ANU-1640. **$D^{14}C = -544.3 \pm 5.1‰$** **6310 ± 90**

Tridacna shell resting on fossil micro-atolls in growth position at base of cemented coral shingle platform on S side Fisher I. (12° 15′ S, 143° 14′ E). From 0.6m below platform surface. Coll by D Hopley.

Stainer Reef

ANU-1639. **$D^{14}C = -462.1 \pm 5.5‰$** **4980 ± 80**

ANU-1639R. **$D^{14}C = -460.6 \pm 5.2‰$** **4960 ± 80**

Coral (*Favites abdita*) from area of fossil micro-atolls in growth position which emerge 5cm above sandy reef flat, some 250m ESE of Stainer sand cay (13° 57′ S, 143° 50′ E). ANU-1639R is repeat determination of same specimen. Coll by D Hopley.

Stapleton Reef series

ANU-1663. **$D^{14}C = -322.6 \pm 6.5‰$** **3130 ± 80**

ANU-1664. **$D^{14}C = -325.3 \pm 7.7‰$** **3160 ± 90**

ANU-1721. **$D^{14}C = -480.3 \pm 8.5‰$** **5260 ± 130**

Drill core series (14° 20′ S, 144° 50′ E); ANU-1663 coll from depth 8.5m below hwst and consists of loose calcareous sand. ANU-1664 is reef calcarenite coral fragment from ca 10m below hwst. ANU-1721 is unidentified coral fragment (possibly *Galaxa* sp) from 13m below hwst. Coll by B G Thom.

ANU-1555. **$D^{14}C = -332.0 \pm 6.1‰$** **3240 ± 70**

Moderately well sorted clean coarse calcareous sand. Bulk sample from depth of 55 to 80cm beneath grassy surface of 2.3m high sand cliff exposure on S side of Stapleton cay ca 100m from W end. Coll by R McLean.

Bewick Reef series

ANU-1387. **$D^{14}C = -307.0 \pm 6.5‰$** **2950 ± 80**

Moderately sorted medium-sized calcareous sand. Bulk sample of partly weathered creamy-brown sand from soil pit horizon 25 to 40cm beneath grassy surface on E slope of E-most ridge on Bewick (14° 28′ S,

144° 47′ E) sand cay, ca 25m W of cay-mangrove margin. Coll by R McLean.

ANU-1559. **$D^{14}C = -420.0 \pm 5.7‰$** **4380 ± 80**

Moderately sorted medium-sized calcareous sand. Bulk sample of grayish weathered sand from depth 15cm beneath surface at crest of W-most ridge on Bewick sand cay. Ca 25m SE of drill hole site. Coll by R McLean.

ANU-1386. **$D^{14}C = -223.5 \pm 6.9‰$** **2030 ± 70**

Tridacna shell from surface of high beach rock outcropping on N shore of Bewick sand cay close to drill site. Base of tridacnid valve was lightly cemented to beach rock surface on which was growing *Sesuvium* and algae. Beach rock outcropping fronted by mangroves and backed by sandy slope covered with grasses and *Pemphis*. Coll by R McLean.

ANU-1280. **$D^{14}C = -977.1 \pm 3.1‰$** **>30,350 ± 1150**

Fine-grained calcarenite.

ANU-1281. **$D^{14}C = -986.2 \pm 3.7‰$** **>34,400 $^{+2500}_{-1900}$**

Coral fragment.

ANU-1282. **$D^{14}C = -990.4 \pm 2.3‰$** **>37,300 $^{+2200}_{-1700}$**

Coral and coralline algae fragment.

ANU-1283. **$D^{14}C = -560.6 \pm 6.8‰$** **6610 ± 130**

Coral *(Porites?)* fragment.

ANU-1284. **$D^{14}C = -577.3 \pm 6.9‰$** **6920 ± 130**

Coral fragment.

ANU-1395. **$D^{14}C = -547.8 \pm 6.5‰$** **6380 ± 120**

Coral fragment. Drill core series: samples ANU-1280 to -1282 recovered below disconformity in drill core, as indicated by recrystallization of biomicrite (ANU-1280) and corals (ANU-1281, -1282) to low magnesium calcite. ^{14}C results must be considered *minimum ages* only. Samples ANU-1283, -1284, and -1395 are aragonite rich coral fragments (possibly *Porites* sp). ANU-1283 recovered from below disconformity. Sample's location believed to be result of cave-in during drilling. Disconformity occurs at ca 4m below lwst, with ANU-1395 located at contact. Coll by B G Thom. *Comment*: nine samples recovered from shallow coring on Bewick and Stapleton were dated. ANU-1283, -1284, and -1395 were non-crystallized corals with high aragonite content. ANU-1281 and -1282 were clearly recrystallized samples in which primary aragonite of coral specimens had been converted to calcite. Similar modification is suggested by low Mg calcite content of biomicrite (ANU-

1280). Only three dates were obtained from Stapelton core. Two of these were on samples of high aragonite content, while one, a reef calcarenite fragment possibly containing coralline algae, had a high magnesium calcite content (ANU-1664). Other samples were coral fragments (ANU-1721) and loose carbonate sand (ANU-1663).

ANU-1272A. **$D^{14}C = +129.2 \pm 7.7‰$** **>Modern**
Est $d^{13}C = -4.0 \pm 2.0‰$

Halimeda, green algae, inorganic carbonate fraction.

ANU-1272B. **$D^{14}C = +173.1 \pm 8.5‰$** **>Modern**
Est $d^{13}C = -24.0 \pm 2.0‰$

Organic carbon fraction of ANU-1272A. Dilution, 49% sample.

ANU-1273A. **$D^{14}C = +122.1 \pm 6.6‰$** **>Modern**
Est $d^{13}C = -4.0 \pm 2.0‰$

Halimeda, green algae, inorganic carbonate fraction.

ANU-1273B. **$D^{14}C = +115.3 \pm 8.4‰$** **>Modern**
Est $d^{13}C = -24.0 \pm 2.0‰$

Organic carbon fraction of ANU-1273B. Dilution, 47% sample. *Comment*: contemporary environmental check: 2 samples of calcium carbonate secreting algae (ANU-1272, -1273) coll to check contemporary ocean bicarbonate ^{14}C levels. Results indicate predictable increase in ^{14}C activity due to atom bomb testing (Gillespie and Polach, 1979). Coll by H A Polach.

ANU-1385. **$D^{14}C = -77.0 \pm 7.6‰$** **640 ± 70**

Coral *(Platygyra)* from loosely cemented coral shingle deposit with bassett edge — lower platform morphology on NE Bewick reefs, traverse no. 1. Outcropping 100m landward of reef edge, between inner edge of reef flat and 1.5m high scarp of high platform which forms seaward side of gravel cay. Coll by R McLean.

ANU-1208. **$D^{14}C = -297.5 \pm 6.2‰$** **2840 ± 70**

Coral.

ANU-1609. **$D^{14}C = -224.2 \pm 6.9‰$** **2040 ± 70**

Tridacna. ANU-1208 and ANU-1609 from strongly cemented rampart rock of high platform 20m SW ANU-1385 on traverse no. 1, NE part of gravel cay on Bewick reef, firmly embedded in corroded platform surface. Coll by R McLean.

ANU-1608. **$D^{14}C = -90.1 \pm 7.2‰$** **760 ± 65**

Tridacna shell from surface of innermost of 3 shingle ramparts on traverse no. 2, E side of Bewick reef. Sample exposed on grassy slope abutting mangrove swamp 100m W of gravel cay's active beach. Coll by R McLean.

Ingram-Beanley Reef series

ANU-1393. **$D^{14}C = -76.5 \pm 7.6‰$** **640 ± 70**

ANU-1394. **$D^{14}C = -415.3 \pm 6.8‰$** **4310 ± 100**

Coral *(Porites)* from separate reef blocks of boulder tract on N side of reef (14° 25′ S, 144° 55′ E), 300m NE Ingram I. ANU-1393 coll from largest single coral head 2.2m above reef flat level, 80m from reef edge. ANU-1394 from innermost coral head, 1.5m high, in sandy reef flat 130m from reef edge. Coll by R McLean.

ANU-1642. **$D^{14}C = -335.3 \pm 6.3‰$** **3280 ± 80**

Calcareous sand.

ANU-1410. **$D^{14}C = -331.2 \pm 6.3‰$** **3230 ± 80**

Calcareous sand. Both bulk samples of moderately well sorted sand from 2 to 5cm beneath cay surface. ANU-1642 at 50m from beachline in center of low cuspate promontory on W side of Ingram I. ANU-1410 from highest part of cay, 120m NW of SE end. Coll by R McLean.

Watson Island series

ANU-1389. **$D^{14}C = -61.3 \pm 7.9‰$** **510 ± 70**

Tridacna shell.

ANU-1390. **$D^{14}C = -95.5 \pm 7.5‰$** **810 ± 70**

Coral favid.

ANU-1391. **$D^{14}C = -175.4 \pm 7.1‰$** **1550 ± 70**

Tridacna shell.

ANU-1392. **$D^{14}C = -168.2 \pm 7.2‰$** **1480 ± 70**

Tridacna shell. Samples taken from outer rampart to innermost fossil ridge across SE end of Watson, a coral shingle island (14° 29′ S, 144° 56′ E). All samples from loose surface shingle; ANU-1389 from highest part of contemporary outer rampart; ANU-1390 from top of lower platform; ANU-1391 and -1392 from penultimate and innermost ridges, respectively, on N side of island proper abutting mangrove swamp. Coll by R McLean.

Howick Cay

ANU-1605. **$D^{14}C = -260.2 \pm 6.7‰$** **2420 ± 70**

Coral *(Diploastrea heliopora)* from series of massive coral heads cemented into high calcarenite platform on SW corner of Howick Cay (14° 30′ S, 144° 57′ E). Coll by R McLean.

Houghton Reef series

ANU-1287. **$D^{14}C = -517.4 \pm 9.9‰$** **5850 ± 170**

Faviid coral head from area of fossil micro-atolls in mangrove swamp N central part of reef, 220m S reef edge, 400m E sand cay (14° 32′ S, 144° 58 E). Coll by R McLean.

ANU-1595. **$D^{14}C = -339.4 \pm 6.1‰$** **3330 ± 80**

Faviid coral head beneath calcarenite at juncture of reef flat and rocky scarp. Coll by McLean.

ANU-1596. **$D^{14}C = -282.6 \pm 6.3‰$** **2670 ± 70**

Calcarenite bulk sample containing calcareous sand and cement. Coll by R McLean.

ANU-1413. **$D^{14}C = -357.4 \pm 6.1‰$** **3550 ± 80**

Tridacna shell from 20cm thick cemented stick coral layer overlying calcarenite. Coll by H A Polach. Last three samples form vertical sequence in high calcarenite platform at W end sand cay.

Coquet Island

ANU-1411. **$D^{14}C = -125.2 \pm 6.1‰$** **1070 ± 60**

Tridacna shell from surface of highest part of broad shingle ridge 80m SE of navigation light on main cay (14° 32′ S, 145° 00′ E). Coll by R McLean.

Leggatt Reef series

ANU-1556. **$D^{14}C = -251.9 \pm 6.5‰$** **2330 ± 70**

Moderately sorted coarse calcareous sand. Bulk sample from surface of high flat (14° 33 S, 144° 51′ E) in center of sand cay. Coll by R McLean.

ANU-1286. **$D^{14}C = -514.0 \pm 7.6‰$** **5800 ± 130**

Tridacna shell in growth position among high micro-atoll field exposed in area of fallen mangrove immediately E of sand cay and S of sand pit. Coll by R McLean.

Hampton Reef

ANU-1207. **$D^{14}C = -454.7 \pm 4.7‰$** **4870 ± 70**

Faviid coral in growth position from area of high micro-atolls (14° 33′ S, 144° 52′ E) covered by *Rhizophora* mangroves and mangrove mud. Coll by B G Thom.

East Pethebridge Island

ANU-1384. **$D^{14}C = -255.9 \pm 6.7‰$** **2370 ± 70**

Faviid coral in growth position area of high micro-atolls (14° 45′ S, 145° 05′ E) in gap between cemented shingle platforms at SW end of island. Coll by R McLean.

Turtle Island series

ANU-1597. **$D^{14}C = -266.0 \pm 6.5‰$** **2480 ± 70**

ANU-1598. **$D^{14}C = -291.0 \pm 6.9‰$** **2760 ± 80**

Calcareous sandy-gravel from soil Pit 1 on lower terrace NW side of island (14° 44′ S, 145° 13′ E) 25m S of beach line. Bulk samples;

ANU-1597 at depth 25 to 35cm, ANU-1598 at depth 85 to 100cm. Coll by R McLean.

ANU-1388. **$D^{14}C = -338.6 \pm 6.3‰$** **3320 ± 80**

Coral *(Acropora)* fragments from soil Pit 2 on high shingle ridge 25m S of Pit 1. Sample from depth 40 to 55cm. Coll by R McLean.

ANU-1477. **$D^{14}C = -162.6 \pm 7.6‰$** **1430 ± 70**

ANU-1478. **$D^{14}C = -423.3 \pm 6.3‰$** **4420 ± 90**

Tridacna shells from separate outcroppings of cemented rampart rock between mangrove swamp and moat on SW part of reef. ANU-1477 from outer platform 10cm below upper level of cementation. ANU-1478 from inner platform 24cm below surface. Coll by D Hopley.

ANU-1480A. **$D^{14}C = -128.4 \pm 8.4‰$** **1100 ± 80**
Est $d^{13}C = -24.0 \pm 2.0‰$

Fibrous mud.

ANU-1480B. **$D^{14}C = -240.9 \pm 15.4‰$** **2210 ± 170**
Est $d^{13}C = -24.0 \pm 2.0‰$

Organic sediment.

ANU-1479. **$D^{14}C = -457.0 \pm 6.1‰$** **4910 ± 90**

Coral *(Cyphastrea)*. Samples from shallow bore hole in small enclosed depression between two old coral shingle ridges at SE end of main island. Depression is occupied by living mangroves and floored by 0.6m thick deposit of black fibrous mud which overlies at least 0.3m of coral shingle. ANU-1480, fibrous mud, separated into two fractions: 1480A, coarse fibers, rootlets and bark retained of sieve meshes 10F and 25F; and 1480B, fine gray clayey sediment which passed through 44F mesh and contained black organics but not fibers. ANU-1479 from shingle containing corals and shells beneath mangrove mud horizon. Coll by D Hopley and A Bloom.

Nymph Island series

ANU-1285. **$D^{14}C = -368.9 \pm 6.8‰$** **3700 ± 90**

Faviid coral in growth position from high micro-atoll field exposed in drainage outlet to large pool in SW portion of island (14° 38′ S, 145° 15′ E). Coll by R McLean.

ANU-1592. **$D^{14}C = -346.3 \pm 6.0‰$** **3420 ± 75**

Tridacna shell.

ANU-1383. **$D^{14}C = -356.0 \pm 6.2‰$** **3540 ± 80**

Tridacna shell.

ANU-1602. **$D^{14}C = -253.7 \pm 6.5‰$** **2350 ± 70**

Calcitic cement. Samples from high platform of cemented rampart rock 100m SE of pond outlet in SW part of reef. ANU-1592 from

cemented stick shingle layer at top of platform. Coll by D Hopley. ANU-1383 firmly embedded in rock, 0.5m from base of scarp. ANU-1602 from 30cm beneath platform surface. Coll by R McLean.

ANU-1476. **$D^{14}C = -62.5 \pm 8.1‰$** **520 ± 70**

Tridacna shell from cemented lower platform at SE end of small shingle island on SW part of reef. Sample embedded in rock 15cm below upper surface of platform. Coll by D Hopley.

Eagle Reef

ANU-1560. **$D^{14}C = -307.8 \pm 6.3‰$** **2960 ± 70**

Well sorted calcareous sand. Bulk sample from main sand ridge (14° 25′ S, 145° 23′ E) in center of N side of cay, 50m from beach. Coll by R McLean.

Two Isles series

ANU-1558. **$D^{14}C = -384.5 \pm 6.0‰$** **3900 ± 80**

Well sorted calcareous sand. Bulk sample from depth of 45 to 60cm in soil pit beneath forest on backslope of high sand ridge (15° 03′ S, 145° 27′ E) 60m from beach in N central part of main cay. Coll by R McLean.

ANU-1871. **$D^{14}C = -56.4 \pm 7.5‰$** **470 ± 60**

Coral (*Porites*) micro-atoll in growth position excavated from 30cm beneath reef flat surface in center of reef close to degraded bassett edge. Coll by T Scoffin. Unpub date of 1978 to check age of reef flat formation and truncated bassett edge.

Low Wooded Island series

ANU-1594. **$D^{14}C = -95.0 \pm 7.2‰$** **800 ± 60**

Coral (*Porites* cf *lobata*) micro-atoll in growth position at junction of inner edge of contemporary shingle rampart and moat 190m SE of aeroplane wreckage at W end of island (15° 06 S, 145° 25′ E). Coll by R McLean.

ANU-1603. **$D^{14}C = -530.8 \pm 5.4‰$** **6080 ± 90**

Coral (*Platygyra lamellina*) micro-atoll passing beneath lower cemented shingle platform at junction with moat in S central part of island. Coll by D Hopley.

ANU-1604. **$D^{14}C = -338.9 \pm 6.1‰$** **3320 ± 70**

Tridacna shell from surface of high cemented platform outcropping at SW end of enclosed pool 80m W of beach on E side of island. Coll by R McLean.

Three Isles series

ANU-1641. **$D^{14}C = -238.4 \pm 6.7‰$** **2190 ± 70**

Moderately well-sorted coarse calcareous sand. Bulk sample from 20cm depth in soil pit on lower terrace, 75m W of beacon at W end of sand cay. Coll by R McLean.

ANU-1554. **$D^{14}C = -364.5 \pm 6.0‰$** **3640 ± 70**

Well-sorted coarse calcareous sand. Bulk sample from 60cm depth in soil pit in shallow basin in high ridge 40m E of beacon at W end of cay. Coll by R McLean.

ANU-1553. **$D^{14}C = -340.6 \pm 6.2‰$** **3350 ± 80**

ANU-1414. **$D^{14}C = -330.2 \pm 6.2‰$** **3220 ± 80**

Well-sorted coarse calcareous sand from 2 horizons exposed in 2.5m high cliff at E end of cay. Bulk samples at 43 to 68cm (ANU-1553) and 100 to 160cm (ANU-1414) below top of cliff. Coll by R McLean.

ANU-1475. **$D^{14}C = -166.2 \pm 7.4‰$** **1460 ± 70**

Tridacna shell cemented 20cm beneath surface of lower platform at exposed edge above moat on SE side of Third Island. Coll by D Hopley.

ANU-1380. **$D^{14}C = -373.1 \pm 8.6‰$** **3750 ± 110**

ANU-1381. **$D^{14}C = -245.4 \pm 7.6‰$** **2260 ± 80**

ANU-1382. **$D^{14}C = -316.0 \pm 5.6‰$** **3050 ± 70**

Sequence from high rampart rock platform outcropping in central E part of mangrove-shingle cay. ANU-1380, coral *Pavona* firmly cemented in basal facies of platform. Dilution, 47% sample. ANU-1381, calcitic matrix surrounding ANU-1380. ANU-1382, *Tridacna* shell from loosely cemented coral shingle veneer, 20cm thick, on upper surface of high platform. Coll by R McLean.

East Hope Island series

ANU-1412. **$D^{14}C = -313.2 \pm 6.3‰$** **3020 ± 70**

ANU-1643. **$D^{14}C = -310.8 \pm 6.4‰$** **2990 ± 80**

Moderately well-sorted coarse calcareous sand. Bulk samples, ANU-1412 from 79 to 86cm horizon in soil Pit 1 on highest ridge in center of cay (15° 45′ S, 145° 28′ E), and ANU-1643 from 30cm depth in Pit 3 on low sand terrace, 15m from beach line at E end of cay. Coll by R McLean.

West Hope Island series

ANU-1599. **$D^{14}C = -140.0 \pm 7.4‰$** **1210 ± 70**

Coral *(Acropora)* fragments from 40cm beneath surface of E-most ridge in shingle ridge sequence found on NE side of island (15° 45′ S, 145° 27′ E). Coll by R McLean.

ANU-1600. **$D^{14}C = -99.9 \pm 7.5‰$** **(?)>850 ± 70**

Coral *(Acropora)* fragments from surface of highest shingle ridge in sequence 75m from E beach and 25m from mangrove swamp to W. Sample possessed large quantity of post-mortem contaminants. Coll by R McLean.

Pickersgill Cay

ANU-1606. **$D^{14}C = -252.2 \pm 6.7‰$** **2330 ± 70**

Well-sorted coarse calcareous sand. Bulk sample from top of unvegetated sand bank (15° 52′ S, 145° 33′ E). Coll by R McLean.

Low Isles series

ANU-1607A. **$D^{14}C = -88.0 \pm 7.5‰$** **740 ± 70**

ANU-1607B. **$D^{14}C = -67.4 \pm 12.2‰$** **560 ± 110**

ANU-1601. **$D^{14}C = -46.5 \pm 9.7‰$** **380 ± 80**

Samples from cemented coral shingle deposit forming bassett edges on inner edge of reef flat 250m NW of Green Ant I. on E side of reef (16° 24′ S, 145° 33′ E). ANU-1607A, coral *(Acropora)*. ANU-1607B, dilution, 41% sample, and ANU-1601 were high magnesium calcite matrix. Coll by R McLean.

ANU-1593. **$D^{14}C = -95.1 \pm 7.2‰$** **800 ± 70**

Tridacna shell from surface of inner shingle rampart at S end of mangrove-shingle island on E side of reef. Coll by R McLean.

ANU-1557. **$D^{14}C = -272.0 \pm 6.4‰$** **2550 ± 70**

Moderately sorted very coarse calcareous sand. Bulk sample from sand cay surface 75m W of Lighthouse. Coll by R McLean.

General Comment: radiometric ages and measured or estimated elevs of concordant coral colonies provide indisputable evidence that sea level in N region of Great Barrier Reef first reached its approx present position ca 6000 yr BP. Dated materials of this age from four different reefs which cover some 3° lat indicate spatial extent of evidence and likelihood that similarly aged materials could be preserved on other reefs in region. Levels of extensive Houghton and Leggatt micro-atoll fields relative to living reef flat and moated corals suggest that by 5800 yr BP the sea had passed above its present level. The possibility of moating at these two central reef sites at such an early stage of development of reef-top features is considerably less than would be likely later on. Stainer and Hampton corals also indicate that sea level was above present level 1000 yr later (4900 BP) while those from Three Isles and Nymph suggest that highest level for which we have evidence, in excess of 1m, was attained ca 3700 yr BP. Dates of transported clasts from cemented shingle ramparts of equivalent ages at these 2 sites illustrate that fossil *in situ* corals could have been in moated situations. Surface level of fossil micro-atoll field at East Pethebridge is 0.6m above measured living reef flat corals, but this could also have been a moated situation. But age of 2370 ± 70 yr BP (ANU-1384) indicates that sea level was then close to or marginally above present level. Subsequent course of sea level and time of its return to present level is not well documented although by 2300 yr BP it was near present level. Also important is that reefs and superficial reef-top deposits, at least on some reefs in area, have had up to 6 millennia in which to evolve and adjust to sea level around present

position. Even if some corals were moated and reflect locally perched water levels, these fundamental conclusions are not affected.

The drilling program resulted in 2 drill holes which gave some data on development of reef island complexes in N Great Barrier Reef Province in late Quaternary. Bewick I. hole suggested presence of several discontinuities in the subsurface where 8 lithologic units were identified, separated in 3 instances by facies transitions and in 4 other cases by disconformities, the uppermost of which was confirmed by several lines of evidence, including ^{14}C dates, and clearly separated Holocene from late Pleistocene sediments. The Bewick core also showed marked changes in environmental conditions in time, upper part containing sediments deposited under relatively high energy conditions.

The observed degree of contamination on validity of ^{14}C ages cannot be quantified. Mineralogic and microscopic examination suggests that the great bulk of skeletal, rock, and sediment sample ages are valid. Of samples listed it is believed that of surface samples, only ANU-1600 gives an unreliable age, although some others should be used with caution. Drill core dates beyond 30,000 yr BP on recrystallized material should be considered as min ages only. The last interglacial (ca 120,000 yr BP) is a more likely age for coral growth (Thom, Orme, and Polach, 1978), but until unrecrystallized corals can be found, this assumption cannot be tested, eg, by uranium series dating.

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[RADIOCARBON, VOL 23, No. 1, 1981, P 14-23]

BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS XII

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The following list consists entirely of dates for archaeologic samples from the British Isles, mainly measured over the period from May 1979 to June 1980[1]. The dates were obtained by liquid scintillation counting of benzene using the laboratory procedures outlined in previous lists (see, eg, BM-VIII, R, 1976, v 18, p 16).

The dates are expressed in radiocarbon years relative to AD 1950 based on the Libby half-life for ^{14}C of 5570 yr, and are corrected for isotopic fractionation ($\delta^{13}C$ values are relative to PDB). No corrections have been made for natural ^{14}C variations. The modern reference standard is NBS oxalic acid. Errors quoted with the dates are based on counting statistics alone and are equivalent to $\pm$ 1 standard deviation ($\pm 1\sigma$).

Descriptions, comments, and references to publications are based on information supplied by the persons who submitted the samples.

The results published here represent the first stage of a research program devoted to the British Bronze age, initiated in 1979. This program derived from a growing awareness that traditional chronologic schemes were coming increasingly under attack, and that the existing framework provided by radiocarbon dates was insufficient as it was of sporadic coverage and depended heavily upon single determinations. At the same time, renewed activity in the excavation of settlement sites provided an ideal opportunity for the collection of multiple stratified samples.

The criteria adopted for selection of samples for the program were as follows:

1. Multiple samples chosen from recent excavations to demonstrate stratified sequences; where possible two or more samples from the same context were dated for added confidence (eg, Aldermaston Wharf, Billingborough Fen).

2. Smaller series, in some instances only single samples, chosen from secure contexts to fill lacunae or develop regional sequences (eg, Barling, Handley Barrow 24).

3. Emphasis laid throughout on security of context and nature of sample in relation to processes of site formation. Material that could be

[1] Dates obtained over the same period for other, unrelated, samples will form a separate list, BM-XIV.

related to a specific event was preferred to that from only a generalized context.

4. Preference given to samples associated with distinctive artifact assemblages.

There are few surprises in this date list in light of evolving concepts of British Bronze age chronology. Perhaps the most significant result is evidence for distinct regional processes. This can be seen most clearly in the later part of the period where contiguous zones of the Thames Valley and the Wessex chalk uplands stand in sharp contrast. In the latter area, settlements and cemeteries with Deverel-Rimbury wares continue well into the 1st millennium bc[2], whilst in the former, this tradition was evidently replaced by an innovative and sharply contrasting series of pottery styles before that time (*cf* Handley Barrow 24, Knight's Farm). Comparable evidence for other areas is as yet only hinted at, but clearly one focus of attention for further dating must be finer resolution of the pattern of regional specialization.

From the results listed here it is evident that replacement of "traditional" chronologic methods (typology and closed associations) by a framework for the British Bronze age based on radiocarbon dates would be premature. The determinations from several settlement sites, notably the Holne Moor sequence (BM-1607, -1608, -1610, -1611, -1612), suggest that even when dates form a cluster this is likely to bracket two centuries or so and that finer chronology must continue to depend, for the time being at least, on observed stratigraphies.

ACKNOWLEDGMENTS

I K thanks J Barrett, R Bradley, I H Longworth, and S Needham for informative discussions.

SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

A. British Isles

Billingborough Fen, Lincolnshire

Charcoal samples from Bronze age settlement (Chowne, 1978) at Billingborough Fen, Sleaford, Lincolnshire, England (52° 55′ N, 0° 20′ W, Natl Grid Ref TF 126334). Coll 1977-1978 and subm by P Chowne, S Lincs Archaeol Unit.

BM-1410. Billingborough Fen **3150 ± 60** $\delta^{13}C = -24.8‰$

Sample BFE77F10d from primary silting of N side of main enclosure ditch.

BM-1411. Billingborough Fen **3430 ± 110** $\delta^{13}C = -24.3‰$

Sample BFE77F43c from primary silting of E side of main enclosure ditch.

[2] British convention for uncorrected radiocarbon dates in the Christian calendar.

2210 ± 40

BM-1429. Billingborough Fen $\delta^{13}C = -25.3‰$

Sample BFE78.4 from top layer of Middle Bronze age enclosure ditch, overlying bank material and assoc with Late Bronze age pottery group.

2800 ± 60

BM-1430. Billingborough Fen $\delta^{13}C = -25.6‰$

Sample BFE78.164 from secondary silt of main enclosure ditch.

General Comment (PC): dates compare favorably with site stratigraphy and phasing suggested by Chowne (1979).

Itford Bottom, Sussex

Charcoal samples from trench in dry valley at Itford Bottom, Beddingham, Lewes, E Sussex, England (50° 50′ N, 0° 0′ E, Natl Grid Ref TQ 441049) assoc with possible Bronze age land clearance. Coll 1978 and subm by M Bell, Dept Human Environment, Inst Archaeol, Univ London.

8770 ± 90

BM-1544. Itford Bottom $\delta^{13}C = -24.5‰$

Sample IB/B/SH/1 (*Pinus* sp, id by Joan Sheldon) from fossil tree hole sealed by Bronze age plough-wash. *Comment* (MB): gives Boreal date for closed woodland conditions indicated by terrestrial Mollusca from feature, but some sp present indicate later date (M P Kerney, pers commun).

3720 ± 120

BM-1545. Itford Bottom $\delta^{13}C = -24.9‰$

Sample IB/B/2 (various sp, mainly *Quercus, Corylus, Fraxinus,* and *Crataegus,* id by Joan Sheldon) from basal horizon of truncated buried soil containing Middle Bronze age pottery. *Comment* (MB): charcoal probably represents scrub clearance followed by cultivation. Early Bronze age date is perfectly acceptable for burning of secondary scrub.

Aldermaston Wharf, Berkshire

Samples from Bronze age settlement site at Aldermaston Wharf, 2km SE Beenham, Berkshire, England (51° 25′ N, 1° 10′ W, Natl Grid Ref SU 607678). Site on Kennet gravels 7km W Knight's Farm, below. Assoc pottery sequence suggests single short occupation overlapping part of Knight's Farm sequence. Coll 1976 and subm by R J Bradley, Dept Archaeol, Univ Reading.

3000 ± 40

BM-1590. Aldermaston Wharf $\delta^{13}C = -22.8‰$

Sample 1, Pit 68. Carbonized grain (barley and emmer wheat, id by J Arthur) from extensive deposit on base of pit directly sealed by single deposit of midden material, assoc with coarse post-Deverel-Rimbury jars and finer bowls.

2790 ± 35

BM-1591. Aldermaston Wharf $\delta^{13}C = -22.4‰$

Sample 2, Pit 68. Repeat of BM-1590 above, different sample.

3240 ± 140

BM-1592. Aldermaston Wharf $\delta^{13}C = -24.2‰$

Sample 3, Pit 6. Charcoal from lower fill of rapidly accumulated midden deposit, assoc with range of diagnostic pottery types.

General Comment (RJB): pottery from this single-period site suggests date is in early 1st millennium bc and dates generally agree. BM-1592 is surprisingly early, but at 2σ, would be consistent with BM-1590 in suggesting some use of site by end of 2nd millennium bc. BM-1590, -1591 do not overlap at 1σ, but do bracket suggested time of occupation based on pottery. These dates refer to post-Deverel-Rimbury phase and are consistent with other dates from region, at Knight's Farm (BM-1593 to BM-1597, below) and Rams Hill (HAR-228 to HAR-232, R, 1974, v 16, p 182).

Knight's Farm, Berkshire

Charcoal samples from Bronze age settlement site Knight's Farm, Burghfield, Berkshire, England (51° 30′ N, 1° 0′ W, Natl Grid Ref SU 679702). Site on Kennet gravels 7km E Aldermaston Wharf was occupied continuously from late Middle Bronze age to Late Bronze age/Early Iron age transition. Coll 1977 by S Lobb and subm by R J Bradley.

3630 ± 50

BM-1593. Knight's Farm $\delta^{13}C = -24.8‰$

Sample KF77/86 from fill of possible oven.

3200 ± 100

BM-1594. Knight's Farm $\delta^{13}C = -24.7‰$

Sample KF77/103 from homogeneous fill of large rubbish pit accumulated over short period, assoc with late Deverel-Rimbury pottery. Pit marks beginning of long settlement sequence.

2240 ± 120

BM-1595. Knight's Farm $\delta^{13}C = -23.1‰$

Sample KF77/106 from homogeneous fill of rubbish pit accumulated over short period, assoc with wide variety of unabraded pottery including angular finger-printed vessels. Pit marks end of long settlement sequence.

2820 ± 110

BM-1596. Knight's Farm $\delta^{13}C = -21.4‰$

Sample KF77/159 from fill of post-hole of large round-house belonging to distinctive type of Late Bronze age structure.

General Comment (RJB): dates refer to long Bronze age and Early Iron age occupation. BM-1593 is much earlier than any other date from site; this may result from burning of mature wood or feature may be unconnected with rest of site. Pottery sequence begins in Deverel-Rimbury phase and BM-1594 assoc with this material agrees with other dates for

these wares (HAR-2754, 3060 ± 100; HAR-2929, 3150 ± 100, both unpub). BM-1596 compares with HAR-1011, 2690 ± 80 and HAR-1012, 2550 ± 80 (both unpub). Overall, dates form internally consistent sequence and agree with those for Aldermaston Wharf (BM-1590 to BM-1592, above).

Holne Moor, Devon

Charcoal samples from multi-phase settlement site at Holne Moor Site F, Holne Moor, Holne, Devon, England (50° 30′ N, 3° 50′ W, Natl Grid Ref SX 678711). Coll 1977 and subm by A Fleming, Dept Prehist & Archaeol, Univ Sheffield (Fleming, 1976).

BM-1604. Holne Moor **6760 ± 240**
$\delta^{13}C = -24.8‰$
Sample XA from below wall of House 1.

BM-1605. Holne Moor **1000 ± 60**
$\delta^{13}C = -25.1‰$
Sample XB from outside entrance to House 1.

BM-1606. Holne Moor **4730 ± 360**
$\delta^{13}C = -24.5‰$
Sample XC from upper fill of House 1 ditch.

BM-1607. Holne Moor **3250 ± 50**
$\delta^{13}C = -24.6‰$
Sample XD from floor of House 2.

BM-1608. Holne Moor **3060 ± 50**
$\delta^{13}C = -24.2‰$
Sample XE from doorway of House 2, sealed by debris.

BM-1609. Holne Moor **3270 ± 60**
$\delta^{13}C = -24.6‰$
Sample XF from top 10cm of pre-reave bank.

BM-1610. Holne Moor **3150 ± 80**
$\delta^{13}C = -24.3‰$
Sample XG sealed by N wall of House 2.

BM-1611. Holne Moor **3150 ± 80**
$\delta^{13}C = -24.2‰$
Sample XK sealed by wall of House 2.

BM-1612. Holne Moor **2490 ± 110**
$\delta^{13}C = -24.1‰$
Sample XL from inner edge of wall of House 1, sealed by House 2.

General Comment (AF): BM-1607 to BM-1611 fully agree with archaeol expectations. BM-1609 should date initial layout of Dartmeet parallel system and implies dates for House O (for outline of sequence, see Fleming, 1979). Other four dates in this group relate to occupation of House 1 (sample descriptions for BM-1607, -1608 do not contradict this statement as House 2 was built inside House 1 without stratigraphically distinct floor levels). BM-1612 should date building of House 2, but supporting evidence is awaited. BM-1604 is much earlier than expected and could relate to natural fire or Mesolithic occupation (two microliths

were found within 20m). BM-1605 was a composite sample and could be mix of prehistoric and Medieval material (ca AD 1300). BM-1606 is ca 2000 yr earlier than expected.

Petters Sports Field, Egham, Surrey

Charcoal samples from Late Bronze age enclosure at Petters Sports Field, The Avenue, Egham, Surrey, England (51° 30′ N, 0° 35′ W, Natl Grid Ref TQ 016715). BM-1620 to BM-1624 from final fill of enclosure ditch, BM-1625 from fill of pit within enclosure; samples date assoc pottery and bronze artifacts. Coll 1976 -1977 by R Poulton and subm by M G O'Connell, Surrey Archaeol Soc, Guildford.

BM-1620. Petters Sports Field **2360 ± 90**
$\delta^{13}C = -25.3‰$
Sample F117/Ia.

BM-1621. Petters Sports Field **2360 ± 60**
$\delta^{13}C = -24.2‰$
Sample F117/Ib.

BM-1622. Petters Sports Field **2720 ± 110**
$\delta^{13}C = -25.0‰$
Sample F117/Ic. Fractionation correction estimated.

BM-1623. Petters Sports Field **2460 ± 80**
$\delta^{13}C = -24.4‰$
Sample F117/Id.

BM-1624. Petters Sports Field **2450 ± 70**
$\delta^{13}C = -24.1‰$
Sample F117/Ie.

BM-1625. Petters Sports Field **2670 ± 90**
$\delta^{13}C = -24.2‰$
Sample F405/Iα.

General Comment (SN): BM-1620, to BM-1624 relate to same context containing large group of Late Bronze age/Early Iron age pottery; they are later than expected for these wares, but are internally consistent. Results should date uppermost ditch fill sealing horizon into which double-hoard dated traditionally to 8th or early 7th centuries BC, had been inserted. BM-1625 dates separate pit and suggests earlier settlement activity more in line with dates so far obtained for occupation at Runnymede Bridge 400m away. BM-1622 may also derive from this phase of activity and be residual in context.

BM-1631. Barling, Essex **3290 ± 90**
$\delta^{13}C = -24.1‰$

Charcoal from Baldwin's Farm Gravel Pit, Barling, Essex, England (51° 35′ N, 0° 50′ E, Natl Grid Ref TQ 937896). From small pit assoc with Deverel-Rimbury bucket urn sherds. Coll 1977 and subm by C Couchman, Essex Co Council Planning Dept, Chelmsford. *Comment* (IK): date is appropriate to regional "Deverel-Rimbury" aspect of later Bronze age on current evidence.

2780 ± 35

BM-1632. Braintree, Essex $\delta^{13}C = -24.4‰$

Charcoal from base of pit at Marlborough Rd, Braintree, Essex, England (51° 55′ N, 0° 30′ E, Natl Grid Ref TL 769238) assoc with Middle Bronze age pottery. Coll 1977 and subm by C Couchman. *Comment* (IK): date is appropriate to regional "Deverel-Rimbury" aspect of later Bronze age on current evidence.

3140 ± 45

BM-1640. Nottington Barrow, Dorset $\delta^{13}C = -25.1‰$

Charcoal (mature pine) from Nottington Barrow, Weymouth, Dorset, England (50° 35′ N, 2° 30′ W, Natl Grid Ref SY 667825). Sample from funeral pyre in mound assoc with cremation burial and Wessex I 3-riveted dagger (Farrar, 1951). Coll 1938 by K Selby and subm 1978 by R T Schadla-Hall, Hampshire Co Mus Service, Winchester. *Comment* (IK): date agrees well with those for other "Wessex" burials, which cluster in 13th to 11th centuries bc (BM-680, -681, -682, -708, -709: R, 1976, v 18, p 27, 30; BM-1119: R, 1979, v 21, p 344).

2790 ± 40

BM-1643. Blackpatch, Sussex $\delta^{13}C = -23.3‰$

Carbonized grain from Middle Bronze age setttlement at Blackpatch, Alciston, E Sussex, England (51° 50′ N, 1° 10′ E, Natl Grid Ref TQ 495047). Sample from base of 1 of 3 oval pits belonging to House 3 (Drewett *et al,* 1978). Coll 1978 and subm by P Drewett, Sussex Archaeol Field Unit. *Comment* (IK): date is later than expected for classic Deverel-Rimbury assemblage with assoc bronze, but falls within late Wessex regional aspect of culture (*cf* Bishop's Cannings, BM-1713 to BM-1717, below).

Handley Barrow 24, Cranborne Chase, Dorset

Charcoal samples from Middle Bronze age urnfield, Handley Barrow 24, Sixpenny Handley, Cranborne Chase, Dorset, England (51° 0′ N, 1° 50′ W, Natl Grid Ref SU 009165) assoc with varied and well-preserved assemblage of Deverel-Rimbury wares, and with other Middle Bronze age activity in Cranborne Chase (Barrett *et al,* 1978; Pitt Rivers, 1898). Coll 1893 by A Pitt Rivers and subm 1978 by R J Bradley.

2710 ± 40

BM-1644. Handley Barrow 24 $\delta^{13}C = -24.2‰$

Sample D, from compact charcoal patch at edge of cemetery, assoc with sherds of bucket urn.

2840 ± 35

BM-1645. Handley Barrow 24 $\delta^{13}C = -24.4‰$

From fill of chalk-cut hole containing Cremation 16 inside bottom half of barrel urn, on outer edge of main group of cremations.

2900 ± 40

BM-1646. Handley Barrow 24 $\delta^{13}C = -25.0‰$

From contents of globular urn containing Cremation 18, on edge of main group of cremations, assoc with decorated sherd.

2820 ± 40

BM-1647. Handley Barrow 24 $\delta^{13}C = -24.0‰$

From fill of lower half of barrel urn, mixed with Cremation 32, situated on edge of main group of cremations.

2810 ± 60

BM-1648. Handley Barrow 24 $\delta^{13}C = -23.3‰$

From fill of pit containing bucket or barrel urn holding Cremation 38, situated in core of urnfield.

2670 ± 45

BM-1649. Handley Barrow 24 $\delta^{13}C = -25.0‰$

From fill of pit containing bucket urn and Cremation 46, on edge of cemetery close to presumed Early Bronze age burial which may be point of origin of urnfield.

General Comment (RJB): dates are remarkably consistent internally, particularly for samples coll in 19th century. Dates give broad time span of cremation cemetery, although no charcoal was assoc with single Collared Urn from site; latest dates (BM-1644, -1649) are from outer edge of cemetery. Dates suggest late extension to currency of Deverel-Rimbury pottery in S Wessex and help fill gap created by apparent rarity of post-Deverel-Rimbury types from area.

Dean Bottom, Wiltshire

Charcoal from multi-period Bronze age settlement at Dean Bottom, 5km NW Marlborough, Wiltshire, England (51° 25′ N, 1° 50′ W, Natl Grid Ref SU 147742). Samples assoc with assemblage of domestic Beaker pottery in fill of pit. Coll 1977 and subm by C J Gingell, Wilts Archaeol & Nat Hist Soc, Devizes.

3770 ± 35

BM-1668. Dean Bottom $\delta^{13}C = -23.6‰$

Sample 18 from middle layer of Beaker pit.

3580 ± 40

BM-1669. Dean Bottom $\delta^{13}C = -24.2‰$

Sample 19 from basal layer of Beaker pit.

General Comment (CJG): dates are for characteristic Beaker period storage pit and confirm those obtained elsewhere for settlements assoc with Middle Beaker material. Rapid filling of pit is apparent from stratigraphy and large numbers of conjoining sherds and undamaged bones are present. Thus, no archaeol evidence for redeposition of either charcoal sample; difference between dates may be statistical, due to initial age of wood, or both.

Welsh St Donats, S Glamorgan

Charcoal samples (*Quercus* sp, id by G Hillman) from Bronze age round barrow, Welsh St Donats, S Glamorgan, Wales (50° 20′ N, 3° 20′ W, Natl Grid Ref ST 041749). Coll 1977 and subm by J Price and M Ehrenberg, Dept Archaeol, Univ Coll, Cardiff (Price & Ehrenberg, 1977).

2810 ± 35

BM-1679. Welsh St Donats $\delta^{13}C = -24.0‰$

Sample WSD77/1 from fill of pit sealed under turf mound and above central cremation assoc with bronze knife dagger. Sample dates dagger and construction of mound.

3190 ± 35

BM-1680. Welsh St Donats $\delta^{13}C = -25.2‰$

Sample WSD77/2 from old ground surface ca 1m from central burial and sealed by mound. Sample dates construction of turf mound.

3250 ± 35

BM-1681. Welsh St Donats $\delta^{13}C = -23.6‰$

Sample WSD77/3 surrounding one of pair of crouched inhumations, assoc with bronze awl and late Beaker, lying on old ground surface under low stone cairn and turf mound, E of central cremation.

General Comment (JP): BM-1679 is much later than expected from assoc knife dagger of Early Bronze age type, ca 1400 BC (1200 bc; 3150 BP). BM-1680 is consistent with BM-1681 which, though late, is acceptable for late Beaker vessel.

Bishop's Cannings, Wiltshire

Charcoal samples from Bronze age settlement at Bishop's Cannings Down, S Avebury, Wiltshire, England (51° 20′ N, 2° 0′ W, Natl Grid Ref SU 058666). Coll 1976-1977 and subm by C J Gingell.

2740 ± 60

BM-1713. Bishop's Cannings $\delta^{13}C = -23.8‰$

Sample 43 from Layer 43, post-pipe of Feature 218, post-hole of House B, assoc with characteristic Bronze age pottery.

2900 ± 40

BM-1714. Bishop's Cannings $\delta^{13}C = -24.5‰$

Sample 158 from Layer 158, S post-pipe of Feature 161, entrance to House B.

2860 ± 40

BM-1715. Bishop's Cannings $\delta^{13}C = -24.5‰$

Sample 167 from Layer 167, post-pipe within Feature 177, House A.

2830 ± 100

BM-1716. Bishop's Cannings $\delta^{13}C = -24.7‰$

Sample 99 from Layer 99 within Feature 205, post-hole of House A.

2790 ± 50

BM-1717. Bishop's Cannings $\delta^{13}C = -23.2‰$

Samples 169, 174 from Layer 169, upper fill in entrance post-hole, Feature 187 to 189, House A, and Layer 174, post position in Feature 188, House A entrance post-hole.

General Comment (CJG): dates obtained for these two Bronze age round-houses are satisfactory on archaeol grounds. Close assoc of pottery

with samples and with houses in general emphasize survival of Bucket, Biconical, and Globular Urns, and in particular, Kimmeridgian shell-tempered urns characteristic of this site, to end of Middle Bronze age and perhaps later.

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[RADIOCARBON, VOL 23, No. 1, 1981, P 24-32]

US GEOLOGICAL SURVEY, DENVER, COLORADO RADIOCARBON DATES III

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INTRODUCTION

This list contains the results of measurements made during 1978 and 1979. Ages were computed on the radiocarbon half-life of 5568 ± 30 years. Statistical errors quoted herein are 1σ counting errors which include sample, background, and standard. The age limit reported is calculated on the basis of 3σ activity. The $\delta^{13}C$ values in table 1 were measured by Krueger Enterprises, Inc, Geochron Laboratories Division[1] and calculated based on Craig's Peedee Belemnite (PDB) limestone standard (Craig, 1957). The total alkalinity as bicarbonate values reported in table 1 was determined using techniques described by Brown, Skougstad, and Fishman (1970). Unless otherwise stated, all samples were collected and submitted by personnel of the US Geological Survey.

Benzene was synthesized from precipitated barium carbonate (Noakes, Kim, and Akers, 1967). Since the publications of Schroder *et al* (1973) and Schroder, Emerson, and Beetem (1978), improvements in the counting techniques have been made (Yang and Emerson, 1979). Samples were counted in Teflon vials made of DuPont's polytetrafloro ethylene (PTFE) rod, similar to the designs of Calf and Polach (1974) and our low ^{40}K glass vial previously used. This resulted in an increase in ^{14}C counting efficiency of 5 percent for 3mL to 1mL benzene, PCS (phase combining solvent) and 10 percent increase for 4mL to 1mL benzene, PCS counting solution relative to low ^{40}K glass vial. No significant decrease in background count rate was observed for 3mL to 1mL benzene, PCS solution in Teflon vial compared to glass vial. However, for larger sample sizes (4mL to 1mL and 5mL to 1mL benzene, PCS), the background count rates in Teflon vials remained nearly the same as for 3mL to 1mL benzene, PCS, yet low ^{40}K glass vial background count rate increased by approximately 1.25 counts per minute per milliliter of counting solution (Yang and Emerson, 1979).

SAMPLE DESCRIPTIONS

A. Oregon

DE-1. 01N/02E-24aad **3100 ± 160**

Sample coll Nov 17, 1977, from Multnomah Co (45° 33′ 36″ N, 122° 29′ 57″ W) from depth 139.3m. Hole drilled to 149.4m. Alt of well head 8.1m above msl. Static water level was 2.1m.

DE-2. 01N/02E-15cba **<50**

Sample coll Nov 3, 1977, from Multnomah Co (45° 34′ 07″ N, 122° 33′ 13″ W) from depth 68.9m. Hole drilled to 68.9m. Alt of well head 5.3m above msl. Static water level was 2.7m.

[1] The use of company and brand names in this paper is for identification only and does not imply endorsement by the US Geological Survey.

DE-3. 01N/02E-15cba **2600 ± 210**

Sample coll Nov 9, 1977, from Multnomah Co (45° 34′ 22″ N, 122° 33′ 41″ W) from depth 20.7m to 67.1m. Hole drilled to 121.9m. Alt of well head 5.2m above msl. Static water level was 2.7m.

DE-4. 01N/02E-15bca **100 ± 140**

Sample coll Nov 9, 1977, from Multnomah Co (45° 34′ 22″ N, 122° 33′ 13″ W) from depth 74.4m to 97.5m. Hole drilled to 100m. Alt of well head 7.7m above msl. Static water level was 6.1m.

DE-5. 01N/02E-24adc **3000 ± 140**

Sample coll Dec 17, 1977, from Multnomah Co (45° 33′ 23″ N, 122° 29′ 57″ W) from depth 76.5m to 97.5m. Hole drilled to 97.5m. Alt of well head 5.2m above msl. Static water level was 3m.

DE-6. 01N/03E-21acc **<100**

Sample coll Jan 26, 1977, from Multnomah Co (45° 33′ 26″ N, 122° 26′ 29″ W) from depth 13.4m to 39.6m. Hole drilled to 45.7m. Alt of well head 5.7m above msl. Static water level was 2.1m.

B. Utah

DE-7. **>35,600**

Sample coll Aug 16, 1978, from Grand Co (38° 50′ 37″ N, 109° 44′ 01″ W) at depth 118.9 to 163.1m. Sample contained H_2S.

DE-8. Well (-23-6)6acc **31,000 ± 840**

Sample coll Nov 28, 1978, from Emery Co (38° 50′ 45″ N, 111° 17′ 18″ W) at depth 219.5m.

DE-9. Well (D-22-6)17abc **27,700 ± 850**

Sample coll Dec 14, 1978, from Emery Co (38° 54′ 26″ N, 111° 16′ 08″ W) at depth 335.3m.

C. Nevada

DE-10. **1100 ± 160**

Sample coll July 21, 1978, from Churchill Co (39° 29′ 19″ N, 118° 48′ 34″ W) at depth 39.6m. Well pumped several days before sampling.

DE-11. **9900 ± 210**

Sample coll July 19, 1978, from Churchill Co (39° 22′ 54″ N, 118° 43′ 18″ W) at depth 36m. Well pumped 1500L before sampling.

DE-12. **5300 ± 160**

Sample coll Aug 10, 1978, from Churchill Co (39° 28° 39″ N, 118° 46′ 34″ W) at depth 146.3m. Well pumped several hr before sampling.

DE-13. **7600 ± 150**

Sample coll Oct 6, 1978, from Churchill Co (39° 28′ 25″ N, 118° 47′ 08″ W) at depth 153.9m.

TABLE 1
Summary of δC^{13} and alkalinity for water sources

Sample no.	Coll date	δC^{13} (‰ PDB)	Total alkalinity as bicarbonate (mg/L)	Water source by state
DE-1	11/17/77	-20.0	78	Oregon
DE-2	11/3/77	-20.7	62	"
DE-3	11/9/77	-19.8	76	"
DE-4	11/9/77	-11.5	419	"
DE-5	12/17/77	-20.4	85	"
DE-6	1/26/78	-20.8	61	"
DE-7	8/16/78	-19.4	--	Utah
DE-8	11/28/78	-12.6	--	"
DE-9	12/14/78	-10.0	--	"
DE-10	7/21/78	--	--	Nevada
DE-11	7/19/78	--	--	"
DE-12	8/10/78	--	--	"
DE-13	10/6/78	--	--	"
DE-14	2/8/78	--	--	"
DE-15	6/21/79	--	268	"
DE-16	6/20/79	--	--	"
DE-17	6/22/79	--	--	"
DE-18	6/20/79	--	192	"
DE-19	6/19/79	--	374	"
DE-20	6/25/79	--	--	"
DE-21	6/26/79	--	180	"
DE-22	7/2/79	-14.1	--	South Dakota
DE-23	7/3/79	-11.4	--	"
DE-24	7/17/79	-12.2	--	"
DE-25	7/16/79	-11.7	--	"
DE-26	7/26/79	- 7.7	179	"
DE-27	7/26/79	- 8.2	175	"
DE-28	7/27/79	- 8.5	175	"
DE-29	7/24/79	- 5.2	182	"
DE-30	7/19/79	-11.0	390	"
DE-31	7/30/79	- 8.7	195	"
DE-32	7/29/79	- 6.8	182	"
DE-33	7/31/79	- 8.0	175	"
DE-34	7/31/79	-13.2	378	"
DE-35	7/29/79	- 7.7	190	"
DE-36	7/28/79	- 7.3	182	"
DE-37	8/6/79	-20.2	633	"
DE-38	8/5/79	-11.4	64	"
DE-39	8/4/79	- 8.3	163	"
DE-40	8/7/79	-26.2	864	"
DE-41	8/6/79	-19.5	980	"
DE-42	8/6/79	-14.0	242	"
DE-43	8/4/79	- 9.9	204	"
DE-44	8/1/79	-15.8	446	"
DE-45	8/3/79	-11.0	173	"
DE-46	8/2/79	-10.2	211	"
DE-47	8/1/79	-14.0	431	"
DE-48	8/21/79	-24.2	--	"
DE-49	8/29/79	-10.6	--	"
DE-50	8/30/79	-13.4	--	"
DE-51	9/7/79	-11.1	--	"
DE-52	9/6/79	-15.9	--	"
DE-53	8/9/79	-10.2	214	Wyoming
DE-54	8/11/79	- 7.0	235	"
DE-55	8/6/79	- 9.6	213	"
DE-56	8/6/79	-11.6	225	"
DE-57	8/12/79	- 9.4	365	"
DE-58	8/12/79	-14.4	418	"
DE-59	8/9/79	-16.0	107	"
DE-60	8/12/79	-13.3	231	"
DE-61	8/8/79	- 9.2	195	"
DE-62	8/9/79	-14.0	214	"
DE-63	8/9/79	- 7.9	320	"
DE-64	8/11/79	-10.1	244	"
DE-65	8/7/79	- 9.3	210	"
DE-66	8/7/79	-16.1	58	"
DE-67	8/4/79	-16.6	220	"
DE-68	8/4/79	-11.6	190	"

DE-14. **14,100 ± 400**

Sample coll Feb 8, 1978, from Churchill Co (39° 33′ 40″ N, 118° 43′ 19″ W) at depth 79.2m. Sample coll 4 hr after starting pumping.

DE-15. Well 10S/47-30dcc **8400 ± 140**

Sample coll June 21, 1979, from Windmill Ranch 13km N of Beatty in Oasis Valley, Nye Co (37° 01′ 60″ N, 116° 45′ 30″ W). Hole drilled to 36.9m and cased to 19.8m below land surface datum. Alt of well head 1179.6m above msl. Static water level was 5.5m below land surface datum. Pump yielded 190Lpm.

DE-16. Spring 10S/47-33aab **<100**

Sample coll June 20, 1979, from spring in Oasis Valley, Nye Co (37° 01′ 49″ N, 116° 43′ 08″ W). Ditch along base of steep volcanic slope intersects seeps from fractured volcanic rock and channels water to a reservoir. Alt of reservoir 1182.6m above msl.

DE-17. Water Supply Well J-13 **9900 ± 130**

Sample coll June 22, 1979, from Nevada Test Site, Nye Co (36° 48′ 29″ N, 116° 23′ 40″ W). Hole drilled to 1063.1m and cased to 1031.7m below land surface datum. Alt of well head 1011.3m above msl. Static water level was 282.9m below land surface datum. Casing perforated 303.5 to 422.5m and 819.9 to 1009.5m. Pump discharged 2600Lpm.

DE-18. Spring 10S/47-14bab **7600 ± 100**

Sample coll June 20, 1979, from Fleur de Lis Ranch, Oasis Valley, Nye Co (37° 04′ 27″ N, 116° 41′ 24″ W) from depth 1.8m below land surface datum. Alt of spring 1213.7m above msl.

DE-19. Well 12S/47-7dbd **3500 ± 60**

Sample coll June 19, 1979, from Beatty Municipal Well #2, Oasis Valley, Nye Co (36° 54′ 18″ N, 116° 45′ 24″ W) from depth 54.9 to 91.4m. Hole drilled to 91.4m and cased to 54.9m below land surface datum. Pump yielded 870Lpm.

DE-20. Well 10S/47-14bab **21,500 ± 330**

Sample coll June 25, 1979, from Coffer's Well, Oasis Valley, Nye Co (37° 04′ 27″ N, 116° 41′ 24″ W). A 2.4m well beside a reservoir was equipped with a centrifugal pump from which water was obtained for analysis. Springs were located in bottom of reservoir. Alt of well head is 1213.7m above msl. Pump yielded 1325 Lpm.

DE-21. Well 11S/47-27cba **9300 ± 120**

Sample coll June 26, 1979, from Marvin's Well, Oasis Valley, Nye Co (36° 56′ 57″ N, 116° 42′ 46″ W) 5.6km N of Beatty, Nevada at depth 10.6m. Hole drilled to 16.8m and cased to 15.2m below land surface datum. Alt of well head 1060.7m above msl. Static water level was 9.1m below land surface datum. Pump yielded 76Lpm.

D. South Dakota

DE-22. Well 7S/1E-15acda (TVA Lakota) 18,300 ± 330

Sample coll July 2, 1979, from Fall River Co (43° 26′ 38″ N, 103° 58′ 52″ W) at depth 182m.

DE-23. Well 11N/1E-17dcac >37,500

Sampled coll July 3, 1979, from Russ Carver Well #2, Butte Co (44° 54′ 41″ N, 104° 01′ 24″ W) at depth 640m.

DE-24. Well 5N/9E-34ccbd >36,100

Sample coll July 17, 1979, from Meade Co (44° 20′ 47″ N, 103° 01′ 18″ W) at depth 722.4m.

DE-25. Well 8N/2E-14dc 8100 ± 140

Sample coll July 16, 1979, from Butte Co (44° 39′ 05″ N, 103° 50′ 12″ W) at depth 131.1m.

DE-26. Well 104N/61W-36ddaa >26,200

Sample coll July 26, 1979, from Richard Renken Well (43° 45′ 55″ N, 98° 05′ 12″ W) at depth 103.6m. Static water level was 6.5m below land surface datum.

DE-27. Well 105N/58W-31bacc >30,600

Sample coll July 26, 1979, from Miner Co (43° 51′ 42″ N, 97° 50′ 39″ W) at depth 192m; flow rate 144Lpm. Static water level was 10.8m below land surface datum.

DE-28. Well 113N/61W-cbbb 29,900 ± 1600

Sample coll July 27, 1979 from Beadle Co (44° 34′ 12″ N, 98° 09′ 34″ W) at depth 274.3m; flow rate 151Lpm.

DE-29. Well 109N/70W-babd >30,700

Sample coll July 24, 1979, from Hand Co (44° 16′ 53″ N, 99° 15′ 33″ W) at depth 592.8m; flow rate 151Lpm. Alt of well head 60.5m above msl.

DE-30. Well 1N/15E-36adcc >40,300

Sample coll July 19, 1979, from Pennington Co (44° 00′ 06″ N, 102° 15′ 04″ W) at depth 378.1m.

DE-31. Well 123N/64W-27ddaa 32,300 ± 1000

Sample coll July 30, 1979, from Brown Co (45° 26′ 40″ N, 98° 30′ 50″ W) at depth 342.9m; flow rate 57Lpm.

DE-32. Well 128N/66W-8abbc >28,300

Sample coll July 29, 1979, from McPherson Co (45° 55′ 27″ N, 98° 49′ 03″ W) at depth 581.2m; flow rate 227Lpm.

DE-33. Well 122N/62W-23dadd >34,100

Sample coll July 31, 1979, from Brown Co (45° 21′ 44″ N, 98° 14′ 51″ W) at depth 349.9m; flow rate 34Lpm.

DE-34. Well 125N/57W-6baba >33,400

Sample coll July 31, 1979, from Marshall Co (45° 40′ 27″ N, 97° 43′ 22″ W) at depth 378.6m; flow rate 11.4Lpm. Static water level was 30.5m below land surface datum.

DE-35. Well 128N/67W-35bbcd2 31,900 ± 1700

Sample coll July 29, 1979, from McPherson Co (45° 51′ 48″ N, 98° 52′ 53″ W) at depth 515.4m; flow rate 227Lpm.

DE-36. Well 123N/65W-22aad 29,000 ± 1400

Sample coll July 28, 1979, from Brown Co (45° 27′ 29″ N, 98° 38′ 24″ W) at depth 409.3m; flow rate 189Lpm. Static water level was 100.6m below land surface datum.

DE-37. Well 1N/24E-9cadd 28,800 ± 1100

Sample coll Aug 6, 1979, from Haakon Co (44° 03′ 25″ N, 101° 14′ 13″ W) at depth 722.4m; flow rate 568Lpm. Static water level was 70.4m below land surface datum.

DE-38. Well 99N/74W-1cdcd >23,000

Sample coll Aug 5, 1979, from Tripp Co (43° 24′ 57″ N, 99° 32′ 52″ W) at depth 457.2m; flow rate 1.9Lpm.

DE-39. Well 98N/70W-11c 29,900 ± 1400

Sample coll Aug 4, 1979, from Gregory Co (43° 19′ 45″ N, 99° 05′ 20″ W) at depth 259.1m; flow rate 114Lpm. Static water level was 16.2m below land surface datum.

DE-40. Well 6N/24E-03baaa >35,400

Sample coll Aug 7, 1979, from Haakon Co (44° 30′ 40″ N, 101° 12′ 30″ W) at depth 792.5m; flow rate 15Lpm.

DE-41. Well 1N/20E-24bcab >39,700

Sample coll Aug 6, 1979, from Haakon Co (44° 02′ 02″ N, 101° 39″ 40″ W) at depth 780.9m; flow rate 379Lpm.

DE-42. Well 2S/22E-28bad >35,700

Sample coll Aug 6, 1979, from Jackson Co (43° 49′ 55″ N, 101° 31′ 20″ W) at depth 832.1m; flow rate 946Lpm.

DE-43. Well 96N/63W-08cda >28,400

Sample coll Aug 4, 1979, from Charles Mix Co (43° 08′ 26″ N, 98° 19′ 06″ W) at depth 204.8m; flow rate 22.7Lpm. Static water level was 10m below land surface datum.

DE-44. Well 107N/49W-14abbc >40,400

Sample coll Aug 1, 1979, from Moody Co (44° 04′ 41″ N, 96° 40′ 36″ W) at depth 143.3m; flow rate 5.7Lpm.

DE-45. Well 93N/55W-4bbc **>30,500**

Sample coll Aug 3, 1979, from Yankton Co (42° 54′ 40″ N, 97° 21′ 25″ W) at depth 124.1m; flow rate 38Lpm.

DE-46. Well 91N/49W-19bcca **4000 ± 140**

Sample coll Aug 2, 1979, from Union Co (42° 41′ 13″ N, 96° 41′ 13″ W) at depth 99.1m; flow rate 833Lpm.

DE-47. 127N/49W-29bbbc **>41,400**

Sample coll Aug 1, 1979, from Perkins Co (45° 45′ 35″ N, 96° 49′ 58″ W) at depth 161.5m; flow rate 9.8Lpm. Static water level was 3.86m below land surface datum.

DE-48. Well 5N/17E-21aacc **>39,200**

Sample coll Aug 21, 1979, from Pennington Co (44° 23′ 00″ N, 102° 03′ 53″ W) at depth 938.8m.

DE-49. Well 8S/6E-14cbba **17,400 ± 230**

Sample coll Aug 29, 1979, from Fall River Co (43° 21′ 13″ N, 103° 22′ 48″ W) at depth 609m.

DE-50. Well 11S/2E-21dc **28,300 ± 1000**

Sample coll Aug 30, 1979, from Fall River Co (43° 04′ 16″ N, 103° 52′ 41″ W) at depth 731.5m.

DE-51. Well 2S/13E-14acad **>36,600**

Sample coll Sept 7, 1979, from Pennington Co (43° 52′ 27″ N, 102° 03′ 48″ W) at depth 807.7m

DE-52. Well 3S/14E-28dada **30,400 ± 1000**

Sample coll Sept 6, 1979, from Pennington Co (43° 45′ 10″ N, 102° 26′ 31″ W) at depth 865.6m.

E. Wyoming

DE-53. Well 15N/18W-9bba **14,200 ± 350**

Sample coll Aug 9, 1979, from Niobrara Co (47° 05′ 00″ N, 109° 27′ 41″ W) at depth 187.1m.

DE-54. Well 16N/17W-18bdd **>40,000**

Sample coll Aug 11, 1979, from Niobrara Co (47° 09′ 05″ N, 109° 37′ 16″ W) at depth 378m.

DE-55. Well 10N/17W-16bb2 **17,500 ± 370**

Sample coll Aug 6, 1979, from Weston Co (47° 14′ 30″ N, 110° 27′ 52″ W) at depth 134.7m.

DE-56. Well 17N/10W-26bb **8900 ± 160**

Sample coll Aug 6, 1979, from Weston Co (47° 12′ 41″ N, 110° 25′ 24″ W) at depth 106.7m.

DE-57. Well 17N/15W-34bdc **>39,200**

Sample coll Aug 12, 1979, from Niobrara Co (47° 11′ 36″ N, 109° 48′ 06″ W) at depth 507.5m.

DE-58. Well 16N/17W-36aca **33,500 ± 1900**

Sample coll Aug 12, 1979, from Niobrara Co (47° 06′ 33″ N, 109° 30′ 32″ W) at depth 118.9m.

DE-59. Well 14N/18W-10dbb **<50**

Sample coll Aug 9, 1979, from Niobrara Co (45° 59′ 11″ N, 109° 04′ 13″ W) at depth 28m.

DE-60. Well 16N/17W-21add **>35,000**

Sample coll Aug 12, 1979, from Niobrara Co (47° 07′ 54″ N, 109° 34′ 06″ W) at depth 88.4m.

DE-61. Well 18N/10W-35cdl **36,000 ± 2600**

Sample coll Aug 8, 1979, from Weston Co (47° 16′ 32″ N, 110° 25′ 04″ W) at depth 247.3m.

DE-62. Well 15N/18W-27aa **4200 ± 140**

Sample coll Aug 9, 1979, from Niobrara Co (47° 02′ 19″ N, 109° 25′ 14″ W) at depth 152.4m. *Comment*: possible contamination from underlying strata.

DE-63. Well 16N/17W-28adc **>39,200**

Sample coll Aug 11, 1979, from Niobrara Co (47° 07′ 21″ N, 109° 04′ 13″ W) at depth 221m.

DE-64. Well 16N/18W-32dcd **18,600 ± 280**

Sample coll Aug 11, 1979, from Niobrara Co (47° 05′ 58″ N, 109° 27′ 58″ W) at depth 213.4m.

DE-65. Well 17N/10W-20bd **10,100 ± 180**

Sample coll Aug 7, 1979, from Weston Co (47° 13′ 13″ N, 110° 29′ 00″ W) at depth 33.5m.

DE-66. Well 16N/10W-5aa **8100 ± 180**

Sample coll Aug 7, 1979, from Weston Co (47° 11′ 02″ N, 110° 27′ 37″ W) at depth 14m.

DE-67. Well 18N/11W-22cc **>36,000**

Sample coll Aug 4, 1979, from Weston Co (47° 18′ 11″ N, 105° 19′ 08″ W) at depth 345.6m.

DE-68. Well 18N/10W-13ca **33,300 ± 2100**

Sample coll Aug 4, 1979, from Weston Co (47° 18′ 49″ N, 110° 23′ 47″ W) at depth 422.8m.

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[RADIOCARBON, VOL 23, NO. 1, 1981, P 33-37]

INSTITUT ROYAL DU PATRIMOINE ARTISTIQUE RADIOCARBON DATES VII

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This list contains most of the measurements made during 1979, since our last list (R, 1979, v 21, p 180-185). The laboratory procedures were outlined previously (R, 1968, v 10, p 29-34; R, 1971, v 13, p 29-31). The collagen extraction follows Longin (1970).

I. GEOLOGIC SAMPLES

A. Belgium

Booitshoeke series

Alternating clay and peat layers in Western Belgian Coastal plain. Coll and subm 1978 by C Baeteman, Geol Service, Belgium.

IRPA-285. Booitshoeke Zeedijk 1 **2080 ± 140**

Top of peat layer, 55cm thick, at 100cm below surface (51° 05′ 38″ N, 2° 44′ 05″ E).

IRPA-286. Booitshoeke Zeedijk 2 **3740 ± 140**

Base of peat layer, 55cm thick, at 155cm below surface (51° 05′ 38″ N, 2° 44′ 05″ E).

IRPA-287. Booitshoeke Zeedijk 3 **3970 ± 190**

Top of lower peat layer, 40cm thick, at 170cm below surface (51° 05′ 38″ N, 2° 44′ 05″ E).

IRPA-288. Booitshoeke Zeedijk 4 **4770 ± 220**

Base of lower peat layer, 40cm thick, at 210cm below surface (51° 05′ 38″ N, 2° 44′ 05″ E).

IRPA-289. Booitshoeke Vaart BH 10 **3250 ± 150**

Top of peat layer, 35cm thick, at 100cm below surface (51° 05′ 25″ N, 2° 43′ 50″ E).

IRPA-290. Booitshoeke Vaart BH 11 **4030 ± 400**

Base of peat layer, 35cm thick, at 135cm below surface (51° 05′ 25″ N, 2° 43′ 50″ E). Dilution: 30% sample.

IRPA-291. Booitshoeke Vaart BH 12 **4260 ± 210**

Top of lower peat layer, 65cm thick, at 200cm below surface (51° 05′ 25″ N, 2° 43′ 50″ E).

IRPA-292. Booitshoeke Vaart BH 13 **4300 ± 200**

Base of lower peat layer, 65cm thick, at 265cm below surface (51° 05′ 25″ N, 2° 43′ 50″ E).

Avekapelle series

Peat layer in Western Belgian Coastal plain from 115 to 300cm below surface (51° 04′ 44″ N, 2° 45′ 25″ E). Coll and subm by C Baeteman.

IRPA-334. Avekapelle 32-35 **3450 ± 180**
Sample 175 to 185cm below surface.

IRPA-335. Avekapelle 25-28 **4240 ± 190**
Sample 205 to 215cm below surface.

IRPA-336. Avekapelle 58-60 **3340 ± 170**
Sample 130 to 140cm below surface.

General Comment: ages of first end of peat growth in Booitshoeke and beginning of wetter conditions in Avekapelle agree well. Age of second start of peat growth and end of wet conditions seriously disagree. Age of top is nearly identical in Booitshoeke Vaart and Avekapelle, and is similar with IRPA-283, -337, and -338 (Baeteman *et al,* 1979).

B. North Sea

IRPA-333. Whale bone **1980 ± 110**
Whale bone (*Exchrichtus gibbosus*) found at bottom of North Sea (51° 30′ N, 0° 42′ E). Coll 1978 by N Craps and subm 1979 W Desmedt, Inst Royal Sci Nat, Belgium. *Comment*: sample washed with 25% HCl; dated with carbonate because of insufficient collagen.

C. Southeast Africa

Namib-Erongo series

Calcareous rock from East Africa. Samples were washed with 25% HCl until 50% loss of material. Coll 1974 and subm 1977 by W D Blümel, Geol Inst, Univ Karlsruhe, West Germany.

IRPA-275. Namib 51a **21,300 ± 570**
Carbonate from layer in Namib reserve (24° S, 16° E), alt + 900m.

IRPA-276. Namib 44a **>45,000**
Carbonate nodules and sand from layer in Namib reserve (24° S, 16° E), alt + 900m.

IRPA-277. Erongo 98a **19,600 ± 470**
Carbonate from layer on Erongo Mt (21° 30′ S, 15° 20′ E), alt + 1200m.

IRPA-278. Erongo 95 **29,900 ± 660**
Carbonate from layer on Erongo Mt (22° 30′ S, 15° 20′ E), alt + 1200m.

General Comment: dates agree with expected age.

II. ARCHAEOLOGIC SAMPLES

A. Belgium

Leffinge series

Multidisciplinary study on Roman saltmaking furnaces at Leffinge in Belgian Coastal plain (51° 08′ 40″ N, 2° 52′ 13″ E). Coll July 1978 by C Baeteman, C Verbruggen, and H Thoen; subm 1978 by C Baeteman.

IRPA-282. LFZ 78/27/15 **4470 ± 220**

Base of peat layer, 40cm thick, at 120cm below surface.

IRPA-283. LFZ 78/15/24 Oven XII **3140 ± 170**

Top of peat layer, 40cm thick, underlying Furnace XII, at 80cm below surface.

IRPA-284. I LFZ 78/17/a_3 **2380 ± 130**

IRPA-284. II **2120 ± 120**

Ashes from furnace, from center of layer, 25cm thick, at 85cm below surface. *Comment*: I and II are two fractions of same sample.

IRPA-337. LFZ A-Peat **3340 ± 190**

Top of same peat layer as IRPA-283. Dated to compare with palynologic analysis.

IRPA-338. LFZ A-Wood **3230 ± 160**

Wood in same peat layer as IRPA-337.

General Comment: dates of top and base agree with Antw-227, -102, and -249 (Vanhoorne and Van Dongen, 1976; Vanhoorne, Van Strydonck, and Dubois, 1978). Expected date for IRPA-284 was 1700 BP; radiocarbon dating reveals that furnace fuel was probably a mixture of Roman-age material (wood) and peat. The peat layer under furnaces was not disturbed.

IRPA-346. Bredene **460 ± 90**

Human bones from excavation at Bredene (51° 14′ 43″ N, 2° 57′ 11″ E), at 80cm depth. Coll 1976 by R Eeckhout and subm 1979 by H Thoen, Univ Gent, Belgium. *Comment*: dated with collagen; no archaeol data.

Dinant series

Human bones from excavation in transept of collegiate church in Dinant (50° 15′ 44″ N, 4° 54′ 50″ E). Coll Sept 1978 by M Osterrieth and subm 1979 by P Bonenfant, Univ Libre, Brussels, Belgium.

IRPA-293. Dinant I **780 ± 40**

IRPA-294. Dinant II **830 ± 50**

General Comment (PB): dates confirm expected age between 11th and 13th centuries.

IRPA-220. Liège n° 5 **1100 ± 230**

Wood from excavation at Liège (50° 30′ 51″ N, 5° 34′ 45″ E). Coll 1974 and subm 1979 by M Otte, Serv Archeol Prehist, Univ Liège, Belgium. *Comment*: date agrees with archaeol data.

B. Asia

Tell ed-Dér series

Samples in muddy clay from occupied ground of tell, alt 36 to 37m, at Tell ed-Dér, Iraq (33° 05′ 08″ N, 44° 14′ 35″ E). Coll 1975 by H Gasche and subm 1979 by L De Meyer, Seminar Archeol, Univ Gent, Belgium. *Comment*: samples with (P) were indurated with Paraloid which was removed by dry distillation. These dates complete those published in R, 1979, v 21, p 180-185.

IRPA-304. DPr 509 **4070 ± 230**

Burned wood (*Populus*) from Layer 21.3.1, Boring E.

IRPA-305. DPr 531 (P) **4030 ± 200**

Burned wood (*Populus* and *Pinus*) from Layer 22.3.1, Boring E.

IRPA-306. DPr 532 (P) **4160 ± 210**

Burned wood (*Populus*) from Layer 15.3.1, Boring E.

IRPA-307. DPr 533 **5180 ± 250**

Burned wood (*Populus*) from Layer 21.3.1, Boring E.

IRPA-309. DPr 535 (P) **3910 ± 200**

Wood and clay from Layer 22.3.1, Boring E.

IRPA-310. DPr 584 **4010 ± 200**

Burned wood from Layer 27.3.1, Boring E.

Apamee series

Animal bone and charcoal fragments from occupied ground of tell, alt 210m, at Qal at el-Mudiq (Hama), Syria (35° 25′ N, 36° 24′ E). Coll 1974 and subm 1976 by J Balty, Mus Royaux Art et Hist, Brussels, Belgium.

IRPA-205. AP. 74. III. 1.1 **1400 ± 80**

Bone fragments from Room E.

IRPA-206. AP. 74. III. 2 **580 ± 30**

Bone fragments from Room F.

IRPA-208. AP. 74. III. 23 **1090 ± 80**

Bone fragments under Column C19.

IRPA-209. AP. 74. III. 26 **1280 ± 70**

Bone fragments from second floor, C12-C13.

IRPA-210. AP. 74. III. 30 **910 ± 70**
Bone fragments.

IRPA-212. AP. 75 **1310 ± 80**
Charcoal from E Cathedral.

IRPA-213. AP. 74. V. 5, 6 and 15 **3500 ± 170**
Bone fragments from Layer III.

IRPA-214. AP. 74. V. 8.3 **3200 ± 150**
Bone fragments from Hole 2.

IRPA-215. AP. 74. V. 7.3 **3710 ± 210**
Bone fragments from Hole 1.

General Comment: dates agree with archeol data: coins and ceramics. IRPA-213, -214, and -215 dated with carbonate because of insufficient collagen; dates are too young, probably because of carbonate contamination.

References

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[RADIOCARBON, VOL 23, No. 1, 1981, P 38-42]

PHYSICAL RESEARCH LABORATORY RADIOCARBON DATE LIST IV

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The dates presented below are from some important archaeologic and Quaternary sites. All the dates are in years BP, based on $\tau 1/2 = 5568$ years. When converting archaeologic dates into the AD/BC scale, 1950 should be used as the base year. The dates are not corrected for ^{13}C fractionation. All the dates older than 10,000 years have been given with 2σ errors.

Samples were converted to methane for measuring ^{14}C activity in gas proportional counters as described earlier (R, 1971, v 13, p 442-449). All archaeologic samples were given NaOH treatment.

ACKNOWLEDGMENTS

We thank N B Vaghela for laboratory assistance.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

Ayodhya series, Uttar Pradesh

Ayodhya (26° 45′ N, 82° 10′ E), Dist Faizabad, subm by Dir Gen Archaeol, New Delhi.

PRL-452. Early historical deposit **2190 ± 100**

Charcoal, Tr AYD-6, Loc Sec A-C, Layer 11, depth 4.6m; submitter's Sample Ch S 1.

PRL-456. Early historical deposit **2350 ± 140**

Charcoal, Tr AYD-4, Loc V-X (SE), Pit X sealed by Layer 30, depth 11.2m; submitter's Sample Ch S 5.

PRL-458. Early historical deposit **1920 ± 150**

Charcoal, Tr AYD-8, Loc O-V, Layer 9, depth 3.1m; submitter's Sample Ch S 7.

PRL-459. Early historical deposit **1920 ± 90**

Charcoal, Tr AYD-6, pit sealed by Layer 7, depth 4m; submitter's Sample Ch S 8.

PRL-462. Northern Black Polished (NBP) Ware **1990 ± 90**

Charcoal, Tr AYD-7, Loc H-J, Layer 8, depth 4.5m; submitter's Sample 130.

PRL-466. NBP deposit **2070 ± 90**

Charcoal, Tr AYD-5, Loc Sq C1 Qd 1, pit sealed by Layer 12, depth 4.4m; submitter's Sample 1251.

PRL-467. NBP deposit **1910 ± 90**

Charcoal, Tr AYD-5, Loc Sq C1 Qd 1, Layer 13, depth 4.4m; submitter's Sample 1252.

Daimabad series, Maharashtra

Daimabad (19° 31′ N, 74° 42′ E), Dist Ahmednagar, subm by Dir Gen Archaeol, New Delhi.

PRL-411. Malwa and Jorwe cultures overlap deposit **3230 ± 100**

Charcoal, Tr FZ 64, Layer 7, depth 1.6m; submitter's Sample DMD/2/1976-77.

PRL-412. Malwa culture **3250 ± 110**

Charcoal, Tr FZ 64, Layer 8, depth 1.7m; submitter's Sample DMD/3/1976-77.

PRL-419. Buff and Cream ware culture **2980 ± 110**

Charcoal, Tr Y′4, Layer 10, depth 1.8m; submitter's Sample DMD/11/1976-77.

PRL-420. Late Harappan culture (?) **1410 ± 140**

Charcoal, Tr HZ 64, Layer 14, depth 0.8m; submitter's Sample DMD/13/1976-77.

PRL-426. Late Harappan culture **3600 ± 150**

Charcoal, Tr CZ 61, Pit 25, depth 3.7m; submitter's Sample 26/1975-76/(2).

PRL-428. Buff and Cream ware culture **3400 ± 110**

Charcoal, Tr CZ 61, Pit 10, depth 3.2m; submitter's Sample 28/1975-76/(1).

PRL-429. Sawalda culture **3390 ± 150**

Charcoal, Tr CZ 61, Layer 16, depth 3.9m; submitter's Sample 29/1975-76. *Comment*: Sawalda culture has been dated to ca 3400 BP.

Mahagara series, Uttar Pradesh

Mahagara (25° 54′ N, 82° 3′ E), Dist Allahabad; subm by G R Sharma, Allahabad Univ, Allahabad.

PRL-407. Neolithic deposit **3300 ± 100**

Charcoal, Tr MGR-G/7, Loc XXXVI-XXXVIII, Band B in Pit sealed by Layer 17, depth 2.4 to 2.6m; submitter's Sample AU/ALLD/MGR-77/1.

PRL-408. Neolithic deposit **3190 ± 110**

Charcoal, Tr MGR-G/7, Loc XXXIX-XL, Layer 12, depth 1.25 to 1.35m; submitter's Sample AU/ALLD/MGR-77/2.

PRL-409. Neolithic deposit **3260 ± 150**

Charcoal, Tr MGR-G/7, Loc XXXIX-XL, Floor F/H13 sealed by Layer 8, depth 1.15m; submitter's Sample AU/ALLD/MGR-77/3.

Ranihat series, Uttar Pradesh

Ranihat (33° 15′ N, 78° 47′ E), Dist Tehri, subm by K P Nautiyal, Garhwal Univ, Garhwal, Srinagar.

PRL-392. Red ware deposit **1640 ± 140**

Charcoal, Tr RNT-1, Loc IV-VI, Layer 10, depth 3.1m; submitter's Sample RNT-1, 5.

PRL-394. Red ware deposit **1520 ± 140**

Charcoal, Tr RNT-1, Loc IV-VI, Layer 8, depth 2.75m; submitter's Sample RNT-1, 3.

PRL-470. Sangamner, India, gravel bed **14,400 $^{+340}_{-320}$**

Shells from gravel bed near Sangamner (19° 54′ N, 74° 16′ E), Dist Ahmednagar, subm by S N Rajaguru, Deccan Coll, Poona. *Comment*: gravel bed yielded Upper Palaeolithic tools.

Sanghol series, Punjab

Sanghol, Dist Ludhiana subm by G B Sharma, Dept Tourism and Archaeol, Patiala.

PRL-509. Late Harappan deposit **3570 ± 150**

Charcoal, Tr EX-1, Layer 48, depth 5.4m; submitter's Sample 1.

PRL-510. Late Harappan deposit **3550 ± 150**

Charcoal, Tr EX-2, pit sealed by Layer 19, depth 3.4 to 3.8m; submitter's Sample 3.

PRL-511. Late Harappan deposit **3740 ± 160**

Charcoal, Tr FX-2, Layer 23, depth 3.9 to 4.02m; submitter's Sample 4.

PRL-512. Late Harappan deposit **3350 ± 110**

Charcoal, Tr FX-2, Layer 22, depth 3.8 to 4.12m; submitter's Sample 5.

PRL-513. Late Harappan deposit **3540 ± 150**

Charcoal, Tr EX-1, hearth sealed by Layer 40, depth 7.7m; submitter's Sample 6.

PRL-515. Gray and Red ware deposit **1940 ± 100**

Charcoal, Tr DX 1, Layer 33, depth 6.2; submitter's Sample 8.

PRL-516. Black Slipped ware deposit **1870 ± 100**

Charcoal, Tr DX 1, Layer 32, depth 7m; submitter's Sample 9.

PRL-517. Black Slipped ware deposit **1990 ± 140**

Charcoal, Tr DX 1, Layer 31, 6m; submitter's Sample 10.

PRL-518. Black Slipped ware **1980 ± 100**

Charcoal, Tr DX 1, Layer 30, depth 5.5 to 6m; submitter's Sample 11.

II. QUATERNARY SAMPLES

Bhimrana series, Gujarat

Coral from Bhimrana (22° 21′ N, 69° 21′ E), Dist Jamnagar; subm by S K Gupta, PRL, Ahmedabad. *Comment*: samples measured to date sea-level changes along Saurashtra coast.

PRL-498. Inland coral reef **>35,000**

Coral, depth 0.22m; submitter's Sample TF-909A.

PRL-499. Inland coral reef **>35,000**

Coral, depth 0.22m; submitter's Sample TF-909B.

PRL-472. Kathupalli, lagoon sediment **670 ± 100**

Shell from lagoon sediment 2km NW of Kathupalli (13° 19′ N, 80° 19′ E), Dist Chingleput, alt +4m; subm by J Nageshwar Rao, Quaternary Div, Geol Survey India, Hyderabad; submitter's Sample NJ-239.

PRL-497. Kharaghoda, Rann sediments **15,300 $^{+590}_{-550}$**

Crocodile jaw bones from Kharaghoda Little Rann, Dist Kutch. Subm by S K Gupta, PRL, Ahmedabad; submitter's Sample 49. *Comment*: sample measured to date sand layers representing period of high rainfall in W India.

Krishna-Godavari delta series, Andhra Pradesh

Sediments from Krishna-Godavari delta were measured to date recent sedimentary deposits; subm by A T R Raju, Inst Petroleum Exploration, Oil and Nat Gas Comm, Dehra Dun.

PRL-448. Mukkalatippa, deltaic sediment **Modern**

Wood from river cutting at Mukkalatippa (16° 38′ N, 82° 13′ E), Dist East Godavari, depth 1.51m; submitter's Sample 1.

PRL-449. Chapala Uppada, deltaic sediment **5650 ± 120**

Calcareous segregations from Krishna-Godavari delta near Chapala Uppada (17° 55′ N, 83° 28′ E), Dist Visakhapatnam, depth 15.1m; submitter's Sample 2.

PRL-450. Jaganadhapuram, deltaic sediment **5550 ± 110**

Shells coll from deltaic sediment near Jaganadhapuram (18° 05′ N, 83° 30′ E), Dist Visakhapatnam, depth 1.2m; submitter's Sample 3.

PRL-451. Kovvada, deltaic sediment **25,200 $^{+1800}_{-1500}$**

Lignite from well near Kovvada (16° 57′ N, 82° 11′ E), Dist East Godavari, depth 197m; submitter's Sample 4.

General Comment: PRL-450, -451 were obtained to determine recent deltaic sedimentation rate.

Laccadives storm beach series

Storm beaches at Chetlad (11° 41′ N, 72° 11′ E), Bitra (11° 35′ N, 72° 09′ E) and Kiltan Islands (11° 29′ N, 73° E); subm by H N Siddiqui, Nat Inst Oceanog, Panaji, Goa. *Comment*: sample studied to assess ages of storm beach.

PRL-477. Dead coral **280 ± 90**

Dead coral from N end of Chetlat I.; submitter's Sample CHT-14.

PRL-479. Dead coral **1620 ± 100**

Dead coral from N end of Chetlat I.; submitter's Sample CHT-16.

PRL-481. Dead coral **Modern**

Dead coral from N end of Bitra I.; submitter's Sample BR-6.

PRL-484. Dead coral **2780 ± 110**

Dead coral from old coral storm beach, S end of Kiltan I.; submitter's Sample KT-18.

Pacific Ocean sediment series

Box core of calcareous sediments (Krishnamurthy *et al*, 1979, p 273-283), from Ontong Jawa plateau (0° 0.3′ S, 161° 58.5′ E) water depth 4169m. Coll by W H Berger, subm by Devendra Lal, PRL, Ahmedabad. *Comment*: samples measured to study sedimentation rate and benthic mixing.

Sample	Core no.	Core depth (mm)	^{14}C age
PRL-430	ERDC-129BX	0 to 5	4170 ± 160
PRL-431	"	5 to 10	4490 ± 130
PRL-432	"	10 to 15	3220 ± 150
PRL-433	"	15 to 20	4880 ± 160
PRL-559	"	30 to 40	6750 ± 180
PRL-434	"	40 to 50	6220 ± 100
PRL-560	"	50 to 70	8610 ± 140
PRL-435	"	70 to 90	9760 ± 220
PRL-561	"	150 to 200	15,900 $^{+290}_{-280}$
PRL-437	"	200 to 250	21,600 $^{+890}_{-800}$
PRL-438	"	280 to 330	29,000 $^{+1300}_{-1100}$

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[RADIOCARBON, VOL 23, No. 1, 1981, P 43-80]

PRETORIA RADIOCARBON DATES II

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This list contains 227 radiocarbon dates pertaining to the western part of southern Africa, between Luanda (9°S) in the north and the Orange R (29°S) in the south.

Unless otherwise stated, all samples are pretreated with hot diluted hydrochloric acid. Most samples were analyzed in two counters described previously (R, 1971, v 13, p 378), but a few dates are included from mini-counter which requires only 60mg carbon (Vogel & Behrens, 1976). Ages are calculated with the conventional half-life of 5568 yr. Corrections for variation in isotope fractionation, based on ^{13}C analysis of measured CO_2, are applied to all dates. This is also done for dates on marine shell, but since no correction is made for the apparent age of surface ocean water, these appear about 400 yr too old as listed. Some comparisons between charcoal and shell indicate that apparent age of shell from the west coast of southern Africa is about 440 yr:

	Charcoal	Shell	Difference
Arrisdrift	1200	1590	390 ± 70
Steenbras Bay	2070	2540	470 ± 70
		2440	370 ± 70
Grillenberg	980	1500	520 ± 70
			440 yr

The most probable historic date for samples with radiocarbon ages of less than 400 yr is deduced from the calibration curve for the Southern Hemisphere (R, 1970, v 12, p 466) and given in comments.

An interesting pattern is emerging in the geographic distribution of the archaeologic dates for the region. In figure 1 a histogram of the archaeologic dates in this list plus those in Deacon (1966), Vogel (1970) and Vogel & Marais (1971) is presented. As has been pointed out by Wendt (1975) there are no dates between 5100 BP and 2300 BP for the region between the Orange R and Windhoek, while there are several N of Windhoek. This gap must probably be interpreted as a period of sparse or no occupation of the area. It may be noted that, during the preceding period, from 9000 to 5000 BP, no sites are known on the interior plateau of South Africa, while at the same time the coastal region and escarpment were well occupied (Deacon, 1974). Inquiry into the reasons for such patterning will increase our understanding of the human ecology on the subcontinent. For additional dates for sites excavated by W E Wendt, see Freundlich, Schwabedisseu, and Wendt (1980).

The most important result with regard to the geologic section is the accumulation of dates between 36,000 and 28,000 BP and at ca 21,000 yr. The samples represent slightly moister conditions in the Namib desert during these two periods.

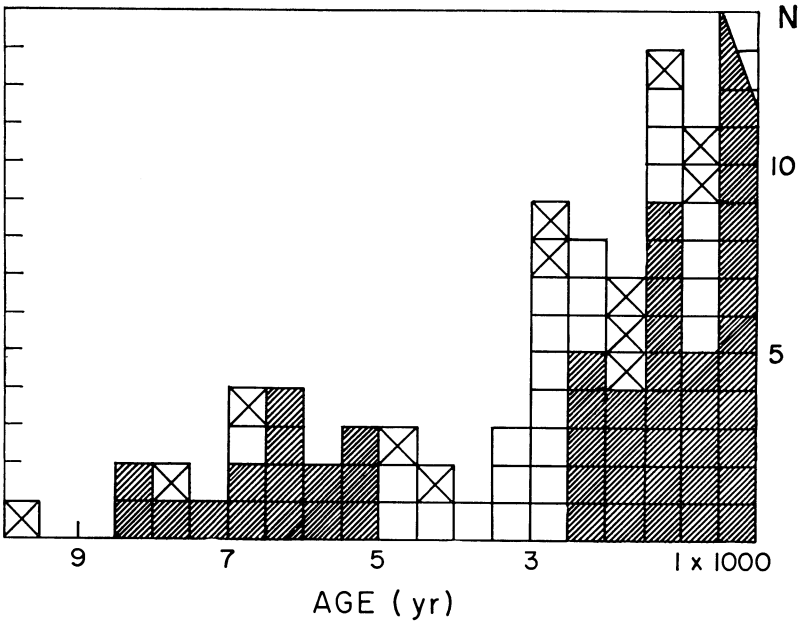

Fig 1. Histogram of the archaeologic dates of the region. The hatching indicates dates for sites S of Windhoek showing a marked gap in the period 5100 to 2300 BP. The open squares are for the region between Windhoek and the Kunene R while the crossed squares are the samples from Angola. In these areas there is a more uniform coverage.

ACKNOWLEDGMENTS

Thanks are due to all who assisted in processing the samples, especially Annemarie Fuls for her exacting work, and Lies Lursen and Siep Talma for seeing to the ^{13}C analyses.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

Arrisdrift series

At Arrisdrift on right bank of Orange R (28° 28′ S, 16° 41′ E), 30km from Oranjemund, dist Lüderitz, camp site in sand-filled gully between low dunes revealed sea shells, coarse stone flakes, and pottery with unusual decoration. Samples coll 1976; subm 1977 by W E Wendt, Box 3752, Windhoek.

Pta-1933. Arrisdrift 1 **1200 ± 50**

$\delta^{13}C = -27.1‰$

Charcoal from hearth at 5cm depth in Strip B.

Pta-1945. Arrisdrift pot **1250 ± 130**

$\delta^{13}C = -22.4‰$

Carbonaceous material scraped off potsherd from Strip A at 5cm depth. *Comment*: 190mg from surface produced, after pretreatment with acid, 114ml CO_2 which was measured in small counter (Vogel & Behrens, 1976).

Pta-2089. Arrisdrift 5A **1300 ± 50**
$\delta^{13}C = -6.0‰$

Uncharred ostrich eggshell fragments from Strip A at 5cm depth.

Pta-2136. Arrisdrift 5C **1280 ± 40**
$\delta^{13}C = -6.0‰$

Uncharred ostrich eggshell fragments from Strip C at 7 to 8cm depth.

Pta-2565. Arrisdrift 4A **1590 ± 50**
$\delta^{13}C = -0.6‰$

Patella shell from hearth at 5cm depth in Strip A. *Comment*: outer 10% of carbonate leached with acid and rest analyzed. If apparent age of 400 yr for surface ocean water is subtracted, result agrees with other dates; see Steenbras Bay series, below.

General Comment: different materials give identical results within margin of error indicating occupation at ca 1250 BP.

Fish River Mouth series

On bank of Fish R (28° 04′ S, 17° 10′ E) near junction with Orange R, dist Lüderitz, open site with evidence of fishing, glass beads, etc. Samples coll 1975; subm 1976 by P T Robertshaw, Albany Mus, Grahamstown, Cape Prov.

Pta-1895. Fish River midden **90 ± 40**
$\delta^{13}C = -25.3‰$

Charcoal from 3 to 10cm depth in shallow midden.

Pta-1902. Fish River burial **190 ± 40**
$\delta^{13}C = -12.9‰$

Human ribs from burial under stone mound at 1m depth at same site. *Comment*: purified collagen extracted from bone used for analysis. *General Comment*: according to calibration curve results suggest date between AD 1750 and 1850 although AD 1690 also possible.

Apollo 11 series

Large cave, called Apollo 11 (27° 45′ S, 17° 06′ E), in limestone wall of Nuob R valley, W of Hunsberge, ca 35km N of Orange R, dist Lüderitz. Excavations in 1969, 1972, and 1976 revealed succession of deposits containing Middle and Later Stone age assemblages and is especially notable for stratified stone slabs with paintings (Wendt, 1974; 1976). Unless otherwise stated samples coll 1972; subm 1973 by W E Wendt.

Pta-505. Apollo 11. V2 **>50,500**
$\delta^{13}C = -5.9‰$

Ostrich eggshell from Sq A11 at 80 to 85cm depth in Layer G with "upper" Middle Stone age assemblage including blades and dorsally retouched points. Coll 1969; subm 1971. *Comment*: 50% carbonate removed with acid and rest analyzed.

Pta-507. Apollo 11. V1 **>49,000**
$\delta^{13}C = -5.1‰$

Ostrich eggshell from Sq A10 at 20 to 55cm depth in Layer G with "upper" Middle Stone age assemblage. Coll 1696; subm 1971. *Comment*: 50% carbonate removed with acid and rest dated.

Pta-1415. Apollo 11. V12 **>48,400**
$\delta^{13}C = -2.4‰$

Ostrich eggshell from Sq B3, in front of cave, at 115 to 120cm depth in Layer F with Middle Stone age blade industry of Howieson's Poort affinity. *Comment*: 37% carbonate removed with acid and rest analyzed.

General Comment: results, as well as several KN-dates from this site (Wendt, 1974), confirm Middle Stone age, including Howieson's Poort industry, beyond range of radiocarbon dating (Vogel & Marais, 1971; Vogel & Beaumont, 1972; Clark, 1975).

Pta-1032. Apollo 11. V11 **21,600 ± 300**
$\delta^{13}C = -22.3‰$

Twigs from Sq $A8X_2$ at 65 to 70cm depth in bottom of Layer E which contained indeterminate artifact assemblage. *Comment*: pretreated with acid and alkali. Much younger than overlying samples (Pta-1040, below) and must be rejected as spurious. Contamination cannot explain discrepancy, but one sub-recent twig in sample could.

Pta-1041. Apollo 11. V10 **39,800 ± 1700**
$\delta^{13}C = -20.3‰$

Twigs from Sq $A9X_2$ at 49 to 57cm depth in Layer E with indeterminate macrolithic industry directly below 2 painted stone slabs. *Comment*: pretreated with acid and alkali. Comparable to KN-I 869: 33,370 ± 550 and overlying KN-I 847: $46{,}400\ ^{+3500}_{-2500}$.

Pta-1040. Apollo 11. V9 **26,300 ± 400**
$\delta^{13}C = -10.1‰$

Piece of charred wood in Sq $A8X_2$ at 60cm depth in top of Layer E, same level as painted stones. *Comment*: pretreated with acid and alkali. Sample, together with KN-I 813: 26,700 ± 650, KN-2056: 28,400 ± 450, dates painted stone slabs.

Pta-1039. Apollo 11. V8 **18,500 ± 200**
$\delta^{13}C = -19.5‰$

Unburnt twigs and fine plant remains from Sq $A8X_2$ at 51 to 57cm depth at base of Layer D, just overlying painted slabs, assoc with undiagnostic macrolithic early Later Stone age assemblage. *Comment*: pretreated with acid and alkali. Comparable to KN-2057: 18,660 ± 210, KN-I 812: 19,760 ± 175.

Pta-1010. Apollo 11. V7 **13,000 ± 120**
$\delta^{13}C = -24.5‰$

Concentration of charcoal from Sq A8X$_2$ at 36 to 38cm depth in Layer D. *Comment*: pretreated with acid and alkali.

Pta-1021. Apollo 11. V6 **12,500 ± 120**
$\delta^{13}C = -23.7‰$

Scattered charcoal from Sq A8X$_2$ at 25 to 27cm depth in top of Layer D. *Comment*: pretreated with acid and alkali.

Pta-1020. Apollo 11. V4 **7280 ± 80**
$\delta^{13}C = -23.5‰$

Scattered charcoal from Sq A7 at 19 to 26cm depth in Layer C with typical microlithic Later Stone age assemblage (Wilton industry). Coll 1969; subm 1973. *Comment*: pretreated with acid and alkali. Stratigraphically between KN-I 610: 9430 ± 90 and KN-I 609: 6200 ± 65 in same layer. KN-I 611: 10,420 ± 80 possibly also belongs to this level.

Pta-1019. Apollo 11. V5 **6480 ± 80**
$\delta^{13}C = -24.8‰$

Concentration of charcoal from Sq B9 at 19 to 21cm depth in Layer C where it tapers out. *Comment*: pretreated with acid and alkali. Erroneously given as 6680 BP (Wendt, 1974; 1976).

Pta-1918. Apollo 11. V13 **1960 ± 45**
$\delta^{13}C = -24.8‰$

Scattered twigs from Sq A8X$_1$ at 15 to 20cm depth in base of level with late Later Stone age assemblage including potsherds, glass beads, and iron. This basal level now considered separate layer (Layer B) with pottery Wilton industry. Coll 1976; subm 1977. *Comment*: KN-I 870: 1670 ± 55 and KN-I 846: 1460 ± 55 in similar stratigraphic position. Deposits too thin to accurately determine first occurrence of pottery.

Pta-1009. Apollo 11. V3 **320 ± 40**
$\delta^{13}C = -25.8‰$

Concentration of charcoal in Sq B3 under dripline at 5 to 8cm depth in Layer A containing coarse Later Stone age assemblage with potsherds, glass beads, and iron fragments. *Comment*: pretreated with acid and alkali. Compare KN-I 608: 440 ± 45 for same layer. Calibration of result suggests date between AD 1480 and AD 1630.

General Comment: this most complete sequence in SW Africa suggests following dates for different Stone age assemblages.

Layer A.	Final LSA with pottery	— between AD 1480 and 1630
Layer B.	Pottery Wilton (?)	— between 1960 and 1460 BP
Layer C.	Pre-pottery Wilton	— from 9430 to 6200 BP
Layer D.	Early LSA	— from ca 19,000 to 12,500 BP
Layer E.	Undefined industry	— from 39,800 to 26,300 BP
Layer F.	Howieson's Poort MSA	— >48,400 BP
Layer G.	Typical MSA	— >49,000 BP

Pta-2663. Aurus 6 **1160 ± 50**
$\delta^{13}C = -21.2‰$

Cache of nara seeds from deposit in cave at Aurus waterhole (27° 38′ S, 16° 13′ E), 100km N of Oranjemund, S Namib desert. Subm 1977 by W E Wendt.

Pockenbank 1 series

Medium-sized cave in limestone wall of small valley on farm Pockenbank (27° 13′ S, 16° 31′ E) 60km SSE of Aus, dist Lüderitz. Some rock paintings in cave and engravings on bare rock nearby. Below surface dust deposit consists of 10 to 20cm compact lens at rear with pottery Wilton assemblage, then down to ca 40cm depth a poor Later Stone age horizon without microliths, followed by horizon with coarse macrolithic artifacts down to 120cm, and typical Middle Stone age level with flake-blades and retouched points down to 220cm (Wendt, 1972). Excavated 1969; subm 1973 by W E Wendt.

Pta-544. Pockenbank V3 **31,200 ± 450**
$\delta^{13}C = -20.1‰$

Charcoal from Sq A8 at 100 to 104cm depth towards bottom of layer with indeterminate macrolithic artifacts perhaps with some Middle Stone age affinities. *Comment*: pretreated with acid. Since sample all dissolved in alkali, this fraction precipitated and analyzed. Result, thus, only minimum date.

Pta-504. Pockenbank V2 **49,500 $^{+5400}_{-3100}$**
$\delta^{13}C = -5.5‰$

Ostrich eggshell from Spit 102 to 112cm in Sq A8. *Comment*: outer 20% carbonate etched off with acid and rest analyzed.

Pta-503. Pockenbank V1 **35,600 ± 680**
$\delta^{13}C = -4.9‰$

Ostrich eggshell from Spit 92 to 102cm in Sq A8. *Comment*: ca 50% carbonate etched off with acid and rest analyzed.

General Comment: since both eggshell dates older than charcoal date (Pta-544), latter must be rejected and lower part of level must be older than 43,300 (Pta-504, 2σ).

Pta-1203. Pockenbank V4 **19,700 ± 220**
$\delta^{13}C = -22.7‰$

Charcoal from lens, 12 to 16cm depth in Sq A5 in early Later Stone age layer. *Comment*: pretreated with acid and alkali. Compare Pta-1039: 18,500 ± 200, Pta-1010: 13,000 ± 120, Pta-1021: 12,500 ± 120 for similar industry in Apollo 11 cave, above.

Pta-1202. Pockenbank V5 **370 ± 50**
$\delta^{13}C = -23.9‰$

Twigs, grass, and leaves from 3 to 8cm depth in Sq A7 assoc with microlithic Later Stone age (Wilton) with potsherds, glass beads, and iron

objects. *Comment*: calibrated date of AD 1470 (or AD 1590) is reliable result for late Wilton with pottery.

Aar 2 series

Second small cave excavated on farm Aar (26° 43′ S, 16° 31′ E), 20km E of Aus, dist Lüderitz, contained recent, Late, and Middle Stone age material in ca 1m deposit. Samples coll 1972; subm 1973 by W E Wendt (1972; 1975).

Pta-1751. Aar 2. P3 **6940 ± 80**
$\delta^{13}C = -6.2‰$

Ostrich eggshell from Sq B4 at 8 to 16cm depth in typical microlithic Late Stone age layer without pottery. *Comment*: pretreated with acid to remove 34% sample and remaining carbonate analyzed.

Pta-1050. Aar 2. P2 **120 ± 45**
$\delta^{13}C = -24.3‰$

Charcoal from Sq B3 at 23 to 27cm depth in ashy pit of Later Stone age layer with glass beads. *Comment*: pretreated with acid and alkali.

Pta-1046. Aar 2. P1 **100 ± 45**
$\delta^{13}C = -23.2‰$

Charcoal from Sq A3 at 6 to 9cm depth in same Later Stone age layer as sample P2 above. *Comment*: pretreated with acid and alkali.

General Comment: most probable date for P1 and P2, above, derived from calibration curve is AD 1825, but AD 1690 also possible.

Pta-2265. Aar 1 Pot **80 ± 40**
$\delta^{13}C = -20.8‰$

Carbonaceous material scraped off pot found in small shelter on farm Aar (26° 43′ S, 16° 31′ E) in 1967. Subm 1978 by W E Wendt.

Steenbras Bay series

Open shallow shell midden at Steenbras Bay (26° 40′ S, 15° 08′ E) on Lüderitz peninsula containing typical microlithic Later Stone age artifacts without pottery (Wendt, 1975, p 24). Coll 1972; subm 1973 by W E Wendt.

Pta-1049. Steenbras Bay S3 **2070 ± 50**
$\delta^{13}C = -24.9‰$

Scattered charcoal fragments from Sq X3 at 10 to 20cm depth in middle level of midden with mainly *Mytilus* shells. *Comment*: pretreated with acid and alkali.

Pta-1045. Steenbras Bay S2 **2540 ± 50**
$\delta^{13}C = +0.0‰$

Patella shell from Sq X3 at 20cm depth at base of midden. *Comment*: outer 15% carbonate leached with acid and rest analyzed.

Pta-1042. Steenbras Bay S1 **2440 ± 50**
$\delta^{13}C = +0.3‰$

Patella shell from Sq X4 at 3 to 5cm depth in surface layer of midden. *Comment*:outer 17% carbonate leached with acid and rest analyzed.

General Comment: as expected isotope corrected dates for sea shell here average 420 yr too high. Correction of 400 yr, thus, also applies to this coast with its extensive upwelling.

Pta-2264. Lüderitz potsherd **300 ± 50**
$\delta^{13}C = -17.7‰$

Soot scraped from potsherd from vicinity of Lüderitz (26° 38′ S, 15° 09′ E) now in Lüderitz Mus. Coll by W E Wendt; subm 1977 by Wendt and Vogel. *Comment*: calibrated date between AD 1480 and 1640.

Pta-2296. Nautilus pot **400 ± 50**
$\delta^{13}C = -19.0‰$

Soot scraped from pot found at Nautilus/Buschfeld (26° 37′ S, 15° 11′ E), 3km N of Lüderitz and now in Lüderitz Mus (Cat No. 1192 or 1193). Coll by W E Wendt; subm 1977 by Wendt and Vogel. *Comment*: calibrated date, AD 1460.

Haalenberg series

Small shelter in granite Inselberg near Haalenberg (26° 36′ S, 15° 34′ E), 40km E of Lüderitzbucht, dist Lüderitz, revealed sequence of Later and Middle Stone age occupation. Excavated 1976; samples subm 1977 by W E Wendt.

Pta-2115. Haalenberg P4 **40,100 ± 1630**
$\delta^{13}C = -3.8‰$

Ostrich eggshell fragments from Sq B, Spit 6 at 26 to 28cm depth, near bedrock. Base of early Later Stone age level, but few Middle Stone age artifacts occur on bedrock. *Comment*: outer 34% carbonate removed with acid and rest analyzed. Result earlier than similar assemblages at, eg, Nos, below.

Pta-1927. Haalenberg P3 **2200 ± 50**
$\delta^{13}C = -26.5‰$

Charred bark(?) from Sq B, Spit 4 at 20 to 24cm depth at base of Later Stone age level.

Pta-2650. Haalenberg P2 **2300 ± 50**
$\delta^{13}C = -22.5‰$

Charcoal from Sq B, Spit 3 at 12 to 18cm depth in Later Stone age level with few microliths.

Pta-1923. Haalenberg P1 **(106.5 ± 0.6)%**
$\delta^{13}C = -16.1‰$

Twigs from Sq B, Spit 1 at 2 to 6cm depth in level without European artifacts, stone microliths or pottery, but with some crude stone flakes.

Comment: sample contains atom bomb ^{14}C and dates to AD 1957 according to calibration curve for post 1950 (Vogel & Marais, 1971, p 392). Obviously recent introduction.

Tiras 5 series

Small shelter in granite hills on farm Tiras (26° 13′ S, 16° 34′ E), 60km NNE of Aus, dist Bethanie, with white "sailing ship" painting on overhang and 35cm of Later Stone age deposit stratified in two levels. Samples coll 1970; subm 1973 by W E Wendt (1972; 1975).

Pta-1184. Tiras 5. P2 **130 ± 45**

$\delta^{13}C = -18.4‰$

Charcoal from ash lens in Sq A2 at 12 to 14cm depth in top of microlithic Later Stone age level.

Pta-1183. Tiras 5. P1 **100 ± 50**

$\delta^{13}C = -16.5‰$

Twigs from Sq A1 at 5 to 9cm depth in upper Later Stone age level with metal fragments, pottery and some stone artifacts.

General Comment: samples pretreated with acid and alkali. Sample P2 probably does not date bottom Later Stone age level, but belongs to base of upper level. Most probable date from calibration curve is AD 1820 but AD 1690 also possible. Similar to results from Aar 2, above.

Pta-2295. Hottentot Bay Pot **490 ± 50**

$\delta^{13}C = -18.4‰$

Soot scraped from pot found 1969 at Hottentot Bay (26° 09′ S, 14° 58′ E), 60km N of Lüderitz and now in Lüderitz Mus. Coll by W E Wendt; subm 1977 by Wendt and Vogel. *Comment*: calibrated date AD 1420.

Namtib series

Shelter on small, isolated granite hill on farm Namtib (26° 02′ S, 16° 15′ E) 85km N of Aus, dist Lüderitz, excavated 1970. Deposit consisted of two Later Stone age layers (Wendt, 1972). Samples coll 1970; subm 1973 by W E Wendt.

Pta-1186. Namtib P2 **5400 ± 70**

$\delta^{13}C = -18.9‰$

Concentrated charcoal fragments from Sq A3 at 31 to 38cm depth in bottom of microlithic Later Stone age layer.

Pta-1185. Namtib P1 **7840 ± 90**

$\delta^{13}C = -24.2‰$

Scattered charcoal fragments from Sq A4 at 21 to 28cm depth in upper, disturbed Later Stone age layer with pottery and nondescript stone artifacts.

General Comment: both samples pretreated with acid and alkali. Sample P1 obviously does not date upper layer and must be derived charcoal. Date for Sample P2 acceptable for Wilton industry; compare Apollo 11, Aar 2, above.

Kumakams series

Small shelter on farm Kumakams (25° 41′ S, 16° 59′ E), dist Maltahöhe contains shallow deposit with Later Stone age assemblage including microlithic elements and glass. Coll 1972; subm 1977 by W E Wendt.

Pta-1991. Kumakams 1. P2 **50 ± 45**

$\delta^{13}C = -24.5‰$

Charcoal lumps from 8 to 10cm depth.

Pta-2143. Kumakams 1. P1 **30 ± 35**

$\delta^{13}C = -23.8‰$

Charcoal lumps from 15cm depth.

General Comment: together results suggest calibrated date post AD 1850 but deposit may contain older artifacts.

Pta-2662. Maguams **380 ± 50**

$\delta^{13}C = -23.0‰$

Charcoal from 25cm depth assoc with microlithic Later Stone age assemblage in shelter with rock paintings on farm Maguams (25° 32′ S, 16° 52′ E), dist Maltahöhe (Wendt, 1972). Coll 1969; subm 1977 by W E Wendt. *Comment*: calibrated date AD 1470, but 1590 also possible.

Nos series

At Nos waterhole (25° 28′ S, 15° 30′ E) in granite Inselberg halfway between escarpment and coast in Central Namib desert, dist Lüderitz, 30cm cultural deposit with pre-, typical and sub-recent Later Stone age levels, excavated in 1970. Samples coll and subm 1973 by W E Wendt.

Pta-1750. Nos P3 **22,100 ± 220**

$\delta^{13}C = -4.3‰$

Portion of 6.5kg lens of ostrich eggshell in Sq A3 at 15 to 30cm depth in basal "pre-Later Stone age" level with coarse indeterminate stone artifacts. *Comment*: pretreated with acid to remove 35% sample and remaining carbonate analyzed. Compare Apollo 11, Pta-1041: 39,800 ± 1700, Pta-1040: 26,300 ± 400 and Pockenbank Pta-544: 31,200 ± 450, above, for similar artifact assemblages.

Pta-1131. Nos P2 **330 ± 50**

$\delta^{13}C = -22.1‰$

Scattered fragments of charcoal, twigs, and seeds from Sq A2 at 10 to 15cm depth in top of 2nd layer with pottery and typical microlithic Later Stone age tools. *Comment*: pretreated with acid and alkali. Calibrated date between AD 1470 and 1630.

Pta-1132. Nos P1 **40 ± 50**

$\delta^{13}C = -23.2‰$

Scattered charcoal, twigs, and seeds from Sq A3 at 3 to 5cm depth in upper layer with pottery, iron fragments, and nondescript stone artifacts. *Comment*: pretreated with acid and alkali. Calibration curve suggests post AD 1830 date.

Pta-2470. Sossusvlei **270 ± 50**
$\delta^{13}C = -23.7‰$

Charcoal from hearth of small camp site with pottery, glass beads, and crude stone flakes in foot of low dune at Sossusvlei (24° 46′ S, 15° 21′ E), Central Namib desert. Coll 1977 and subm by W E Wendt. *Comment*: possibility that old dead wood was burned. Calibrated date is AD 1520 or 1630. Compare Nos, Tiras 5, Aar 2, Kumakams, above, for related sites.

Zebrarivier series

Test pit A1 in narrow cave about 10m deep into flank of mountain ridge on farm Zebrarivier (24° 29′ S, 16° 16′ E), dist Maltahöhe revealed Later Stone age level overlying early Later Stone age and Middle Stone age levels down to 120cm (Wendt, 1972). Coll 1970; subm 1977 by W E Wendt.

Pta-1996. Zebrarivier P1 **11,900 ± 90**
$\delta^{13}C = -23.0‰$

Twigs and charcoal from 25cm depth at base of level with poor Later Stone age assemblage containing some microlithic elements. *Comment*: very early for microlithic (Wilton) industry, see Apollo 11 series above.

Pta-2142. Zebrarivier P2 **>48,200**
$\delta^{13}C = -22.9‰$

Charcoal from 70cm depth in Middle Stone age level.

Grillenberg series

130km S of Walvis Bay and 6km N of abandoned diamond digging settlement, Grillenberg is a complex of hut circles (24° 6′ S, 14° 34′ E) constructed of thin granite slabs set upright into sand. Site situated between extended barkan dunes in complete desert with no plant in sight. Site 15km from coast and 12km S of nearest water hole at Conception Bay. Coll and subm 1977 by J C Vogel.

Pta-1832. Grillenberg charcoal **980 ± 50**
$\delta^{13}C = -12.0‰$

Scattered charcoal in hearth area between hut circles, 3 to 6cm below surface.

Pta-1824. Grillenberg shell **1500 ± 40**
$\delta^{13}C = +0.7‰$

Bivalve shells from same hearth area, 3 to 6cm below surface. *Comment*: 34% removed with acid and remaining carbonate dated. If apparent age of sea shells of 400 yr is subtracted, result in accordance with Pta-1832, above.

General Comment: occurrence of well-constructed settlement so far from both fresh water and the sea, and even further from other food resources is strange. No potsherds or other artifacts noticed on site; bones present in hearth.

Conception Bay series

Fresh water available at 3m depth ca 8km SE of old landing place at Conception Bay (24° 01′ S, 14° 34′ E), 110km S of Walvis Bay. Surroundings dotted with stone artifacts, shallow shell middens and often a human skeleton exposed by shifting sand.

Pta-1863. Conception bone **710 ± 50**

$\delta^{13}C = -12.9‰$

Collagen from femur of intact adult skeleton buried in sand in crouched position and still covered with hair probably of caross in which corpse was wrapped (Kolb, 1719), some 200m N of German water hole. Coll and subm 1977 by J C Vogel. *Comment*: purified collagen prepared from 50g bone.

Pta-902. Conception pot CP1 **620 ± 40**

$\delta^{13}C = -17.5‰$

Carbonaceous matter scraped from surface of broken bag-shaped pot with pointed base, decorated neck and 2 externally applied, horizontally pierced lugs, found in sand near skeleton CB2. Coll and subm 1973 by J C Vogel (Jacobson & Vogel, 1979).

Pta-1801. Conception pot CP2 **310 ± 20**

$\delta^{13}C = -19.0‰$

Carbonaceous matter scraped from surface of bag-shaped pot with pointed base and 2 horizontally pierced lugs found 1976 by B Kensley near old house at "windmill" and subm 1976 by L Jacobson, State Mus Windhoek. *Comment*: most probable calibrated date between AD 1490 and 1620.

Pta-1834. Conception midden **220 ± 50**

$\delta^{13}C = -21.5‰$

Scattered charcoal from shallow shell midden close to CB 1 and 2 on which copper bead was noticed. Coll and subm 1977 by J C Vogel. *Comment*: most probable calibrated date AD 1650.

General Comment: Conception Water Place obviously visited over many centuries in this millennium in connection with utilization of marine resources.

Pta-2361. Hudaob hut circles **70 ± 50**

$\delta^{13}C = -24.5‰$

Charcoal from near surface between hut circles formed of upright schist slabs ca 1km S of Hudaob on Kuiseb R (23° 43′ S, 15° 26′ E), 45km upstream from Gobabeb, dist Walvis Bay. Coll and subm 1978 by J C Vogel. *Comment*: calibrated date post AD 1820, but direct assoc with hut circles not certain. Compare Grillenberg, above for similar hut circles.

Cha-ré Shelter series

Cha-ré rock shelter (23° 39′ S, 15° 55′ E), 35km N of Solitaire, dist Rehoboth, contains 120cm deposit with Later Stone age artifacts. Samples coll and subm 1977 by B H Sandelowsky, Box 11174, Klein Windhoek.

Pta-2077. Cha-ré 3 **6840 ± 70**
$\delta^{13}C = -23.6‰$

Charcoal concentration at 70 to 90cm depth in dark brown layer.

Pta-2075. Cha-ré 2 **5740 ± 60**
$\delta^{13}C = -16.5‰$

Charcoal from hearth at 25 to 30cm depth in ashy layer.

Pta-2082. Cha-ré 1 **30 ± 50**
$\delta^{13}C = -20.6‰$

Organic matter from dung floor at 15cm depth. *Comment*: most probable calibrated date post AD 1870.

General Comment: deeper levels of same age as in Mirabib shelter, below.

Gorob River mouth series

Remains on Kuiseb R terrace at juncture of Gorob R (23° 40′ S, 15° 17′ E), dist Walvis Bay, indicate previous occupation by herders. Coll and subm 1977 by B Sandelowsky.

Pta-1988. Gorob mouth charcoal **1210 ± 50**
$\delta^{13}C = -25.2‰$

Charcoal from ash layer on surface with potsherds, stone artifacts, etc.

Pta-2066. Gorob mouth log **110 ± 50**
$\delta^{13}C = -26.2‰$

Wood from collapsed log enclosure on terrace near eight stone cairns.

General Comment: site obviously occupied intermittently over long period. Calibrated date for Pta-2066 is post AD 1800 but 1690 also possible.

Pta-1344. Gorob skeleton **750 ± 80**
$\delta^{13}C = -14.0‰$

Collagen from femur of incomplete skeleton found below stone mound on barren desert plain (23° 37′ S, 15° 18′ E), 5km NE of juncture of Gorob R with Kuiseb R, dist Walvis Bay. Coll and subm 1974 by B H Sandelowsky. *Comment*: 1.3g purified collagen obtained from 150g bone. See Pta-2006, below.

Pta-2596. Gobabeb **12,800 ± 140**
$\delta^{13}C = -23.7‰$

Charcoal from hearth covered by 5cm sand and surrounded by scatter of stones and *Oryx* bones on dune overlooking Kuiseb R (23° 33′ S, 15° 00′ E), 2km W of Gobabeb, dist Walvis Bay (Sandelowsky, 1976). Coll and subm 1979 by J C Vogel. *Comment*: pretreated with acid and alkali. Date shows unexpected stability of dune surface since Upper Pleistocene.

Pta-2006. Narob grave **1720 ± 45**
$\delta^{13}C = -25.9‰$

Plant material next to skeleton at 30cm below natural surface under Stone Cairn A, W of Narob (23° 29′ S, 14° 57′ E), on right bank of Kuiseb

R, 15km downstream from Gobabeb, dist Walvis Bay. Coll and subm 1977 by B H Sandelowsky. *Comment*: sample probably assoc with burial. Earliest date for cairn burial thus far, see Pta-1344, above.

Mirabib Hill Shelter

Excavations by B H Sandelowsky in rock shelter near Mirabib hill (23° 27′ 48″ S, 15° 19′ 30″ E), an Inselberg in the Namib desert 22km N of Kuiseb R and 88km inland from Sandwich Bay, revealed stratified deposit to max depth of 85cm with Later Stone age artifacts, plant, and animal remains. Stone artifacts mainly of quartz (Sandelowsky, 1974a; 1977). Samples coll 1973 to 1975 and subm by B H Sandelowsky.

Pta-1368. Mirabib 8 **8410 ± 80**
$\delta^{13}C = -25.2‰$

Scattered charcoal from Sqs C/D 34, towards back of shelter, 65cm to bedrock.

Pta-1013. Mirabib 4 **8200 ± 80**
$\delta^{13}C = -23.9‰$

Charcoal from Sq C 35 at 35 to 40cm depth.

Pta-1012. Mirabib 3 **6470 ± 80**
$\delta^{13}C = -24.2‰$

Charcoal from Sq C 35 at 25 to 30cm depth. *Comment*: pretreated with acid and alkali.

Pta-1011. Mirabib 2 **5190 ± 80**
$\delta^{13}C = -23.1‰$

Charcoal from Sq C 35 at 5 to 10cm depth just below patch of dung floor. *Comment*: pretreated with acid and alkali.

Pta-1536. Mirabib 12 **6500 ± 80**
$\delta^{13}C = -24.1‰$

Scattered charcoal from Sq F 35, towards front of shelter, 70cm to bedrock.

Pta-1347. Mirabib 7 **6330 ± 60**
$\delta^{13}C = -23.7‰$

Scattered charcoal from Sq E 35 at 50 to 55cm depth just above layer of aeolian sand. *Comment*: pretreated with acid and alkali.

Pta-1348. Mirabib 6 **5570 ± 50**
$\delta^{13}C = -23.6‰$

Charcoal from hearth in Sq G 35 at 25cm depth. *Comment*: pretreated with acid and alkali.

Pta-1535. Mirabib 9 **1550 ± 50**
$\delta^{13}C = -21.5‰$

Dung from lowest of three dung floors in Sqs F/G 34 at 6.5cm depth. Coll 1975 by J C Vogel. Hair coll from sample id. as sheep

(Sandelowsky, van Rooyen, & Vogel, 1979), proving presence of herders in region by AD 400.

General Comment: results indicate three periods of occupation: at back of cave 35cm deposit dates to 9th millennium BP, followed by level dating to between ca 6500 and 5200 BP and overlain by thin herder layer with dung floors, potsherds, etc, dating to AD 400.

Wortel series, Walvis Bay

Several shell middens at Wortel (23° 03′ S, 14° 28′ E), inland of coastal dunes in delta of Kuiseb R, 9km S of Walvis Bay were investigated by L Jacobson in 1976 (Jacobson & Vogel, 1977).

Pta-1645. Wortel KM2 **400 ± 50**

$\delta^{13}C = -24.2‰$

Charcoal from hearth in midden KM2 at 5cm depth assoc with potsherds, bone points, ostrich eggshell beads, and grindstones. Coll and subm 1976 by L Jacobson. *Comment*: calibrated date AD 1460.

Pta-1651. Wortel KM3 **260 ± 50**

$\delta^{13}C = -12.0‰$

Charcoal from hearth in midden KM3 at 25cm depth assoc with potsherds, etc. Coll and subm 1976 by L Jacobson. *Comment*: calibrated date AD 1635 or 1520.

Pta-2554. Wortel WM1 **370 ± 30**

$\delta^{13}C = -21.1‰$

Scattered charcoal fragments from midden WM1 assoc with copper fragments and beads. Coll and subm 1979 by J Kinahan, State Mus, Windhoek. *Comment*: calibrated date AD 1470 or 1590.

General Comment: these middens pre-date European colonization of SW African coast.

Rehoboth series

Smelting site for iron and/or copper in townlands of Rehoboth (23° 20′ S, 17° 05′ E) investigated 1970 by B H Sandelowsky (1974b). Assoc stone tuyères widely distributed in central and S parts of region, from Ovitoto near Okahandja to Warmbad (Sandelowsky & Pendleton, 1969). Samples coll 1970; subm 1971 by B H Sandelowsky.

Pta-434. Rehoboth 3 **250 ± 45**

$\delta^{13}C = -23.7‰$

Charcoal assoc with slag in Sq C4/c2 at 25cm depth.

Pta-433. Rehoboth 2 **230 ± 40**

$\delta^{13}C = -24.2‰$

Scattered charcoal assoc with slag in Sq A1/b4 at 35cm depth.

Pta-432. Rehoboth 1 **220 ± 50**

$\delta^{13}C = -24.2‰$

Scattered charcoal assoc with slag in Sq A2/b1 at 5cm depth.

General Comment: taken together, most probable calibrated date is AD 1645 ± 5 (±1σ); only direct date for metal working in territory thus far.

Pta-2573. Friedenau slag **420 ± 50**

$\delta^{13}C = -23.4‰$

Charred material contained in slag from near Matchless copper deposit on farm Friedenau (22° 42′ S, 16° 50′ E), dist Windhoek. Coll and subm 1979 by J Kinahan. *Comment*: oldest evidence of copper smelting in region.

Otjompaue series

Copper smelting furnaces formed partly of stone slabs on farm Otjompaue (22° 35′ S, 16° 50′ E), dist Windhoek. Coll and subm 1979 by J Kinahan.

Pta-2559. Otjompaue furnace 2 **280 ± 40**

$\delta^{13}C = -24.0‰$

Concentration of charcoal from 18cm depth in base of smelting furnace 2.

Pta-2564. Otjompaue furnace 1 **130 ± 50**

$\delta^{13}C = -23.4‰$

Concentration of charcoal from 15cm depth in base of smelting furnace 1.

General Comment: calibrated dates of AD 1620 or 1520 and AD 1690 or 1820, respectively, suggest 17th century date for these furnaces; compare Rehoboth series, above.

Pta-1627. Karamba GK 203 **80 ± 35**

$\delta^{13}C = -25.1‰$

Charcoal from lump of slag found on surface at farm Karamba (21° 57′ S, 18° 08′ E), dist Gobabis. Coll by R Wadley; subm 1976 by L Jacobson. *Comment*: charcoal extracted from slag and pretreated with acid. Most probable calibrated date is AD 1820 to 1920, but AD 1690 also just within ±1σ range.

Big Elephant Shelter series

Big Elephant Shelter in S Erongo Mts on farm Ameib (21° 50′ S, 15° 40′ E), dist Karibib, 20km N of Usakos previously produced dates of 1400 ± 80 (UCLA-724B) and 2550 ± 80 (UCLA-724A), apparently on surface material, togteher with potsherds (Clark & Walton, 1962; Beaumont & Vogel, 1972, p 83). Excavation of NW sec in 1974 by L Wadley yielded apparently homogeneous Later Stone age assemblage with potsherds, glass, copper and iron beads, bones of several antelope and sheep(?), and plant remains (Wadley, 1976; 1979). Samples coll and subm 1975 by L Wadley, Ranfontein, Transvaal.

Pta-1557. Big Elephant Shelter 2 **3130 ± 40**

$\delta^{13}C = -24.7‰$

Accumulation of charcoal in Sq L4 at 35cm depth, near base of deposit.

Pta-1556. Big Elephant Shelter 1 **2600 ± 50**

$\delta^{13}C = -24.5‰$

Charcoal from Sq L4 at 5cm depth, just below grass bedding layer. *Comment*: similar to UCLA-724A: 2550 ± 80 for probably surface sample from this area.

Pta-1558. Big Elephant Shelter 3 **1080 ± 50**

$\delta^{13}C = -24.0‰$

Charcoal from Sq K5 at 31cm depth, near bedrock.

General Comment: Pta-1557 and -1556 unexpectedly old for pottery and sheep but stratigraphy obviously complicated.

Pta-2230. Striped Giraffe Shelter **370 ± 40**

$\delta^{13}C = -15.8‰$

Collagen from skull of sheep with horn cores from 15 to 23cm depth in Spit 3, Sq A4 of Striped Giraffe Shelter (21° 48′ S, 15° 42′ E) in Erongo Mts, dist Karibib. Site excavated 1962 contained micro/macrolithic Later Stone age assemblage with pottery in upper levels (Sandelowsky & Viereck, 1969). Coll 1962 by A Viereck; subm 1977 by L Jacobson and id. as *Ovies aries* by I Plug (1979). *Comment*: 9g purified collagen extracted from 37g bone. Other dates for site are SR-63: 4590 ± 100 close to bedrock and SR-64: 3080 ± 100 15cm higher up.

Pta-2681. Messum 1 **1370 ± 50**

$\delta^{13}C = -14.3‰$

Plant fiber from Sq A9 in upper level assoc with pottery and iron in Shelter 1 in Messum Mt (21° 22′ S, 14° 17′ E), 150km N of Swakopmund, Damaraland. Coll and subm 1977 by W E Wendt. *Comment*: compare Pta-2664, Ururu, below.

Hungarob Schlucht series

Hungarob Schlucht (21° 14′ S, 14° 31′ E) is one of numerous ravines in S Brandberg Massif, 170km N of Swakopmund and on inland margin of Namib desert. Samples subm by L Jacobson.

Pta-1625. Hungarob pot **50 ± 45**

$\delta^{13}C = -23.8‰$

Charcoal scraped from surface of whole pot found in small overhang in Hungarob Schlucht. Vessel bag-shaped with applied lugs and crack repaired with wire. Coll 1974; subm 1976. *Comment*: calibrated date post AD 1830 for last use of vessel.

Pta-2107. Hungarob Site H9 **20 ± 50**

$\delta^{13}C = -23.5‰$

Charcoal from stone hut circle of Brandberg industry at Site H9 in Hungarob Schlucht. Coll and subm 1977. *Comment*: most probable calibrated date AD 1890 which is younger than other sites of Brandberg industry, see below.

Orabes Schlucht series

In Orabes Schlucht (21° 13′ S, 14° 37′ E), Brandberg, both occupied shelters and open hut circle sites occur (Jacobson & Vogel, 1975). Coll and subm 1974 by L Jacobson unless otherwise indicated.

Pta-1296. Upper Orabes Shelter 04.L21 **180 ± 45**

$\delta^{13}C = -23.2‰$

Charcoal from ash layer Spit 2 at 10 to 20cm depth in Upper Shelter, Site 04 assoc with microlithic Later Stone age artifacts and pottery. *Comment*: most probable calibrated date is AD 1645 to 1830 (± 1σ).

Pta-1380. Lower Orabes Shelter 05.L1 **150 ± 35**

$\delta^{13}C = -23.3‰$

Charcoal from hearth in Sq E4, Spit 1 at 6cm depth in Lower Shelter. Site 05 assoc with microlithic Later Stone age artifacts and potsherds and overlying burial of Khoikhoin male (de Villiers, 1975). *Comment*: most probable calibrated date is AD 1650 to 1840 (± 1σ).

Pta-1378. Orabes Open Site 01.BH **220 ± 30**

$\delta^{13}C = -22.6‰$

Charcoal from hearth BH at 2 to 3cm depth in open settlement Site 01 with stone hut circles of Brandberg industry (Rudner, 1957; Jacobson, 1976). *Comment*: most probable calibrated date is AD 1640 to 1650 (± 1σ), but AD 1760 also possible (−1.2σ).

Pta-2106. Orabes Open Site 02.1 **180 ± 40**

$\delta^{13}C = -25.2‰$

Charcoal from open settlement Site 02 of Brandberg industry. Coll and subm 1977. *Comment*: calibrated date is AD 1645 to 1810.

General Comment: hut circle Sites 01 and 02 have 17th/18th century date as do similar sites in Tsisab Schlucht, and Zerrissene Berge, below.

Pta-1868. Amis Schlueht pot **90 ± 70**

$\delta^{13}C = -23.5‰$

Charcoal scraped from pot with pointed base and spout found 1968 by W E Wendt under protruding rock in Amis Schlucht (21° 13′ S, 14° 28′ E), Brandberg, and made available from collection in State Mus, Windhoek, by W Sydow. Subm 1977 by J C Vogel. *Comment*: 1.7g carbonaceous matter scraped from surface and pretreated with acid. Most probable calibrated date is AD 1860, but AD 1690 also within 1σ.

Pta-1377. Grosse Dom Schlucht H4 **360 ± 40**

$\delta^{13}C = -24.4‰$

Charcoal from hearth against roughly packed stone wall forming one of several hut circles on open site in Grosse Dom Schlucht (21° 11′ S, 14° 26′ E), Brandberg, Brandberg culture (Jacobson & Vogel, 1975). Coll and subm 1974 by L Jacobson. *Comment*: most probable calibrated date AD 1480 or 1590. Compare Zerrissene Berge series, below.

Numas Schlucht series

Cave in Lower Numas Schlucht (21° 07′ S, 14° 25′ E), W Brandberg, originally investigated by J Rudner (1973), re-excavated in 1974 by L Jacobson to depth of 80cm (Jacobson & Vogel, 1975), yielded microlithic Later Stone age (Wilton) assemblage. Samples coll and subm 1974 by L Jacobson.

Pta-1620. Lower Numas Cave L70 **4840 ± 50**
$\delta^{13}C = -5.3‰$

Ostrich eggshell from Sqs B3/4 at 60 to 70cm depth. *Comment*: 36% carbonate removed with acid and rest analyzed.

Pta-1295. Lower Numas Cave L61 **4180 ± 60**
$\delta^{13}C = -24.0‰$

Charcoal from Sq B4 at 60cm depth.

Pta-1623. Lower Numas Cave L51 **3950 ± 60**
$\delta^{13}C = -23.9‰$

Charcoal from Sq B3 at 50cm depth. *Comment*: results considerably older than previous dates for shallower samples: Pta-178: 2890 ± 65 at 7cm depth and Pta-179: 2950 ± 65 at 15cm depth (R, 1971, v 13, p 388).

Pta-2645. Numas Schlucht pot **420 ± 140**
$\delta^{13}C = -23.5‰$

Carbonaceous material scraped from isolated pot found in Lower Numas Schlucht. Coll and subm 1977 by W E Wendt. *Comment*: 55mg carbon analyzed in mini-counter (Vogel & Behrens, 1976). Calibrated date AD 1450.

Tsisab Schlucht series

Several sites in Tsisab Schlucht (21° 06′ S, 14° 41′ E), E Brandberg Massif, excavated 1975 and 1976 by L Jacobson. Shelters 3.5km up ravine contain rock paintings, including famous "white lady", and mostly shallow, often disturbed, Later Stone age deposits. Open sites with stone hut circles of Brandberg industry characterized by large informally retouched flakes, pottery and, rarely, iron and smoking pipes (Rudner, 1957; Jacobson, 1976). Samples coll and subm 1975 and 1976 by L Jacobson.

Pta-1547. Girls' School Shelter T6.1 **6510 ± 80**
$\delta^{13}C = -24.4‰$

Charcoal concentration from Sq B6, Spit 2 at 12 to 16cm depth in level with Later Stone age artifacts, including medium sized scrapers; Girls' School Shelter, Site T6. *Comment*: oldest date thus far from Brandberg.

Pta-1776. Girls' School Shelter T6.4 **2780 ± 60**
$\delta^{13}C = -23.8‰$

Scattered charcoal from Sq C, Spit 3 at 17 to 22cm depth in Girls' School Shelter, Site T6 with Later Stone age artifacts. *Comment*: pre-

treated with acid and alkali. Compare dates for sites in Numas Schlucht on other side of Brandberg (below).

Pta-1777. Girls' School Shelter T6.2 **910 ± 40**
$\delta^{13}C = -23.0‰$

Charcoal clump from Sq B, Spit 1 at 6 to 8cm depth in Girls' School Shelter, Site T6 with Later Stone age artifacts and pottery. *Comment*: pretreated with acid and alkali.

Pta-1773. Girls' School Shelter T6.A2 **720 ± 45**
$\delta^{13}C = -23.7‰$

Charcoal from hearth in Sq A, Spit A2 at 4cm depth in Girls' School Shelter, Site T6 assoc with scrapers and overlying potsherds. *Comment*: pretreated with acid and alkali.

Pta-1783. Tsisab Open Site T30.I/1 **420 ±45**
$\delta^{13}C = -10.5‰$

Charcoal from Hearth I amongst stone hut circles and semi-circles at 0 to 5cm depth at open Site T30 of Brandberg industry. *Comment*: most probable calibrated date AD 1450, but AD 1590 also possible (1.2σ).

Pta-1820. Tsisab T30.R **275 ± 50**
$\delta^{13}C = -24.1‰$

Charcoal from Hearth R, 0 to 5cm depth, at Site T30. *Comment*: most probable calibrated date AD 1630 or 1570.

Pta-1821. Tsisab T30.34 **210 ± 50**
$\delta^{13}C = -23.8‰$

Charcoal accumulation at Site T30, 0 to 5cm depth. *Comment*: most probable calibrated date AD 1645 or 1760.

Pta-1784. Tsisab Open Site T20 A.1 **200 ± 40**
$\delta^{13}C = -23.8‰$

Charcoal from hearth, 0 to 5cm depth, at open Site T20 with stone hut circles, Brandberg industry. *Comment*: most probable calibrated date AD 1650 or 1760.

General Comment: no temporal overlap between occupation of rock shelters (6500 to 720 BP) and open settlement sites with stone hut circles. Latter most probably occupied in first half of 17th century.

Pta-1550. Ostrich Shelter T3.2 **2590 ± 60**
$\delta^{13}C = -25.3‰$

Charcoal concentration in Sq D4 at 16cm depth with Later Stone age artifacts at Ostrich Shelter, Site T3.

Pta-1551. Ostrich Shelter T3.1 **2390 ± 50**
$\delta^{13}C = -24.1‰$

Charcoal from hearth in Sq D4 at 12cm depth with Later Stone age artifacts at Site T3.

Pta-1546. Tsisab Shelter T2.1 **2240 ± 50**

$\delta^{13}C = -24.8‰$

Charcoal from hearth complex in Sq C5 at 10cm depth assoc with Later Stone age assemblage at Site T2.

Zerrissene Berge series

Several stone hut circle complexes with walls up to 1.2m high in valleys of Zerrissene Berge (21° 05′ 24″ S, 13° 59′ 16″ E), 7km S of Ugab R and 35 km W of Brandberg, dist Swakopmund, discovered by M & A Carr, apparently belong to Brandberg culture (see above) (Carr *et al,* 1976). Coll and subm 1975 by L Jacobson.

Pta-1577. Zerrissene Berge Z10 **340 ± 40**

$\delta^{13}C = -22.0‰$

Charcoal from ash layer 15cm below surface inside stone structure of Site 10 on Sessob R. *Comment*: most probable calibrated date is AD 1470 to 1620 (± 1σ).

Pta-1610. Zerrissene Berge Z10A **260 ± 30**

$\delta^{13}C = -11.8‰$

Collagen from dog skeleton buried near marker cairn in apex of side valley to Sessob R above hut circles at Site 10. *Comment*: 3.7g purified collagen extracted from 200g bone. Most probable calibrated date is AD 1620 to 1645 (± 1σ).

Pta-1578. Zerrissene Berge Z11 **220 ± 35**

$\delta^{13}C = -22.7‰$

Charcoal from stone-lined hearth attached to hut circle at Site Z11 in side arm of Sessob R valley. *Comment*: most probable calibrated date is AD 1640 to 1655 (± 1σ), but AD 1760 also possible.

Pta-1638. Zerrissene Berge Z2 **80 ± 45**

$\delta^{13}C = -20.3‰$

Dung from floor of storage cairn at Site 2, ca 5km SE of Sites 10 and 11. *Comment*: most probable calibrated date ca AD 1860, apparently related to later occupation of site.

General Comment: results suggest early 17th century date for main occupation of sites as also for similar Brandberg sites.

Pta-2111. Ugab River site BW/1 **400 ± 40**

$\delta^{13}C = -21.3‰$

Charcoal assoc with dung horizon surrounded by crude stone wall(?) in small cave S of Ugab R (20° 59′ S, 14° 00′ E), W of Brandberg in completely uninhabited region. Coll and subm 1977 by L Jacobson. *Comment*: calibrated date AD 1460, predating settlements in Zerrissene Berge, above.

Pta-2654. Zwei Schneider **5850 ± 70**
$\delta^{13}C = -25.2‰$

Charcoal from 10cm depth in shallow microlithic Later Stone age deposit of Zwei Schneider shelter with rock paintings at Twyfelfontein (20° 35′ S, 14° 23′ E), Damaraland. Coll 1968; subm 1977 by W E Wendt.

Pta-2014. Hasenbild T2 **180 ± 60**
$\delta^{13}C = -23.8‰$

Charcoal from hearth, 15 to 20cm deep, Sq B3, in upper part of Later Stone age deposit in Hasenbild shelter with rock paintings at Twyfelfontein (20° 35′ S, 14° 23′ E), Damaraland, 195km W of Outjo. Coll 1968 and subm 1977 by W E Wendt. *Comment*: most probable calibrated date AD 1660 or 1770. Compare KN-I 469: 140 ± 50 (Wendt, 1972) from same shelter.

Pta-2664. Ururu **1000 ± 60**
$\delta^{13}C = -25.4‰$

Bark from 17cm depth in Ururu shelter with crude Later Stone age flakes, ostrich egg shell beads and potsherds on farm Krone (20° 30′ S, 14° 03′ E), Damaraland, 40km W of Twyfelfontein. Coll 1968; subm 1977 by W E Wendt. *Comment*: compare Pta-2021, Unjab midden and Pta-2681, Messum with similar assemblages.

Pta-2021. Unjab Midden **2690 ± 60**
$\delta^{13}C = -23.5‰$

Dispersed charcoal from shallow shell midden on dune slope at mouth of Unjab R (20° 10′ S, 13° 10′ E), Skeleton Coast, 315km N of Swakopmund, dist Outjo, assoc with crude stone artifacts. Coll 1968; subm 1977 by W E Wendt.

Pta-1867. Hoanibmund pot **150 ± 70**
$\delta^{13}C = -21.1‰$

Charcoal scraped from broken pot with nose and probably pointed base found 1968 by E Braune at mouth of Hoanib R (19° 27′ S, 12° 45′ E), Skeleton Coast, and made available by W Sydow from collection in State Mus, Windhoek. Subm 1977 by J C Vogel. *Comment*: ca 2g carbonaceous matter scraped from surface of pot. Most probable calibrated date AD 1690 or 1810.

Pta-2552. Warmquelle **2140 ± 50**
$\delta^{13}C = -23.3‰$

Charcoal from hearth at 8cm depth assoc with ?Khoi pottery in cave 5km N of Warmquelle (19° 10′ S, 13° 46′ E), N Damaraland. Coll and subm 1979 by J Kinahan. *Comment*: very early for Khoi pottery so far N.

Pta-676. Hoarusibmund **70 ± 45**
$\delta^{13}C = -10.5‰$

Charcoal from shell midden at mouth of Hoarusib R (19° 04′ S, 12° 33′ E), Skeleton Coast, assoc with stone flakes and potsherds. Coll 1968

and subm 1972 by W Sydow, Windhoek. *Comment*: most probable calibrated date AD 1870.

Pta-1624. Otjinungwa KK/OT 1 **300 ± 50**
$\delta^{13}C = -24.4‰$

Charcoal from hearth in stone hut circle in Otjinungwa valley ridge (17° 15′ S, 12° 26′ E), Kaokoveld, near Kunene R, assoc with iron arrow head and axe, Kavango pottery featuring cross-hatched incisions and occasional stamping. Coll 1966 by R MacCalman; subm 1976 by L Jacobson. *Comment*: most probable calibrated date is AD 1490 to 1635 (± 1σ).

Pta-1399. Berorue 10/75, Angola **130 ± 40**
$\delta^{13}C = -24.9‰$

Charcoal and charred bone from hearth at 0 to 5cm depth inside ring of stone hut foundations at Iron age settlement site at foot of Berorue Mts (16° 45′ S, 12° 20′ E) in Iona National Park, dist Mocamedes, Angola. Coll and subm 1975 by R J Mason, Univ Witwatersrand, Johannesburg. *Comment*: sample boiled with 20% HCl to decompose bone and alkali solubles extracted with dilute NaOH, residue dated. Calibrated date either AD 1690 or 1820 suggesting that site was occupied after Herero-speaking peoples first settled in region but before re-entry of Himba groups at about AD 1870 (Malan, 1974).

Pta-765. Tchitundo-Hulo, Angola **2620 ± 60**
$\delta^{13}C = -23.6‰$

Charcoal from 24 to 29cm depth in lowest level of deposit in rock shelter on Tchitundo-Hulo Mulume hill (15° 56′ S, 12° 53′ E) on inland fringe of desert, 120km SE of Mocamedes, Angola. Assoc with microlithic (Wilton) Later Stone age assemblage (Ervedosa, 1974). Coll 1972; subm 1973 by C M N Ervedosa, Univ Luanda, Luanda, Angolo. *Comment*: compare Pta-769, below.

Galanga series, Angola

Excavation on hill, 14km from Galanga (12° 04′ S, 15° 09′ E), dist Huambo, Angola, revealed 140cm deposit with Later Stone age assemblage. Samples coll and subm 1972 by J R Dos Santos, Jr and C M N Ervedosa.

Pta-772. Galanga 110cm **4140 ± 70**
$\delta^{13}C = -23.8‰$

Scattered charcoal from 100 to 120cm depth.

Pta-769. Galanga 70cm **2620 ± 50**
$\delta^{13}C = -24.6‰$

Scattered charcoal from 60 to 80cm depth.

General Comment: samples pretreated with acid and alkali. Deposit younger than that of Caninguiri, Mungo (R, 1971, v 13, p 389; Dos Santos, Jr & Ervedosa, 1971, p 136).

Benfica series, Angola

At Benfica (8° 57′ S, 13° 09′ E), 17km S of Luanda on coast thin shell midden covered by soil contains boldly decorated potsherds and clay smoking pipes (Dos Santos, Jr & Ervedosa, 1970). Two more samples dated because of important implication of previous early dating Pta-212: 1810 ± 50 BP (R, 1971, v 13, p 389) for pottery and pipes. Samples coll and subm 1973 by C M N Ervedosa.

Pta-1025. Benfica shell B **2160 ± 60**

$\delta^{13}C = -0.8‰$

Shell from thin shell layer covered by 40cm soil and assoc with pottery. *Comment*: due to apparent age of seawater ca 400 yr must be subtracted for true age, *viz* 1760 BP which compares well with Pta-212 suggesting 2nd century AD date for deposit.

Pta-1026. Benfica shell A **1000 ± 70**

$\delta^{13}C = -0.0‰$

Shell from 8cm depth in same layer but at some distance from Pta-1025. *Comment*: true age ca 400 yr younger, *viz* 600 BP or AD 1350. Much younger than other 2 dates but still before European contacts.

General Comment: 20% sample removed with acid and rest of carbonate dated in both cases.

Angra Fria series

Wood from shipwrecks litter beach near Angra Fria, (18° 15′ S, 11° 56′ E), Skeleton Coast, some of which are heavily eroded by wind. Three such pieces coll by L Ehbrecht. Sampled for dating and subm 1972 by J C Vogel.

Pta-730. Angra Fria 1 **310 ± 50**

$\delta^{13}C = -26.5‰$

Outer annual rings of heavily eroded part of block and tackle coll 1966. *Comment*: most probable calibrated date, AD 1430 to 1630.

Pta-826. Angra Fria 2 **200 ± 40**

$\delta^{13}C = -23.6‰$

Outer annual rings of wooden block. *Comment*: most probable calibrated date, AD 1650, but date between AD 1640 and 1800 within ± 1σ.

Pta-722. Angra Fria 3 **80 ± 50**

$\delta^{13}C = -25.4‰$

Outer annual rings of wooden beam. *Comment*: most probable calibrated date, AD 1860 ± 40, but AD 1690 within 1σ.

General Comment: results (Pta-730) prove that remains of 17th century shipwrecks are still to be found on Skeleton Coast.

II. PALEOENVIRONMENTAL SAMPLES

Oranjemund series

On coast N of Orange R mouth extensive excavations have exposed several fossil beach gravel complexes. In attempt to date these, samples were coll and subm in 1974 by J A Fowler, CDM, Oranjemund.

Pta-1351. Gemsbok, wood **5750 ± 60**
$\delta^{13}C = -25.9‰$

Wood from base of gully cut into bedrock and infilled with marine gravel at present Mean Sea Level; overlain by 5m marine beach sands at Gemsbok (28° 34.9′ S, 16° 21.9′ E). *Comment*: pretreated with acid and alkali. Significantly, marine sands accumulated to + 5m since 6th millennium BP.

Pta-1332. Gemsbok MA 3S **>44,700**
$\delta^{13}C = -0.2‰$

Shell fragments from shell bank in marine beach crest at + 3m above MSL and overlain by 3m sand at Gemsbok (28° 30.0′ S, 16° 19.3′ E). *Comment*: 24% carbonate removed with acid and rest dated.

Pta-1334. Gemsbok MA 5S **42,500 ± 3000**
$\delta^{13}C = +0.1‰$

Shell fragments from shell bank at crest of 'B' beach at + 4m above MSL and overlain by 5m sand at Gemsbok (28° 29.9′ S, 16° 18.5′ E). *Comment*: 32% carbonate removed with acid and rest dated.

Pta-1333. Gemsbok MA 4S **43,200 ± 2800**
$\delta^{13}C = +1.9‰$

Shell fragments from shell bank at crest of 'C' beach at + 9m above MSL and overlain by 1m sand at Gemsbok (28° 29.8′ S, 18.8′ E), 500m inland from previous sample. *Comment*: 21% carbonate removed with acid and rest dated.

Pta-1335. Kerbe Hoek MA 6S **37,400 ± 1330**
$\delta^{13}C = +0.3‰$

Shell fragments from shell bank at + 13m above MSL, assoc with gravel bed on + 9m terrace and overlain by 5m sand at Kerbe Hoek (28° 03.0′ S, 15° 53.9′ E), 75km N of Oranjemund and several km inland from coast. *Comment*: 16% carbonate removed with acid and rest dated.

Pta-1336. Affenrücken MA 7S **37,800 ± 1600**
$\delta^{13}C = -1.1‰$

Shell fragments from shell bank in gully at + 10m above MSL on + 9m terrace and overlain by 6m sand at Affenrücken (27° 57.7′ S, 15° 47.7′ E), 90km NW of Oranjemund and several km inland from coast. *Comment*: 42% carbonate removed with acid and rest dated.

General Comment: compare dates of 38,100 (GrN-4571) and 35,000 (GrN-4572) for shell from 'A' terrace at + 2m near Kerbe Hoek (R, 1970, v 12, p 40). All shell samples contain less than 1% modern carbon which could represent contamination with more recent carbonate precipitation. Dates therefore only minimum ages and all these beach gravels probably preglacial.

Continental Shelf series

Numerous cores taken on Continental shelf between Orange R mouth and Lüderitz during exploration for diamonds provided shell for dating

postglacial rise in sea level (table 1). Samples coll by D O'Shea along four traverses perpendicular to coast between 1 and 25km from shore (except for Pta-1166 and -1167, both ca 55km out) and subm 1973 by R H Joynt, Paarden I., Cape Town.

TABLE 1

Lab no.	Locality	Depth in sed (m)	Depth below surf (m)	$\delta^{13}C$ (‰)	Age (yr BP)
Pta-948	28°16.2′S, 15°58.1′E	2.4	66.4	+0.9	5930 ± 80
Pta-955*	28°16.7′S, 15°57.8′E	7.0	76.5	+0.2	13,600 ± 120
Pta-951*	28°17.6′S, 15°57.1′E	4.4	81.2	−0.7	14,300 ± 130
Pta-945	28°20.2′S, 15°54.2′E	1.9	97.9	+1.5	5850 ± 70
Pta-1164	28°20.8′S, 15°54.1′E	3.0	103.6	−0.2	13,600 ± 120
Pta-956	28°21.2′S, 15°53.7′E	1.3	104.6	+1.1	13,000 ± 110
Pta-952	28°22.4′S, 15°52.4′E	1.3	111.9	+0.1	10,300 ± 100
Pta-1165	28°38.0′S, 15°43.6′E	0.5	156.0	+2.9	10,800 ± 90
Pta-1166	28°38.0′S, 15°43.6′E	0.6	156.1	+0.2	14,500 ± 130
Pta-1167	28°42.7′S, 15°45.4′E	1.6	190.6	+2.6	43,600 ± 2800
Pta-1163	28°07.0′S, 15°47.1′E	0.4	58.4	+1.9	4500 ± 80
Pta-947	28°07.4′S, 15°47.2′E	1.0	59.5	(−2.8)	5950 ± 140
Pta-957*	28°07.8′S, 15°46.7′E	1.8	71.3	−0.2	12,900 ± 120
Pta-1162	28°09.9′S, 15°44.8′E	0.3	89.9	+0.2	3130 ± 50
Pta-958	28°11.2′S, 15°43.6′E	4.2	99.3	+0.5	13,000 ± 110
Pta-1099*	27°55.0′S, 15°40.4′E	3.9	20.4	+0.6	7400 ± 90
Pta-1098*	27°56.4′S, 15°40.5′E	5.7	20.3	+0.8	7650 ± 80
Pta-949*	27°57.9′S, 15°37.1′E	1.0	72.2	+0.5	14,000 ± 160
Pta-1104*	27°58.2′S, 15°36.5′E	1.6	78.4	−0.8	27,800 ± 440
Pta-1105*	28°00.3′S, 15°34.6′E	1.2	87.2	−1.0	16,100 ± 160
Pta-1100	27°50.7′S, 15°31.3′E	1.2	77.1	+0.3	3370 ± 60
Pta-1101	27°56.1′S, 15°26.0′E	5.9	112.0	+0.9	14,500 ± 140

* See General Comment below.

General Comment: outer carbonate etched off from most samples and rest used for dating. 400 yr to be subtracted from all dates to account for apparent age of sea water. Since shell can be deposited in deep water but not so readily transported to higher levels, shallowest occurrence of shell of a certain age can tentatively be taken to date sea level at that time. On this basis the following dates for past sea levels are derived (samples marked with asterisk):

7130 BP (Pta-1099, 1098)	−20.4m
13,300 BP (Pta-955, 951, 957, 949)	−75.5m
15,700 BP (Pta-1105)	−87.2m
27,400 BP (Pta-1104)	−78.4m

In addition, see 7650 BP (GrN-4858, R, 1970, v 12, p 450) for −23m; 5750 BP (Pta-1351, Oranjemund series, above) for ± 0m and, possibly, 4940 BP (Pta-419, Lüderitz series, below) for +3.5m.

Pta-2038. Auchas Silt Terrace **180 ± 40**

$\delta^{13}C = -21.7‰$

Bark of dead tree buried in 3m silt deposit on right bank of Orange R at Auchas (28° 18′ S, 16° 45′ E), 40km upstream from Oranjemund,

dist Lüderitz. Silt deposited by extreme flood apparently killed trees growing on high terrace. Coll 1976; subm 1977 by G Corvinus and W E Wendt. *Comment*: most probable calibrated date for silt deposit AD 1660 or 1770.

Lüderitz series

Low marine platforms above present beach near Lüderitz suggest recent marine transgression along SW coast of Africa. O Davies, Natal Mus, Pietermaritzburg, coll and subm samples in 1970 to establish dates of these high sea levels.

Pta-419. Sturmvogelbucht **5340 ± 60**
$\delta^{13}C = +0.8‰$

Patella shells from shell bed on marine platform below cliff base at + 3.6m above MSL, on W side of Sturmvogelbucht (26° 38′ 30″ S, 15° 07′ 20″ E), ca 6km W of Lüderitz. *Comment*: 48% sample removed with acid, remaining carbonate dated. True age ca 400 yr younger, *ie*, 4940 BP.

Pta-417. Grosse Bucht **1580 ± 50**
$\delta^{13}C = +0.6‰$

Bullia digitalis shells from shell bed on marine platform 1.2 to 1.8m above MSL bounded landwards by storm ridge of pebbles up to + 3m above MSL at S end of Grosse Bucht (26° 46′ 40″ S, 15° 06′ 40″ E), ca 16km SW of Lüderitz. *Comment*: 68% sample removed with acid, rest of carbonate dated. True age ca 400 yr younger, *ie*, 1180 BP.

General Comment: further evidence for + 3.5m and + 1.5m Holocene transgressions.

Pta-1235. Reutersbrunn Oyster **6750 ± 80**
$\delta^{13}C = +1.4‰$

Ostrea atherestonei shell from surface of stormwater beach at Reutersbrunn (24° 43′ S, 14° 46′ E), 30km S of Meob Bay. Coll and subm 1973 by M K Seely, Namib Desert Research Sta, Box 953, Walvis Bay. *Comment*: 30% sample removed with acid and remaining carbonate dated. True age ca 400 yr younger. Compare Pta-1287, Langewandt Oyster, below.

Meob series

Site 22km SE of Meob Bay (24° 31′ S, 14° 37′ E), 175km S of Walvis Bay. Fresh water occurs 2m below surface of extensive deflation area. Remnants of flat surface capped with calcrete layer protrude ca 4m above plain near dune field margin. Calcified reed stalks coll from calcrete surface behind first dune ridge on inland side of plain indicate former higher groundwater table. Subm 1977 by J C Vogel.

Pta-1830. Meob reed fr 1 **11,800 ± 90**
$\delta^{13}C = -9.2‰$

Pta-1831. Meob reed fr 2 **11,700 ± 120**
$\delta^{13}C = -9.3‰$

Calcified reed stalks, probably *phragmites*, from calcrete surface inland from coast. *Comment*: to test for recent contamination of calcium

carbonate sample treated as follows: first 10% carbon dioxide evolved on acidification rejected; next 48% collected as fraction 1; next 10% rejected; final 32% collected as fraction 2. Similarity of results for two fractions exclude significant post-depositional contamination. Date suggests significant lowering of groundwater table and formation of calcrete layer at about 12,000 BP, *ie*, at same time as similar event at Conception Bay, below.

Conception reed series

In surroundings of watering place at Conception Bay (24° 01′ S, 14° 34′ E), 10km S of landing place, fresh water occurs 3m below surface. Remants of flat surface capped with calcrete layer containing calcified reed stalks, protrude from extensive deflation area. Samples coll and subm 1973 by J C Vogel.

Pta-1238. Conception reeds 1 **11,900 ± 100**
$\delta^{13}C = -6.6‰$

Calcified reed stalks, probably *phragmites*, from calcrete surface 4.1m above deflation plain at watering place, Conception Bay. *Comment*: 12% sample removed with acid and remaining carbonate dated.

Pta-1647. Conception reeds 2, fr 1 **12,500 ± 120**
$\delta^{13}C = -8.6‰$

Pta-1648. Conception reeds 2, fr 2 **12,600 ± 140**
$\delta^{13}C = -9.0‰$

Two fractions of another sample of calcified reed stalks from same locality as Pta-1238, above. *Comment*: to test for recent contamination of calcium carbonate sample was treated as follows: first 10% carbon dioxide evolved on acidification rejected; next 40% collected—fraction 1; next 10% rejected; remaining 40% collected—fraction 2.

General Comment: fact that fractions 1 and 2 of sample 2 give identical results suggests contamination is insignificant. Three dates together indicate lowering of groundwater table and calcification of extensive reed marsh ca 12,000 BP (see Meob series, above).

Conception saltpan series

Extending S from Conception Bay (23° 56′ S, 14° 30′ E) is large saltpan separated from beach by sand barrier, now completely dry but with signs of recent submergence. Samples coll and subm 1977 by J C Vogel to date disappearance of coastal lagoon.

Pta-1833. Conception tree **440 ± 50**
$\delta^{13}C = -25.6‰$

Outer annual rings of large tree trunk lying in middle of saltpan ca 7km W of waterhole. Apparently washed up by sea at time when lagoon still existed. *Comment*: pretreated with acid and alkali.

Pta-1826. Conception small shell **920 ± 50**
$\delta^{13}C = +0.8‰$

Donax serra bivalves standing upright in pairs in living position on 50cm shell beds on top of saltpan surface ca 6km W of waterhole. *Comment*: 39% sample removed with acid and remaining carbonate analyzed.

Pta-1827. Conception large shell **940 ± 50**
$\delta^{13}C = +0.9‰$

Lutraria capensis bivalves standing upright in pairs on 50cm shell beds on top of saltpan surface in living position near *Donax* colony (Pta-1826, above). *Comment*: 33% sample removed with acid and remaining carbonate analyzed.

General Comment: due to apparent age of surface seawater, ca 400 yr must be subtracted from seashell dates to obtain true date. Thus, shells (520 BP and 540 BP) only insignificantly older than tree (440 BP) suggesting that lagoon still existed in first half of 15th century (calibrated date). *Donax* prefers wave action while *Lutraria* may occur in lagoons (R N Kilburn, 1977, written commun).

Pta-1287. Langewandt oyster **7640 ± 80**
$\delta^{13}C = +1.3‰$

Ostrea shell lying on stormwater beach at N end of Langewandt (23° 39′ S, 14° 31′ E), 28km S of Sandwich Bay together with driftwood, planks, etc, that have been washed up in recent times. Coll and subm 1973 by J C Vogel. *Comment*: 50% sample removed with acid and remaining carbonate dated. True age ca 400 yr younger. Sample collected because occurrence of oysters on this rockless stretch of coast was strange. Probably shells are washed up from fossil submerged oyster bed. Demonstrates danger of using shell to date fossil beaches, compare Reutersbrunn oyster, Pta-1235: 6750 ± 75, above. See also GrN-4858: 7650 ± 70 for *Ostrea* shell from sea bottom, and GrN-4857: 1610 ± 50 for *Donax* shell from above beach in same area (R, 1970, v 12, p 450).

Sossusvlei Silt series

At Sossusvlei (24° 45′ S, 15° 21′ E), in Central Namib desert, flood waters from the Tsauchab R have left extensive silt deposits. In SW corner lobe of vlei has been cut off by high sand dunes. Small portion is 3m lower than rest of lobe floor. Dating of dead trees in this lobe given below.

Pta-1859. Sossusvlei silt 4 **24,800 ± 320**
$\delta^{13}C = -1.8‰$

Calcareous silt from 2.85cm below surface of lower floor in separate lobe of vlei. Coll 1976; subm 1977 by E M van Zinderen Bakker, Inst Environmental Sci, Univ OFS, Bloemfontein. *Comment*: calcium carbonate content 4.4% of which unknown fraction is primary carbonate; 14% carbonate rejected and remaining proportion analyzed.

Pta-1579. Sossusvlei silt 2 **9600 ± 90**
$\delta^{13}C = -2.0‰$

Calcareous silt from 5 to 10cm below surface of upper floor of separated lobe of vlei. Coll and subm 1975 by J C Vogel. *Comment*: calcium carbonate content 4.2%. All carbonate used for analysis.

Pta-1503. Sossusvlei silt 1 **9460 ± 90**
$\delta^{13}C = -2.6‰$

Calcareous silt from 0 to 5cm below surface of upper floor of separated lobe of vlei. Coll and subm 1975 by J C Vogel. *Comment*: calcium carbonate content 5.4%. All carbonate used for analysis.

General Comment: if Sa 1 and 2 assumed deposited in sub-recent times then 2/3 of carbonate is primary without ^{14}C. Then Sa 4 would be ca 16,000 yr old. Assumption supported by ^{13}C contents. Pollen spectrum in silt similar to that of present vegetation (van Zinderen Bakker, oral commun).

Pta-1646. Sossusvlei silt 3 **(106.4 ± 2.5)%**
$\delta^{13}C = -21.0‰$

Organic material separated from large sample of silt from 2.4m depth in active lobe of Sossusvlei, near present endpoint of Tsauchab R. Coll and subm 1975 by E M van Zinderen Bakker. *Comment*: pit dug close to evaporating floodwater pool revealed successive layers of silt and sand. Large sample of silt from bottom of pit digested with hydrofluoric acid and remaining 0.3g organic material analyzed. Comparison with curve for atmospheric ^{14}C content (Vogel & Marais, 1971, p 392) suggests date of AD 1957, *ie*, 17 yr old in 1975.

Pta-1501. Tsondabvlei silt **8640 ± 70**
$\delta^{13}C = -2.9‰$

Slightly calcareous silt from surface near entrance to Tsondabvlei (23° 56′ S, 15° 22′ E), Central Namib desert. Coll and subm 1975 by J C Vogel. *Comment*: sample contained 4.5% calcium carbonate which was used for analysis. Silt deposits here frequently submerged and possibly reworked by flood waters entering vlei, thus representing a different situation to fossil deposits in Tsondab lower valley and Homeb silts (below) which were apparently deposited in still water and subsequently calcified. Oxygen isotopic composition, $\delta^{18}O = -9.48‰$, indicates pure fresh water carbonate.

Tsondab Lower Valley series

Tsondab R deriving from escarpment ends in Tsondabvlei, but previously extended much further W into Namib sand desert. Some 6km W of present Tsondabvlei remnants of silt deposits occur on N edge of former lower valley of Tsondab R (23° 53′ S, 15° 15′ E) (Seely & Sandelowsky, 1974). In upper part of silt several thin calcified layers occur, representing repeated flooding and dessication.

Pta-1502. Tsondab Lower Valley silt **14,300 ± 130**
$\delta^{13}C = -2.8‰$

Calcified layer in upper section of silt deposits protruding from underneath dune sand. Coll and subm 1975 by J C Vogel. *Comment*: sample contained 5.3% carbonate which was all used for analysis. Oxygen-18 content, $\delta^{18}O = -6.96‰$ indicates mainly fresh water carbonate; thus date probably reliable.

Pta-1043. Tsondab Lower Valley snails **13,300 ± 90**
$\delta^{13}C = -7.1‰$

Small shells of freshwater snails (*Lymnaea natalensis* and *Biomphalasia pfeifferi*) mostly from slightly lower level than silt sample (Pta-1502, above). *Comment*: 23% carbonate removed with acid and rest analyzed. *General Comment*: similarity of results indicates reliability of date from silt and suggests extensive flooding before ca 14,000 BP. Subsequently lower valley was blocked by high sand dunes to E forming present Tsondabvlei.

Pta-1197. Narabeb root cast **28,500 ± 500**
$\delta^{13}C = -3.2‰$

Calcified root casts(?) from site called Narabeb (23° 55′ S, 14° 55′ E), 38km W of Tsondabvlei and 47km from coast in former lower Tsondab R valley, Central Namib desert. Pedotubles originate from above extensive hardpan, but are at lower level than silt deposits along E edge of dune valley (Seely & Sandelowsky, 1974). Coll and subm 1973 by M K Seely. *Comment*: 34% carbonate removed with acid and rest analyzed. Compare similar dates, Pta-1493 and -1494, Homeb series, below.

Pta-2375. Kuiseb silt **(159.1 ± 0.8)%**
$\delta^{13}C = -30.8‰$

Thin layer of leaves 1m from top of 3m silt deposit on N bank of Kuiseb R bed (23° 39′ S, 15° 16′ E), 13km upstream from Homeb. Coll and subm 1978 by J C Vogel. *Comment*: calibrated date (R, 1971, v 13, p 392) AD 1968 ± 1, probably March 1969 flood. Leaf layer slants upward into river bank and postdates trees on terrace. Result shows large movement of silt taking place at present.

Homeb series

At Homeb (23° 38′ S, 15° 09′ E), 15km upstream from Gobabeb in Kuiseb R gorge, 100km SE of Walvis Bay, remnants of well-stratified lacustrine-like silt sediments occur, possibly deposited in stormwater lake at time when Kuiseb R was blocked by sand dunes (Scholz, 1972). In upper part of ca 27m sedimentary column numerous thin carbonate-cemented layers are present. In lower part small freshwater gastropod shells are found. An attempt was made to date formation by means of these carbonates and shells. In addition, samples of calcrete crust on desert plain between dunes S of river and carbonate cement of coarse gravel ca 40m above river bed on S bank were analyzed. Samples coll and subm by J C Vogel.

Pta-1494. Homeb 9a calcrete **28,900 ± 490**
$\delta^{13}C = +0.1‰$

Younger generation of distinctly two-phase hardpan from ca 110m above river bed on top of S bank of Kuiseb R at Homeb. This hardpan crust occurs extensively in dune streets between river and Tsondabvlei. Coll 1975. *Comment*: 19% sample removed with acid and rest analyzed. $CaCO_3$ content: 32%.

Pta-2419. Homeb 9b calcrete **28,100 ± 480**
$\delta^{13}C = +0.5‰$

Another sample of same younger generation calcrete as Pta-1494, above. Coll 1978. *Comment*: 10% carbonate removed with acid and rest analyzed. $CaCO_3$ content: 46%.

Pta-2426. Homeb 9b nodules fr 1 **30,700 ± 510**
$\delta^{13}C = -3.6‰$

Pta-2427. Homeb 9b nodules fr 2 **32,700 ± 600**
$\delta^{13}C = -3.7‰$

Two fractions of nodules forming first phase of hardpan formation, same sample as Pta-2419. *Comment*: 6% carbonate removed with acid, then 50% coll as fraction 1, and remaining 44% coll as fraction 2. Small age difference between fractions 1 and 2 show absence of recent contamination. Results suggest calcrete formed between 33,000 and 28,000 BP.

Pta-1493. Homeb 8a conglomerate **29,400 ± 520**
$\delta^{13}C = -3.3‰$

Calcium carbonate cement of top of coarse river gravel forming terrace on S bank of Kuiseb R at Homeb ca 40m above river bed. Coll 1975. *Comment*: first 21% sample rejected, remaining carbonate analyzed. $CaCO_3$ content: 38%.

Pta-2355. Homeb 8b conglomerate **28,900 ± 500**
$\delta^{13}C = -3.7‰$

Another sample of same river gravel as Pta-1493, coll 1978. *Comment*: first 36% sample rejected; remaining carbonate analyzed. $CaCO_3$ content: 80%.

Pta-2329. Homeb 8c conglomerate fr 1 **34,500 ± 1000**
$\delta^{13}C = -5.0‰$

Pta-2330. Homeb 8c conglomerate fr 2 **35,600 ± 1500**
$\delta^{13}C = -5.2‰$

Two fractions of carbonate cement of river gravel on S bank of Kuiseb R at Homeb, 14m below top of terrace and underlying Homeb 6 and 7, below. *Comment*: 34% carbonate removed with acid, then 35% coll as fraction 1 and remaining 31% coll as fraction 2. Similar age of two fractions shows absence of recent contamination. Results for terrace sug-

gest cementing took place gradually as gravel bed accumulated and ended ca 28,000 BP.

General Comment: similarity of dates for samples 8 and 9 suggests moist period until 28,000 BP; see also similar date for Narabeb root cast, above and Gobabeb reed casts, below.

Pta-1861. Homeb 11 **20,100 ± 220**
$\delta^{13}C = -2.4‰$

Thin calcified crust on top of silt deposit ca 38m above river bed inside valley N of Kuiseb R. Coll 1977. *Comment*: first 36% sample rejected and remaining carbonate analyzed. $CaCO_3$ content: 33%.

Pta-1860. Homeb 13 root casts **19,600 ± 170**
$\delta^{13}C = -8.5‰$

Carbonate root casts (?) from 1m below top of silt deposit. Coll 1977. *Comment*: first 44% sample rejected and rest analyzed. $CaCO_3$ content: 56%.

Pta-1492. Homeb 2 **22,300 ± 320**
$\delta^{13}C = -2.4‰$

Calcified crust ca 6.8m below top of silt. Coll 1975. *Comment*: $CaCO_3$ content: 1.7%; all carbonate used for analysis.

Pta-2083. Homeb 14 **18,100 ± 160**
$\delta^{13}C = -1.9‰$

Calcified crust ca 8m below top of silt. Coll 1977. *Comment*: first 7% sample discarded. $CaCO_3$ content: 10.8%.

Pta-1862. Homeb 15 **25,000 ± 350**
$\delta^{13}C = -1.5‰$

Calcified crust ca 11.5m below top of silt. Coll 1977. *Comment*: first 38% sample discarded and rest analyzed. $CaCO_3$ content: 30.6%.

Pta-1822. Homeb snails **23,500 ± 660**
$\delta^{13}C = -1.8‰$

Small freshwater gastropod shells from lower half of silt deposit. Coll 1974 by B H Sandelowsky and 1975 by J C Vogel. *Comment*: first 15% 7.6g sample discarded and rest analyzed.

General Comment: extremely low carbonate content of silt levels intervening calcified crusts indicates absence of primary carbonate in deposit. Since calcification must have taken place during desiccation of floodwater accumulations in course of silt accumulation and recent contamination by rain or fog seems to be absent in region (see Meob and Conception reeds, above), results expected to date deposition of silt and, thus, damming of Kuiseb R at ca 20,000 BP.

Pta-2008. Homeb 16 **10,600 ± 110**
$\delta^{13}C = -6.1‰$

At mouth of side valley and closer to present river bed ca 3m silt occurs on top of coarse river gravel at ca 9m above river. 50cm above gravel

calcified crust coll 1977 for analysis. *Comment*: first 15% sample discarded and remainder analyzed. $CaCO_3$ content: 12.7%. Deposit apparently much more recent than silts described above.

Pta-1548. Homeb 6 **12,700 ± 100**
$\delta^{13}C = -1.3‰$

Slightly calcified level on top of silt visible on S bank of Kuiseb R ca 30m above bed and separated from cemented gravel remnant (Homeb 8, above) by ca 10m sand. Coll 1975. *Comment*: $CaCO_3$ content 7.7%, all carbonate used for analysis.

Pta-1580. Homeb 7 **6830 ± 70**
$\delta^{13}C = -0.1‰$

Slightly calcified level just below Homeb 6 in silt. Coll 1975. *Comment*: $CaCO_3$ content 4.5%; all carbonate used for analysis.

General Comment: carbonate of latter two samples may derive from overlying conglomerate (Homeb 8, above) by agent of water percolating (through sand and accumulating) on top of silts, thus explaining young dates.

Gobabeb series

In two dune valleys S of Kuiseb R and just W of Gobabeb Desert Research Sta, 88km SE of Walvis Bay, calcified features indicate presence of more moisture in past. Rock outcrops presumably caused moist conditions at these sites when water table was high.

Pta-2651. Gobabeb reed cast fr 1 **21,300 ± 260**
$\delta^{13}C = +1.3‰$

Pta-2652. Gobabeb reed cast fr 2 **21,500 ± 260**
$\delta^{13}C = +1.3‰$

Reed casts near granite outcropping in dune valley (23° 34′ S, 15° 00′ E) high above S bank of Kuiseb R, opposite Gobabeb. Coll and subm 1979 by J D Ward, Pietermaritzburg. *Comment*: 7% carbonate removed with acid; next 42% analyzed as fraction 1; final 51% analyzed as fraction 2. $CaCO_3$ content: 82%. Similarity of results indicates absence of recent contamination and reliability of date.

Pta-1091. Gobabeb root cast **20,900 ± 230**
$\delta^{13}C = -5.2‰$

Calcified root cast from dune valley (23° 32′ S, 14° 58′ E), 6.5km W of Gobabeb and 1km S of Kuiseb R, possibly of nara plant that grew when more moisture was available. Coll and subm 1973 by M K Seely. *Comment*: 22% carbonate removed with acid and rest analyzed. $CaCO_3$ content: 59%.

Pta-2604. Gobabeb termite nest **21,500 ± 190**
$\delta^{13}C = -3.6‰$

Pta-2584. Gobabeb worm cast **22,400 ± 210**
$\delta^{13}C = -2.8‰$

Calcified termite nest and worm channel on base of dune in same valley as Pta-1091. Coll and subm 1979 by J C Vogel. *Comment*: 29% carbonate removed with acid and rest analyzed. $CaCO_3$ content: 27% in both cases.

Pta-2590. Gobabeb reed casts fr 1 **27,400 ± 310**
$\delta^{13}C = -4.5‰$

Pta-2591. Gobabeb reed casts fr 2 **28,500 ± 370**
$\delta^{13}C = -4.4‰$

Reed casts embedded in crust on floor of same dune valley. Coll and subm 1979 by J C Vogel. *Comment*: 7% carbonate removed with acid; next 43% analyzed as fraction 1; final 50% analyzed as fraction 2. $CaCO_3$ content: 66%. Similarity of results indicates minimal recent contamination and reliability of date.

Pta-2588. Gobabeb reed casts fr 1 **31,900 ± 460**
$\delta^{13}C = -8.5‰$

Pta-2589. Gobabeb reed casts fr 2 **31,600 ± 430**
$\delta^{13}C = -8.6‰$

Reed casts from same locality as previous sample, but slightly higher elevation. Coll and subm 1979 by J C Vogel. *Comment*: 7% carbonate removed with acid; next 43% analyzed as fraction 1; final 50% analyzed as fraction 2. $CaCO_3$ content: 71%. Similarity of results indicates absence of recent contamination and reliability of date.

General Comment: repeated occurrences of dates between 39,000 and 28,000 BP (this series, Homeb, Narabeb), and ca 21,000 BP (this series, Homeb), strongly suggest two distinct moist periods during late Pleistocene in Central Namib desert.

Kuiseb Driftwood series

Along lower Kuiseb R logs of driftwood occur high above present river bed in desert. Dating provides information on exceptionally large floods in past.

Pta-2583. Kuiseb wood 2 **940 ± 35**
$\delta^{13}C = -24.2‰$

Outer piece of driftwood log 100m above tree line on N bank of Kuiseb R (23° 26′ S, 14° 56′ E), ca 15km downstream from Gobabeb.

Pta-2582. Kuiseb wood 1 **160 ± 35**
$\delta^{13}C = -25.8‰$

Outer piece of driftwood log 300m above tree line at same location as Pta-2583. Samples coll and subm 1979 by M K Seely. *Comment*: calibrated date younger than AD 1660; could also date to AD 1934 flood.

Pta-2632. Kuiseb wood 3 **290 ± 35**

$\delta^{13}C = -25.6‰$

Outer piece of driftwood log ca 1000m S of Kuiseb R on silt in dune street today blocked by cross dune from river bed (23° 21′ S, 14° 49′ E), 3km upstream from Swartbank. *Comment*: calibrated date between AD 1490 and 1630.

Pta-2638. Kuiseb wood 4 **140 ± 60**

$\delta^{13}C = -25.1‰$

Outer piece of driftwood log at same location as Pta-2632, but closer to river. Samples coll and subm 1979 by J C Vogel. *Comment*: calibrated date AD 1660 to 1950. ^{14}C variations do not allow closer dating, but show exceptional floods have occurred since AD 1660 and cross dune is younger.

Rooibank series

During construction of production well in sand bed of Kuiseb R (23° 14′ S, 14° 43′ E), 10km upstream of Rooibank, near Walvis Bay, wood fragments were recovered at depth. Subm 1972 by P F Hamman, Dept Water Affairs, Windhoek.

Pta-689. Rooibank wood 2 **60 ± 45**

$\delta^{13}C = -25.9‰$

Stick from 21.4m depth in river sand.

Pta-604. Rooibank wood 1 **80 ± 50**

$\delta^{13}C = -26.0‰$

Stick from 13.7m depth in same well as previous sample.

General Comment: results suggest rapid accumulation of 21m sand in river bed in 2nd half of 19th century, possibly following extensive washout by exceptional flood.

Welwitschia series

Famous Gymnosperm (*Welwitschia mirabilis*) endemic to Namib desert is thought to become very old. Radiocarbon determination of life-span, however, only possible by sectioning stunted trunk to obtain oldest wood for dating. Samples taken from center of trunk of living plant can only give min age. Growth rate of the two leaves can be determined by using recent increase in ^{14}C level of atmosphere. Samples from Welwitschia Plain (22° 41′ S, 15° 00′ E), ca 100km from coast, 4km N of Swakop R, Namib Desert Park. Coll and subm by H Borman and J C Vogel.

Pta-1835. Welwitschia 2 **480 ± 45**

$\delta^{13}C = -23.1‰$

Wood from underneath stem of largest *Welwitschia* plant in vicinity; coll 1977. *Comment*: age of plant probably considerably older than 480 yr. Previous date for wood, possibly from same specimen, is M-1885: 920 ± 100 (R, 1970, v 12, p 161).

Pta-889. Welwitschia 1 **260 ± 70**
$\delta^{13}C = -19.9‰$

Old wood from *Welwitschia* plant with stem diam ca 60cm. Coll 1972. *Comment*: sample from center of stem sec, thus close to oldest wood. Calibrated date AD 1630, *ie,* 340 yr old in 1972.

Pta-1907. Welwitschia leaf 3.85m **(128.3 ± 0.5)%**
$\delta^{13}C = -21.5‰$

Pta-1839. Welwitschia leaf 2.85m **(157.3 ± 0.7)%**
$\delta^{13}C = -21.6‰$

Pta-1838. Welwitschia leaf 1.85m **(146.9 ± 0.6)%**
$\delta^{13}C = -21.8‰$

Leaf, 4m long, of medium-sized *Welwitschia* plant growing on Welwitschia Plain, coll Feb 1977. Samples taken at 3.85, 2.85, and 1.85m from stem. To check difference in age of alkali soluble matter and acid and alkali insoluble matter (mainly cellulose) further 20cm sec was pretreated with acid and alkali:

Pta-2155. Welwitschia leaf 3.7m (insol fr) **(125.1 ± 0.5)%**
$\delta^{13}C = -20.9‰$

Pta-2154. Welwitschia leaf 3.7m (alk sol fr) **(137.6 ± 1.1)%**
$\delta^{13}C = -23.5‰$

Comment: alkali soluble fraction, Pta-2154, contains younger carbon than insoluble fraction, Pta-2155, and allowance must be made for this in interpretation of Pta-1907, -1839, and -1838. By matching results to curve for atmospheric CO_2 (R, 1971, v 13, p 392) the tip (3.85m) is dated to growth of AD 1962 and average growth rate is 26cm/yr.

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[RADIOCARBON, VOL 23, NO. 1, 1981, P 81-93]

CAMBRIDGE UNIVERSITY NATURAL RADIOCARBON MEASUREMENTS XV

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The dates presented in this paper are concerned with studies of the vegetational history of Western Scotland and are research projects in collaboration with members of staff and research students of the Subdepartment of Quaternary Research, Cambridge University. The measurements of radioactivity were carried out between 1975 and 1977 at the University Radiocarbon Research Laboratory at Station Road, Cambridge, using highly purified carbon dioxide as filling gas in proportional counters. The dates are conventional radiocarbon dates calculated using the Libby half-life for the ^{14}C isotope of 5568 years and AD 1950 as the reference year. The associated uncertainties represent one standard deviation and are calculated from a combination of the counting statistics of the samples, standards, and backgrounds together with estimates of population variation, variation of the background rate with changes of barometric pressure, and estimates of other laboratory measurement uncertainties. Thus, the stated uncertainty is considered a fairly reliable estimate of the laboratory uncertainty of the dates. The background samples are prepared from Welsh anthracite and the contemporary standard from NBS oxalic acid. A subsidiary standard is also used which is prepared from the AD 1845 to AD 1855 growth rings of an oak tree which grew near Cambridge, and the activity of this is compared frequently with the NBS standard.

The proportional counters in which the radioactivity was measured were so arranged that four might be used simultaneously within one anticoincidence shield. Two counters were of closely similar construction, the body being made from low radioactivity quartz having a tin oxide conducting coating. These were contained inside Faraday shields made from OFHC copper. The axial anode wire was of 0.025mm tungsten held near earth potential, while the EHT was applied to the inner tin oxide conductor. The volume was nominally 1L and the sample gas pressure was normally either 2 or 3 atmospheres. The other two counters were constructed from simple OFHC copper cylinders with volumes about 2L and 0.45L respectively, and here the EHT was applied to the central wire anode. Thus, with these counters it was possible to measure samples within the size range of about 3g to 250mg of carbon, using carbon dioxide as the filling gas. The counting gas was prepared by oxidation of the sample followed by the purification of the combustion gases. Normally oxidation was carried out in a high pressure combustion bomb (Switsur, 1972; Switsur and West, 1973) or when the carbon content of the sample fell below about 2%, as in the case of some lake muds, either a quartz combustion tube was used, or 'wet' oxidation with permanganate. The bomb technique was most convenient. Being highly

automated, it required very little attention, saving the time and salary for one technician, besides producing a more efficient laboratory. The use of either water or potassium permanganate solution inside the pressure vessel container aided absorption of impurities which otherwise would have appeared in the combustion products. Further purification, however, was required before the carbon dioxide was suitable for high sensitivity gas counting. A description of the equipment which may be of value for use with miniature proportional counters, where high purity for the long counting times required is a necessity, is given in a companion paper (Switsur, ms in preparation).

ACKNOWLEDGMENTS

Appreciation is expressed to Alan Ward for the consistently high quality of his work in the Research Laboratory. R G West and other colleagues within the Sub-department of Quaternary Research and in other Departments are thanked for their help and encouragement. Sir Harry Godwin is thanked for his continued interest and support to our projects. The Science Research Council and Natural Environment Research Council are thanked for equipment grants and for the support to the laboratory.

SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES

Scotland

Vegetational history of Scotland

There are three large forest regions in Scotland at present: oak forest with birch predominates to the S of The Great Glen and along the W coast as far N as Isle of Skye; pine forest with some oak and birch predominates in the Torridon region of Wester Ross and in the Grampian Highlands; to the N and W birch forest predominates except on the smaller islands which are treeless even at low alt owing to their exposed nature. We are interested in tracing the origin of this pattern and in following its evolution, in studying the factors controlling vegetational differentiation, the relative importance of local environmental factors, plant migration, and the influence of man on the distribution. Members of the Sub-department of Quaternary Research, Cambridge Univ, have long been engaged in such studies and the rate of vegetational changes occurring since the end of the last glaciation. The work has been intensified recently with the aid of a research grant from the NERC.

Sites have been selected in the major forest areas above, particularly in a transect running N-S along the W coast of Scotland from Sutherland to Caithness which passes through all the important vegetational regions. Detailed pollen analyses are made on each site, providing an historical background to interpret the modern pattern of forest distribution. The study relies on many radiocarbon dates which provide the pseudo-absolute chronology for vegetational changes recorded in the pollen stratigraphy, both for the age of observed changes and migration

rates. Small lakes of comparable size were chosen, deliberately avoiding larger lakes because of large catchment areas and uncertain sources of pollen and sediments. Besides smaller catchment, sediment of small lakes is derived substantially from the production of the lake itself. Pollen data is obtained from the number of grains per unit volume of sediment and is converted by sediment accumulation rate (which requires the detailed radiocarbon dates for calculation) into absolute pollen influx rates in terms of the number of pollen grains per unit time. This influx data then eliminates problems of interdependence of relative pollen percentage data and yields an accurate vegetational history. A radiocarbon calibration curve for the entire postglacial is needed for absolute measurements. The results provide firm environmental and chronologic bases for archaeologic investigations in Scotland.

Many workers in the Sub-department of Quaternary Research were involved in this large program, in obtaining the lake sediment cores, pollen analysis, in radiocarbon determinations, and in interpretation of results. These included P Adams, H J B Birks, H H Birks, A R Hall, B Huntley, B Madsen, R W Mathewes, S M Peglar, I C Prentice, L Rymer, V R Switsur, A P Ward, W Williams, and J E Young. H J B Birks acted as coordinator of the program. Interpretation of the results of this work is in progress and a combined publication by all participants is projected shortly. In the following series, definitive descriptions of radiocarbon samples are presented together with the dates obtained. Samples are identified by depths. The sample size was chosen to be commensurate with growth rate and carbon content to obtain the best temporal resolution. In the lower regions where carbon content was low, loss on ignition tended to overestimate carbon content, the loss probably including both volatile sulphur compounds and bound water from the mineral constituents. Pretreatment was mainly physical, followed by heating with dilute hydrochloric acid.

Loch Assynt series

Vertical sequence through limnic deposits near Loch Assynt, Sutherland (58° 10′ N, 5° 04′ W, Natl Grid Ref 19/210254), ca 16km W Lochinver, one of NERC project sites from predominantly birch forest region, has been subjected to pollen analysis and radiocarbon dating. Core, 6.72m long and 5cm diam, taken with Livingstone piston corer (Wright, 1967) from deposits extending from beginning of Flandrian to recent times. Core was stored wet at 5°C until examined in lab. Following pollen counting, samples were taken for radiocarbon dating as thin slices of mud at levels corresponding to significant changes in pollen spectra. Organic content of deposits, determined by ignition loss, increased upwards in column from ca 20% to ca 50%; samples were thus suitable for oxidation in high pressure combustion unit.

Core coll Aug 1973 by P Adam, H J B Birks, I C Prentice, and J E Young; pollen analyses by H J B Birks and H H Birks and radiocarbon measurements by V R Switsur.

Q-1280. Loch Assynt, 673-668cm **9430 ± 150**

4cm moss-rich silts and sands, Troels-Smith (1955) classification: Tb2, Gal, Ag1, Dh+. Pollen indicates expansion of *Juniperus*. *Comment*: provides basal date for organic deposition at site.

Q-1279. Loch Assynt, 649-641cm **9200 ± 120**

8cm silty fine detrital mud, Troels-Smith classification: Ld2, Ag2, Ga+, Dh+, Dg+. Organic content 22%. Pollen diagram indicates decrease of *Juniperus* with increase of *Betula* pollen.

Q-1278. Loch Assynt, 624-616cm **8950 ± 140**

8cm fine detrital mud, Troels-Smith classification: Ld4, Dg+, Dh+, Ag+. Organic content 25%. Pollen diagram indicates expansion of *Corylus* pollen.

Q-1277. Loch Assynt, 584-576cm **8310 ± 130**

8cm fine detrital mud, Troels-Smith classification: Ld4, Dg+, Dh+, Ag+. Organic content 30%. Pollen diagram indicates fall of *Corylus* pollen.

Q-1276. Loch Assynt, 514-506cm **6500 ± 130**

8cm fine detrital mud, Troels-Smith classification: Ld4, Dg+, Dh+, Ag+. Organic content 35%. Pollen diagram shows expansion of *Alnus* frequencies.

Q-1275. Loch Assynt, 454-444cm **5240 ± 110**

10cm fine detrital mud, Troels-Smith classification: Ld2, Dh1, Dg1, Sh+. Organic content 40%. Pollen diagram shows local expansion of *Pinus* frequencies.

Q-1274. Loch Assynt, 383-377cm **4340 ± 100**

6cm fine detrital mud with some wood fragments, Troels-Smith classification: Dh2, Dg1, Ld1, Sh+, D1+. Organic content 50%. Pollen diagram indicates first major decline of *Pinus* pollen frequencies.

Q-1273. Loch Assynt, 272-267cm **3300 ± 90**

6cm fine detrital mud, Troels-Smith classification: Ld2, Dh2, Dg+, Sh+, D1+. Organic content 40%. Pollen diagram shows final decline of *Pinus* pollen frequencies.

Q-1265. Loch Assynt, 172.5-167.5cm **1570 ± 80**

5cm organic fine detrital mud, Troels-Smith classification: Dh2, Ld2, Dg+, Sh+, D1+. Organic content 50%. Pollen diagram shows major decrease of tree pollen, particularly *Betula* and *Alnus*.

General Comment: results are internally consistent and indicate deposition rate of ca 1cm in 7.6 yr for first 750 yr. Deposition rate for ca next 7000 yr is ca 1cm in 16.8 yr. Figures help determination of pollen influx rate. Compare with data for other sites in Britain: Scaleby Moss (R, 1972, v 14, p 239-246); Red Moss (R, 1970, v 12, p 590-598); Tregaron

(R, 1972, v 14, p 239-246); Nant Ffrancon (R, 1973, v 15, p 156-159); Loch Maree (R, 1973, v 15, p 159-160); Din Moss (R, 1973, v 15, p 536-538); Drimnagall (R, 1975, v 17, p 304-305); and Crose Mere (R, 1975, v 17, p 302-303).

Loch Meodal series

Pollen analyses by W Williams and radiocarbon measurements by V R Switsur were made on samples from core of limnic mud from Loch Meodal in the S of Isle of Skye (57° 8′ N, 5° 5′ W, Natl Grid ref 18/656114) as part of NERC sponsored project vegetational history of W Scotland. Today region is predominantly oak with some birch. The core, 7.6m long and 7.5cm diam, containing deposits representative of entire Flandrian, was obtained Aug 1972 with a Livingstone piston sample corer by P Adams, H J B Birks, W Williams, and J E Young. The still waterlogged core was stored in the lab at 5°C before examination. Its lithology was very uniform as was organic content, apart from lowest levels. Deposits contained much sulphur which was probably included in the loss on ignition 'organic' content. Pretreatment was by dilute hydrochloric acid only, which did not remove sulphur compounds totally. 'Wet' oxidation was used for these samples. A previous measurement on basal layers of this site gave date of Q-960: 9480 ± 150 (R, 1972, v 14, p 243). For more information on past and present vegetation of Isle of Skye, see Birks (1973, p 170-206, 244-272).

Q-1301. Loch Meodal, 735-730cm **9610 ± 150**

5cm fine detritus mud, Troels-Smith classification: Ld2, Dg1, Lso+, As+, Ag+. Organic content 10%. Pollen diagram shows expansion of *Corylus* pollen.

Q-1302. Loch Meodal, 677.5-672.5cm **8240 ± 150**

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}2$, Dg1, Lso+, As+, Ag+. Organic content 18%. Pollen diagram shows rise of *Pinus* pollen frequencies.

Q-1303. Loch Meodal, 630-625cm **6590 ± 110**

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}2$, Dg1, Lso+, As+, Ag+. Organic content 17%. *Alnus* pollen shows initial increase at this level.

Q-1304. Loch Meodal, 615-610cm **6140 ± 110**

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Lso+, As+, Ag+. Organic content 17%. The pollen diagram shows rapid increase in frequencies of *Alnus* pollen at this level.

Q-1305. Loch Meodal, 577.5-572.5cm **5160 ± 100**

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Lso+, As+, Ag+. Organic content 18%. At this level in pollen diagram *Ulmus* pollen frequencies fall rapidly.

Q-1306. Loch Meodal, 512.5-507.5cm 4630 ± 80

5cm fine detritus mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Lso+, As+, Ag+. Organic content 18%. *Pinus* pollen frequencies, never very high, fall to very low levels at this part of pollen diagram.

Q-1307. Loch Meodal, 437.5-432.5cm 4030 ± 60

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Dh+, Lso+, As+, Ag+. Organic content 18%. At this point in pollen diagram *Quercus* frequencies fall to low values.

Q-1308. Loch Meodal, 352-5-347.5cm 3170 ± 50

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Dh+, Lso+, Ag+, As+. Organic content 16%. Pollen curves stable at this level, but date increases precision in pollen influx computations.

Q-1309. Loch Meodal, 252.5-247.5cm 2760 ± 50

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg+, Lso+, Dh+, Ag+, As+. Organic content 17%. As with Q-1308, date is for greater precision in pollen influx computations.

Q-1310. Loch Meodal, 152.5-147.5cm 1930 ± 50

5cm fine detrital mud, Troels-Smith classification: $Ld^{2}3$, Dg1, Dh+, Lso+, Ga+, As+, Ag+. Organic content 22%. *Betula, Alnus, Corylus, Calluna, Graminae,* and *Cyperaceae* pollen curves continue at high levels. Age allows greater precision in sedimentation rate determinations and, hence, pollen influx computations.

General Comment: results are internally consistent and indicate a deposition rate of ca 3.5cm per radiocarbon century between ca 9500 BP and 5000 BP after which time, rate increased to ca 13.3cm per radiocarbon century until ca 2000 BP. Figures in detail enable calculations of pollen influx rates for entire period. Calibration curve for entire Flandrian is required for absolute values. Results may be compared with those at Loch Assynt (above) and sites mentioned in General Comment to that series.

Loch of Winless series

A square-rod Livingstone corer was used to obtain a complete core, 6m long and 5cm diam, from undisturbed sediments through a post-glacial lake and fen at Loch of Winless, Caithness (58° 28′ N, 3° 13′ W, Natl Grid ref 39/293547) 8km WNW of Wick, 22.5km SE Thurso, alt 10m OD. Core was taken June 1972 by H J B Birks and J E Young. Pollen analyses were made by S Peglar and radiocarbon measurements by V R Switsur. Site is in region of predominantly birch forest. Previous dates from lower levels of deposits are reported in Switsur and West (1973).

Q-1325. Loch of Winless, LW 405-395cm 9430 ± 110

10cm silty detrital mud at level where pollen diagram shows *Betula* max. Organic content very low.

Q-1326. Loch of Winless, LW 360-350cm **8650 ± 100**

Silty detrital mud from 250 to 360cm depth in core, of very low organic content.

Q-1327. Loch of Winless, LW 295-290cm **7570 ± 80**

5cm slice of coarse silty detrital mud of moderate organic content.

Q-1328. Loch of Winless, LW 225-220cm **6920 ± 70**

5cm slice of coarse detrital mud of moderate organic content at level in pollen diagram indicating max in *Pinus* frequencies.

Q-1443. Loch of Winless, LW 162.5-157.5cm **4840 ± 90**

5cm slice of peat, Troels-Smith classification: Ag+, As+, Ldl, Dgl, Dh2, Dl+. High organic content. Pollen diagram shows decrease in *Ulmus* frequences.

Q-1444. Loch of Winless, LW 120-115cm **3420 ± 80**

5cm slice of peat, Troels-Smith classification: Ag+, As+, Ldl, Dgl, Dhl, Dl+ taken where pollen diagram shows decrease in frequencies of *Pinus* pollen.

Q-1445. Loch of Winless, LW 105-100cm **3070 ± 80**

5cm slice of peat, Troels-Smith classification: Ag+, As+, Ldl, Dgl, Dh2, Dl+ taken at level in pollen diagram showing decline in forest tree pollen.

Q-1329. Loch of Winless, LW 80-70cm **2210 ± 50**

10cm slice of herbaceous peat where pollen diagram shows decline in tree pollen frequencies.

General Comment: results are internally consistent and indicate deposition rate of ca 5.9cm per radiocarbon century between ca 13,000 and 7000 BP, falling after that time to ca 3.7cm per century until ca 2000 BP, the break corresponding with change of sediment type. Results may be contrasted with sites in this project on W side of country, such as Loch Assynt and Loch Meodal, and with those further S, such as Coire Fee and Loch Cill an Aonghais.

Loch Cill an Aonghais series

Samples from core through limnic sediments at Loch Cill an Aonghais Argyll (55° 47′ N, 5° 32′ W, Natl Grid Ref 16/776617). Pollen analysis made by S Peglar and radiocarbon analysis by V R Switsur as part of NERC supported project on vegetational history of W Scotland. Site lies within region of predominantly oak forests with some birch.

P Adams, H J B Birks, L Rymer, and J E Young obtained a core Aug 1973 using a Livingstone square rod piston corer. Core, 8.5m long and 7.5cm diam, covered all postglacial sedimentation in loch. In its natural wet condition the core was stored at 5°C prior to its lab examination in Cambridge. Organic content was generally low and basal layers were reddish-brown clays or muds with little pollen, interspersed with black sulphur-rich bands.

Q-1417. Loch Cill an Aonghais, 708-702cm 9690 ± 140

6cm fine detrital mud. Pollen diagram of layer shows sudden increase in *Betula* pollen.

Q-1416. Loch Cill an Aonghais, 698-692cm 9230 ± 130

6cm fine detrital mud. Pollen diagram of layer shows sudden increase in frequencies of *Corylus* pollen.

Q-1415. Loch Cill an Aonghais, 615-609cm 7490 ± 110

6cm fine detrital mud. Pollen diagram of layer shows expansion of *Alnus* pollen.

Q-1414. Loch Cill an Aonghais, 543-537cm 5210 ± 80

6cm fine detrital mud. Pollen diagram for layer indicates first decline of *Ulmus* pollen.

Q-1413. Loch Cill an Aonghais, 498-492cm 4650 ± 70

6cm fine detrital mud. Pollen diagram for this layer indicates last decline of *Ulmus* pollen.

Q-1412. Loch Cill an Aonghais, 453-447cm 3810 ± 100

6cm fine detrital mud. Pollen diagram shows small peak in *Betula* pollen spectrum.

Q-1411. Loch Cill an Aonghais, 353-347cm 2930 ± 80

6cm fine detrital mud. Pollen curves are stable at this level, but date increases precision in pollen influx calculations.

Q-1410. Loch Cill an Aonghais, 253-247cm 2420 ± 80

6cm fine detrital mud. Pollen curves are stable at this level, but date increases precision in sedimentation curves and pollen influx calculations.

General Comment: results are internally very consistent and comparable with other sites studied in the project. From ca 9500 to ca 5000 BP, sedimentation rate is quite constant at ca 3cm per radiocarbon century while subsequent rate is more than doubled, at ca 7cm per radiocarbon century.

Coire Fee series

Samples are from core through sediments of freshwater lake at Coire Fee, Glen Clova, August (56° 52′ N, 3° 14′ W, Natl Grid Ref 37/251751). Pollen analysis was by B Huntley and radiocarbon analysis by V R Switsur. Area is predominantly oak forest with some birch. P Adam, H J B Birks, B Huntley, I C Prentice, and J E Young obtained core Sept 1973 with a Livingstone piston corer. Core, 16m long and 5cm diam, was stored wet at 5°C and samples subm for dating Oct 1975. Sediment samples include entire Flandrian. Samples varied throughout column in relative importance of detritus, silt, and sand particles. Coarse plant remains were also present.

Q-1424. Coire Fee, CF #7 **9640 ± 110**

Lake detritus mud with silts and micaceous fragments from 15.75m to date basal sediments of site.

Q-1423. Coire Fee, CF #6 **6930 ± 80**

Lake mud from 13.75m depth. Pollen diagram shows main expansion of *Alnus* pollen frequencies at this level.

Q-1422. Coire Fee, CF #5 **6060 ± 100**

Lake mud from 12.6m depth. Layer shows consistent decreases in both *Pinus* and *Ulmus* pollen frequencies.

Q-1421. Coire Fee, CF #4 **4560 ± 80**

Lake mud from 10.3m depth. Pollen diagram shows consistent fall in *Alnus* pollen frequencies.

Q-1420. Coire Fee, CF #3 **3480 ± 80**

Lake mud from 8.75m depth. Pollen diagram shows secondary fall in *Pinus* pollen frequencies at this level.

Q-1419. Coire Fee, CF #2 **2610 ± 80**

Lake mud from 6.95m depth. At this level pollen diagram shows consistent increase in frequencies of *Calluna* pollen.

Q-1418. Coire Fee, CF #1 **790 ± 60**

Lake mud from 3.25m depth. Pollen diagram shows little change at this level, but date increases precision in sediment rate calculations and, hence, in pollen influx calculations.

General Comment: dates from this site fall on a very smooth curve indicating a steadily increasing sedimentation rate. Rate for first 2000 yr is ca 7.4cm per radiocarbon century and for last 2000 yr ca 20.4cm per radiocarbon century.

Caenlochan Glen series

Samples from core through sediments of freshwater pond at Caenlochan Glen, Angus (56° 52′ 25″ N, 3° 21′ 50″ W, Natl Grid Ref 37/185766) 28km SW Ballater. Pollen analysis was by B Huntley and radiocarbon analysis by V R Switsur. Area is predominantly oak forest with some birch. P Adam, K Edwards, R Gunson, B Huntley, and W Williams obtained core July 1974 with a Livingstone corer. Core was 4.6m long and 5cm diam and contained sediments from entire Flandrian. It was stored wet at 5°C and sampled for dating in March 1976.

Q-1450. Caenlochan Glen, #5 **9100 ± 150**

Coarse detrital mud coll from depth 4.57 to 4.52m to date basal layers of site.

Q-1449. Caenlochan Glen, #4 **8150 ± 150**

Coarse detrital mud from depth 4m to 3.95m. Pollen diagram shows first expansion of *Pinus* pollen.

Q-1448. Caenlochan Glen, #3 **6740 ± 100**

Coarse detrital mud coll from depth 3m to 2.95m. Pollen diagram shows secondary rise in *Pinus* pollen values.

Q-1447. Caenlochan Glen, #2 **4760 ± 80**

Coarse detrital mud from depth 2.05m to 2m. Pollen diagram shows decrease in frequencies of both *Ulmus* and *Cyperaceae*.

Q-1446. Caenlochan Glen, #1 **1110 ± 60**

Coarse detrital mud coll from depth 1.15m to 1.1m. Pollen diagram shows fall in *Cyperaceae* pollen and increase in *Calluna* pollen frequencies.

General Comment: Q-1450 to Q-1447 dates indicate linear deposition rate of 5.8cm per radiocarbon century during the first 5000 yr.

Loch Coultrie series

Samples from core through waterlogged blanket bog overlying limnic sediments in small hollow at site *near* Loch Coultrie, Wester Ross (57° 26′ N, 5° 36′ W, Natl Grid Ref 18/857435). Pollen analysis was by H H Birks and radiocarbon analysis was by V R Switsur. Core, 4.25m long and 7.5cm diam taken April 1975 by H J B Birks, A R Hall, B Huntley and W Williams using a Livingstone piston corer. Core was stored in natural condition at 5°C prior to sampling. Organic content was generally high, allowing high pressure bomb combustion. Stable isotope measurements were made by M A Hall using a V G Micromass 602 mass spectrometer.

9250 ± 120

Q-1518. Loch Coultrie, #1 $\delta^{13}C = -27.8‰$

Silty fine detrital mud from depth 425 to 420cm, Troels-Smith classification: $Ld^{2}3$, Ag1, Dh+, Fg+. Organic content 25%. *Comment*: dates basal organic deposits at site in hollow originally containing a pool.

8630 ± 100

Q-1517. Loch Coultrie, #2 $\delta^{13}C = -26.5‰$

Coarse detrital mud from depth 410 to 405cm, Troels-Smith classification: $Ld^{2}1$, Dh2, Dg1, D1+. Organic content 45%. Pollen diagram shows expansion of *Corylus* pollen frequencies.

7280 ± 80

Q-1516. Loch Coultrie, #3 $\delta^{13}C = -27.2‰$

Highly humified peat from depth 347.5 to 342.5cm, Troels-Smith classification: Sh4, Th+, T1+. Organic content 45%. Pollen diagram shows first increase of *Pinus* pollen frequencies.

5920 ± 80

Q-1515. Loch Coultrie, #4 $\delta^{13}C = -23.5‰$

Highly humified peat from depth 287.5 to 282.5cm, Troels-Smith classification: Sh4, Th+, T1+. Organic content 50%. Pollen diagram shows sharp increase in *Alnus* pollen frequencies.

Q-1514. Loch Coultrie, #5 **5250 ± 80**
$\delta^{13}C = -26.7‰$

Highly humified peat from depth 247.5 to 242.5cm, Troels-Smith classification: Sh4, Th+, Tl+. Organic content 50%. Pollen diagram shows sudden decline of *Ulmus* pollen frequencies.

Q-1513. Loch Coultrie, #6 **4090 ± 70**
$\delta^{13}C = -27.5‰$

Highly humified peat from depth 167.5 to 162.5cm, Troels-Smith classification: Sh3, Th1, Tb+. Organic content 50%. Pollen diagram shows major decline in *Pinus* pollen frequencies at this level.

Q-1512. Loch Coultrie, #7 **3290 ± 70**
$\delta^{13}C = -26.4‰$

Highly humified peat from depth 142.5 to 137.5cm, Troels-Smith classification: Sh3, Th1, Tb+. Organic content 50%. Pollen diagram shows final decline of *Pinus* pollen frequencies.

Q-1511. Loch Coultrie, #8 **1680 ± 50**
$\delta^{13}C = -26.6‰$

Highly humified peat from depth 67.5 to 62.5cm, Troels-Smith classification: Sh3, Th1, Tb+. Organic content 60%. Pollen diagram shows major decline in tree pollen frequencies at this level.

General Comment: sedimentation rate throughout this core is quite uniform with average rate of ca 4.9cm per radiocarbon century.

Little Loch Roag series

Little Loch Roag, Isle of Lewis, Outer Hebrides (58° 7′ N, 6° 58′ W, Natl Grid Ref 19/141248) site is small valley mire within a rock basin in Lweisian gneiss, alt 30m, 28km N Tarbert (Isle of Harris) to N of B8011 rd, and ca 20km from Standing Stones of Callanish and Dun Carloway. A core through the mire, at its deepest part, was taken Aug 1972 by P Adam, H J B Birks, and J E Young with a 5cm diam Livingstone piston corer. It was stored in natural condition at 5°C in a cold room until examined in lab in 1976-1977.

Pollen counts were made by B Madsen and radiocarbon measurements by V R Switsur. Pollen diagram shows virtually no change throughout its length of 3m, so that pollen assemblage zones could not be distinguished as in other sites studied in our work. Hence, radiocarbon dates were basis for chronologic presentation of data. These allowed for sedimentation and, hence, pollen influx rates to be calculated. This work is the first published on vegetational history of the Isle of Lewis. It provides important comparison with work in the Inner Hebrides, Orkneys, Shetland, and Caithness, reconstructing past vegetation, particularly forestation, of the Isle of Lewis.

Q-1531. Little Loch Roag I **9140 ± 140**

Silty peat with transition above to peat, coll from depth 300 to 295cm. *Comment*: dates earliest postglacial peat at base of site.

Q-1530. Little Loch Roag II **5670 ± 120**
Humified peat coll from depth 262.5 to 257.5cm.

Q-1529. Little Loch Roag III **4570 ± 90**
Humified peat coll from depth 212.5 to 207.5cm.

Q-1528. Little Loch Roag IV **3520 ± 70**
Humified peat coll from depth 162.5 to 157.5cm.

Q-1527. Little Loch Roag V **2350 ± 50**
Humified peat coll from depth 112.5 to 107.5cm.

Q-1526. Little Loch Roag VI **1340 ± 40**
Humified peat coll from depth 62.5 to 57.5cm.

General Comment: Q-1530 to Q-1526 dates fall on smooth curve against sample depth with sedimentation rate of ca 4.6cm per radiocarbon century. Extrapolation to basal sediments yields age of ca 6500 yr whereas measurements of Q-1530 yield 9140 ± 140. Low apparent sedimentation rate for early deposits is not discernible in the pollen diagram nor in the core. Dates of appearance of *Corylus, Ulmus, Quercus,* and *Alnus* agree with dates from mainland. First signs of pollen types that might reflect human interference on vegetation of area begin ca 5500 BP, ca 2000 yr earlier than estimated age of Standing Stones of Callanish.

Abernethy Forest series

Abernethy Forest, Inverness-Shire (56° 14′ N, 3° 43′ W, Natl Grid Ref 28/967175) was earlier studied by H H Birks (1970) using pollen-analytic techniques. Results were indeterminate and extent and nature of Late Devensian deposits at site were uncertain owing to possible contamination of sediments coll by narrow Hiller peat sampler. New core with larger diam, 7.5cm, hand operated piston corer (Wright, 1967) was taken June 1972 by H H Birks, H J B Birks, and J E Young. Core 5.5m long, was stored in cold room at 5°C prior to lab examination. Study includes pollen analysis by H H Birks, macrofossil analysis by R W Mathewes, Simon Fraser Univ, Burnaby, British Columbia, Canada, and radiocarbon analysis by V R Switsur, to confirm sequence of Late Devensian and Early Flandrian deposits between ca 3m to 5.5m.

Site is at alt 221m OD in boggy infill of glacial channel between Loch Mallachie and Loch Garten, 44km S E Inverness, on NW side of Cairngorm range. Region is predominantly forested with pine with some birch and oak.

Q-1266. Abernethy Forest No. 1 **11,760 ± 250**
Core sample from 540 to 530cm with transition from above to silt and sand, Troels-Smith classification: Ga2, Ag2, Dh+, Dg+ (Troels-Smith, 1955). *Comment*: dates start of Alleröd climatic amelioration at this site, and confirms Late Devensian age of sediments.

Q-1267. Abernethy Forest No. 2 **11,120 ± 220**
Fine detrital mud coll from 514 to 506cm with transition to less silty mud, Troels-Smith classification: Ld^{1}3, Ag1, Ga+, Dh+, Dg+.

Comment: date confirms Late Devensian age of sediments and dates upper boundary of Alleröd climatic amelioration.

Q-1268. Abernethy Forest No. 3 **9740 ± 170**

Fine detrital silty mud coll from depth 469 to 461cm, Troels-Smith classification: $Ld^{1}2$, Ag2, Ga+, Dh+, Dg+. *Comment*: dates opening of *Betula-Juniperus* pollen assemblage zone.

Q-1269. Abernethy Forest No. 4 **8670 ± 150**

Fine detrital mud from depth 432.5 to 427.5cm, Troels-Smith classifition: $Ld^{1}4$, Ag^{1}, Dh+, Dg+. *Comment*: dates opening of *Betula-Corylus* pollen assemblage zone.

Q-1270. Abernethy Forest No. 5 **7650 ± 120**

Fine detrital lake mud with herbaceous fragments coll from depth 375 to 370cm, Troels-Smith classification: $Ld^{1}3$, Dh1, Dg+. *Comment*: dates expansion of *Pinus* pollen in diagram.

Q-1271. Abernethy Forest No. 6 **6810 ± 110**

Fine detrital lake mud with herbaceous fragments from depth 357.5 to 352.5cm, Troels-Smith classification: $Ld^{1}3$, Dh+, Dg+. *Comment*: dates max frequencies of *Pinus* pollen in diagram.

Q-1272. Abernethy Forest No. 7 **6160 ± 100**

Fine detrital lake mud with herbaceous fragments coll from depth 330 to 325cm in core, Troels-Smith classification: $Ld^{1}2$, Dh1, Dg1. *Comment*: dates time of silting-in of lake and beginning of *Eriophorum* peat formation.

General Comment: sediment growth rate was fairly uniform at ca 3.7cm per radiocarbon century. Main change of slope was at ca 370cm. Site showed grass sedge colonization of bare moraine that developed into shrub tundra, dominated by *Empetrum* and *Betula nana* scrub, resulting from climatic warming during Alleröd time. Younger Dryas climatic deterioration led to formation of open vegetation rich in *Artemisia*. Opening of Flandrian at ca 9700 BP developed *Juniperus* and *Betula nana* scrub, later colonized by tree *Betula* and then *Corylus*. From ca 7225 BP *Pinus* dominated forest.

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[RADIOCARBON, VOL, 23 No. 1, 1981, P 94-135]

UNIVERSITY OF SASKATCHEWAN RADIOCARBON DATES IX*

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This series reports some of the measurements made since publication of the previous list (R, 1979, v 21, p 48-94). Acetylene proportional gas counting methods essentially remain as described in Saskatchewan II (R, 1960, v 2, p 73). Bone dating is now carried out on soluble collagen extract (Longin, 1971). The laboratory is associated with the National Museum of Canada to provide radiocarbon dating service for Canadian archaeologists but commercial services are also available to others.

SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

Great Bear River site series, Northwest Territories

Charcoal, wood, and humus from site (LgRk-1), S bank of Great Bear R, 400m below Great Bear Lake, Dist Mackenzie (65° 07′ 30″ N, 123° 32′ W). Site, 11 to 12m above river, characterized by Angostura points (MacNeish, 1955). Coll and subm 1952 by R S MacNeish, Natl Mus Canada (now at R S Peabody Foundation, Calgary).

S-9. Charcoal, wood, and humus **4650 ± 200**

From S50W45, Pit 2, 1m below surface.

S-10. Charcoal **4800 ± 200**

From S50W45, Pit 2, 50cm below surface.

General Comment (RSM): dates too recent for Angostura. Denbigh-type burin in colln.

Millard Creek site series, British Columbia

Charcoal from site (DkSf-2A), 0.4km from mouth of Millard Creek, 3.2km S of Courtenay, Comox Dist, Vancouver I. (49° 40′ 00″ N, 124° 58′ 25″ W) at ca 7.5m asl. Extensive area of shell deposits covered with 2nd growth forest ca 50yr old. Assoc with bone awls, small shell disk beads, worked cannel coal (lignite), and considerable obsidian and rock crystal detritus. Food bones predominantly deer and salmon (Capes, 1977). Coll and subm 1960, 1973 by K Capes, Courtenay, British Columbia.

S-142. Charcoal, lower level **8300 ± 200**

From lower 30cm of habitation-stained coniferous forest soil deposit.

* SRC Publication No. C-704-2-A-80

S-944. Charcoal, lower level **16,910 ± 270**

From 76 to 81cm below surface, bottom 1/3 of unstratified test pit, assoc with bone whistle.

General Comment (KC): presence of Cascade point seems to place site in Old Cordilleran culture of Northwest, although biconically perforated cannel coal object is trait not hitherto assoc with tradition. S-142 compatible with ages of other sites of tradition; S-944 too early, probably coal contaminated.

S-194. Pointed Mountain site, Northwest Territories **2270 ± 80**

Charcoal from site (JcRx-3), 32km N of Fort Liard, 4km N of Fisherman Lake, Dist Mackenzie (60° 20′ N, 123° 30′ W). From Sq S75E65, depth 35cm, Fireplace No. 1, ca 5000 to 8000 yr (MacNeish, 1954). Coll and subm 1962 by R S MacNeish. *Comment* (RSM): date too recent.

S-577. Mann site, Saskatchewan **4930 ± 100**

Charcoal from cone-shaped hearth, Mann site, N bank S Saskatchewan R (50° 58′ N, 109° 26′ W). Hearth 0.76m deep, 3m below surface contained butchered bison bone, stone flakes but no diagnostic artifacts. Coll and subm 1970 by W Pendree, Eston. *Comment* (AAR): probably early Oxbow site.

S-651. Eriksdale burial, Manitoba **3360 ± 100**

Human tibia (UM-A-LAB1) from burial near Eriksdale (50° 54′ N, 97° 50′ W). Small Pelican Lake point embedded in femur with evidence of healed wound. Coll 1971 by J Maas; subm 1972 by J Maas and E L Syms, Brandon Univ. *Comment* (ELS): date appears too old.

S-652. Lord site, Manitoba **1170 ± 90**

Bone (UM-A-LAB2) from Late Woodland, Blackduck component site along Red R, St Norbert (49° 45′ N, 97° 09′ W). Coll and subm 1972 by J Maas and E L Syms. *Comment* (ELS): acceptable for early Blackduck (Syms, 1976b; 1977).

S-675. Skoglund's Landing site, British Columbia **2510 ± 90**

Charcoal from sand and fire-cracked rock matrix (NMC-434), site (FlUa-1), 5.8km S of Masset on E shore of Masset Sound, Graham I. (53° 57′ N, 132° 07′ W). Two component site ca 13.7m above max high tide. From N 0.45 to 10.88m, E 0.7 to 1.05m, upper occupation level, ca 1.12m below surface. Assoc with 1500 flaked basalt artifacts including primarily retouched flakes and bipolarly percussed forms. Coll and subm 1969 by K R Fladmark, Univ Calgary (now Simon Fraser Univ). *Comment* (KRF): acceptable date.

S-676. Bluejacket site, British Columbia **4160 ± 120**

Charcoal (NMC-436) from site (FlUa-4), 2.4km S of Masset on E shore of Masset Sound, S of Skaga Point (54° 00′ 00″ N, 132° 07′ 45″ W). From Test Pit 1, N 2m E 0.6m, Level 7, 1.25m below surface, in matrix of clam shells, dark soil, and bone fragments. Extensive shell midden deposits 0.3 to 2.4m depth, ca 13.7m asl. Assemblage: retouched basalt

flakes, large crude pebble choppers, boulder spall scrapers, various pecked and ground-stone artifacts, abrasive stones, ground slate, and worked bone. Latter appear to correlate with middle to late periods of Prince Rupert Harbour sequence (MacDonald, 1969). Should date major component late portion of Queen Charlotte sequence ca 2000 to 4000 yr. Coll and subm 1970 by K R Fladmark. *Comment* (KRF): acceptable date.

S-677. Kasta site, British Columbia **6010 ± 100**

Wood charcoal fragments (NMC-438) from site (FgTw-4), 482m inland from Copper Bay, 12.1km S of Sandspit, Moresby I., Queen Charlotte Is. (53° 09′ 00″ N, 131° 48′ 10″ W). From Pit A, Level 2, 0.6m below surface, latest undisturbed occupation. Stratified site, at least 9 occupation levels, no marked difference between levels in artifact assemblage, includes microblades, microblade cores, tool flakes, prepared flake cores, pebble choppers, abrasive stones similar to Lawn Point site. Coll 1970 by B Thomas; subm 1970 by K R Fladmark. *Comment* (KRF): acceptable date, falls near end of Moresby tradition.

Lawn Point site series, British Columbia

Charcoal from site (FiTx-3), 24.1km N of Skidegate Mission, E coast of Graham I., Queen Charlotte Is. (53° 25′ 45″ N, 131° 55′ 00″ W). Multicomponent, upper levels sparse lithic assemblage including large pebble choppers and tool flakes assoc with two rock-ringed hearths. Two lower levels contained microblades, microblade cores, large prepared flake cores, specialized tool flakes, pebble choppers, hammerstones, and one abrasive stone. Coll 1970 by J Hunston and K Wildfong; subm 1970 by K R Fladmark.

S-678. Lawn Point site, upper level **2010 ± 60**

Charcoal (NMC-439) from N 1.9m E 0.95m, 0.66m below surface, in brown sandy soil, light brown sand above, compact dark brown clayey soil below.

S-679. Lawn Point site, Level 12 **7400 ± 140**

Charcoal (NMC-441) from N 2.2m E 1.83m, 2.68m below surface, in brown medium coarse sand, fire-cracked rock and assoc artifacts.

General Comment (KRF): acceptable dates.

S-686. Feland site, Manitoba **500 ± 130**

Mammal bones found near Antler R, SW Manitoba (49° 00′ N, 101° 19′ W). Contained Late Woodland component possibly related to Devils Lake-Sourisford burial complex (Syms, 1977; 1978). Coll 1971 and subm 1972 by E L Syms. *Comment* (ELS): represents terminal date range.

Brockinton site series, Manitoba

Bison bone from E bank of Souris R, S of Melita (49° 12′ N, 101° 02′ W). Stratified multicomponent Late Woodland site (Syms, 1971; 1972). Coll 1971 and subm 1972 by E L Syms.

S-687a. Occupation 1 (earliest) 1110 ± 80

S-687b. Rerun 1320 ± 100

S-688. Occupation 2 1430 ± 80

S-689. Occupation 3 350 ± 130

General Comment (ELS): part of series of 9 dates from 3 labs; in 2 cases samples divided for alternate fraction dating. S-687 dates generally agree with apatite date 1260 ± 130 BP (GaK-3805a: unpub) but different from acid residue dates 630 ± 300 BP and 510 ± 80 BP (GaK-3805b and -3806: unpub) from same occupation. S-688 unacceptable for strata position. S-689 agrees with alkali insoluble fraction date 290 ± 120 BP (A-1206a: unpub) but not humate fraction 1240 ± 65 BP (A-1206b: unpub) (Long and Tamplin, 1977).

S-690. Stendall site, Manitoba 850 ± 80

Bison bone from Pipestone Creek, SW Manitoba (49° 48′ N, 101° 20′ W). Multicomponent Late Woodland containing Blackduck and other undefined materials. Coll 1972 by W M Hlady; subm 1972 by E L Syms. *Comment* (ELS): date younger than 965 ± 70 BP (S-786; R, 1979, v 21, p 63) (Syms, 1977) for Level 3.

Snyder Dam site series, Manitoba

Bone and charcoal from site (DhMg-37), along Souris R, SW Manitoba (49° 10′ N, 101° W). Stratigraphically separated components yielding late Middle Woodland and Late Woodland ceramics (Syms, 1979). Coll 1971 by K Williams; subm 1973 by E L Syms.

S-739. Bone (73-1) from hearth, Occupation 1 930 ± 70

S-741. Charcoal (73-3) from hearth, Occupation 1 1010 ± 60

S-740. Charcoal (73-2) from hearth, Occupation 2 670 ± 70

General Comment (ELS): bone collagen and charcoal dates comparable ca 1 ∂ for Occupation 1, previous bone date 1120 ± 75 BP (S-683: R, 1975, v 17, p 344).

S-743. Reston burial site, Manitoba 670 ± 180

Human long bone fragments discovered by gravel pit operations (Braddell, Minty, and Tamplin, 1970) near Reston (49° 40′ N, 101° 09′ W). Materials assigned to Late Woodland, Devils Lake Sourisford burial complex (Syms, 1976a; 1977; 1978). Coll 1969 by D Braddell; subm 1973 by E L Syms.

Nunguvik Site Series 1, Northwest Territories

Plant material and bone from site (PgHb-1), S of Low Point, W coast of Navy Board Inlet, Baffin I. (73° 01′ 30″ N, 80° 38′ W). Important N Baffin I. site, occupied most of Dorset and Thule periods, more than 80 houses, dated 1290 ± 120 (Gak-2339: unpub). Recent excavation

collns yielded not previously known wooden artifacts assoc with plant material. Coll 1971, 1973 and subm 1973 by Fr C Mary-Rousseliere, Catholic Mission, Pond Inlet.

S-766. Nunguvik site, House 71 **860 ± 70**

Plant material (NMC-510) above flagstones on S side of Dorset House 71. Should date main occupation period ca 1200 yr.

S-767. Nunguvik site, House 71 **2280 ± 90**

Bone (NMC-511) from deep pit in house, under flagstones. Should date earliest occupation or antedate house.

S-845. Nunguvik site, House 76 **1310 ± 90**

Plants (mostly *Cassiope tetragona)* (NMC-649), from thick layer of plant material (possible mattress), ca 25cm below surface in Dorset house, ca 5.5m asl. Artifacts indicate early Middle Dorset period ca 1900 yr.

S-846. Nunguvik site, House 73 **1490 ± 70**

Plants (mostly *Cassiope tetragona)* (NMC-650), Sq 10, from 0.75m to 1.7m above high tide. From thick layer in NE corner of partially excavated house, 20 to 25cm below surface, cultural use uncertain. Dorset house, but semi-subterranean entrance passage suggests Thule influence, ca 800 yr.

S-847. Nunguvik site, House 82 **1690 ± 150**

Caribou bone (NMC-651), 2.4m asl, E of House 76. From lowest of 3 occupation levels, 35 to 40cm below surface. Two harpoon heads suggest early Dorset period ca 2200 yr. If confirmed, would show sea level less than 2m above present level, significantly lower than most estimates for region.

S-848. Nunguvik site, House 71 **1590 ± 100**

Caribou bone (NMC-652) from NNE corner of house, at base of wall, 40 to 45cm below surface, appears to antedate house. Artifacts suggest earlier occupation, ca 1500 yr, than previous burnt bone data 1290 ± 120 BP (Gak-2339: unpub).

S-849. Nunguvik site, House 76 **1520 ± 70**

Caribou bone (NMC-653) from lower level of house, 40cm below surface. Should date earliest occupation before house construction, ca 2300 yr.

S-879. Nunguvik site, House 73 **1320 ± 90**

Caribou bone (NMC-655) from lower level of entrance passage, late Dorset house, 10 to 25cm below flagstone and 30 to 35cm below surface, less than 1m above high tide. Should date first occupation of shore when sea near present level and antedate House 73.

S-880. Nunguvik site, House 46 **1880 ± 90**

Caribou bone (NMC-656) from early Dorset house, on 12m terrace, 20 to 35cm below surface. Should be more reliable than previous mixed-bone date 2655 + 80 BP (S-672: R, 1975, v 17, p 343).

S-882. Nunguvik site, House 52 **850 ± 100**

Caribou bone (NMC-658) from early Thule house, on 12m terrace but 200m from other Thule houses. Bone date 1100 ± 135 yr (S-673: R, 1975, v 17, p 343) corrected as AD 1270 agrees with plant material corrected dates AD 1210 and 1235 (S-477 and -516: R, 1973, v 15, p 202-203) for earlier Thule House 42. Two occupations probably separated by 100 yr.

S-883. Nunguvik site, House 76 **1530 ± 100**

Plants (mostly *Cassiope tetragona)* (NMC-659) from plant material layer ca 35cm below surface, Sq 11, 5 to 6m asl. Should date early occupation and be similar to S-845, ca 1900 to 2000 yr.

General Comment (GM-R): previous early Dorset date on marine animal bones (S-672: R, 1975, v 17, p 343) considered better House 46 date than S-880, ca 270 to 390 BC period. S-847 too recent for House 82 assoc with Dorset harpoon artifacts. S-883 and -849 acceptable for House 76 occupation levels. S-846 and -879, House 73. dates same apparent age range as House 76, though typologically, 76 seems older. House 73 surprisingly old for same relative shore position (less than 1.5m asl) as more recent neighbor House 71. S-767 corrected as AD 70 indicates camping near present sea level at beginning of Christian era prior to House 71 construction. Supported by wall base date S-848, corrected as AD 440. S-766 at AD 1095 probably latest House 71 occupation, almost identical to early Thule house 42 (S-477: R, 1973, v 15, p 202) would suggest simultaneous or close sequel to Dorset and Thule habitations. Thule House 52 slightly early but acceptable compared to previous dates AD 1090 and 1235 (S-477 and -516: R, 1973, v 15, p 202-203). Marine animal bone date corrected as AD 1250 (S-673: R, 1975, v 17, p 343) more satisfactory.

Migod site series, Northwest Territories

Charcoal from site (KkLn-4) on E bank Dubawnt R at effluence of Grant Lake, Dist Keewatin (63° 43′ 00″ N, 100° 26′ 50″ W). Multicomponent with late Shield Archaic and Agate Basin components. Coll and subm 1973 by J V Wright, Natl Mus Canada.

S-812. Migod site, Stratum VI **4790 ± 130**

Charcoal (NMC-670) from Trench 1, 66cm depth. Will date late Shield Archaic component in Keewatin and check minimal Shield Archaic date 1075 ± 90 BC (S-506: R, 1973, v 15, p 205) from Aberdeen Lake site (LdL1-2). Ca 3500 to 4000 yr.

S-834. Migod site, Stratum VIB **7930 ± 500**

Charcoal (NMC-671) from Trench 1, 78.7cm depth. Stratum between late Shield Archaic and Agate Basin components. May represent early Shield Archaic component, no diagnostic artifacts. Ca 4000 to 7500 yr.

S-813. Migod site, Stratum VII **5550 ± 120**

Charcoal (NMC-672) from Trench 1, 86.3cm depth. Agate Basin component and check on Grant Lake site (KhLn-2) dates.

S-1052. Migod site, Stratum VII **6010 ± 130**

Charcoal (NMC-803) from Trench 1, ca 86.4cm depth. Ca 8500 to 9000 yr.

General Comment (JVW): S-812 basically agrees with late Shield Archaic components on Thelon R, Dist Mackenzie by B C Gordon. Ranges of S-813 and -1052 tend to reinforce one another, seriously questioning Agate Basin assignment to Stratum VII, but does not explain older age anomaly of S-834 stratigraphically above Stratum VII.

S-912. Bracken Cairn, Saskatchewan **2470 ± 90**

Human bone fragments from burial, 0.8km S of Frenchman R near Bracken (49° 20′ N, 108° 18′ W). Ocher burial, male, female, and infant, 0.9 to 1.2m below surface, on prominent knoll, covered by large stone cairn. Assoc artifacts discussed elsewhere (King, 1961). Coll 1948, 1956 by L Wright; subm 1974 by W Pendree. *Comment* (AAR): confirms Pelican Lake affiliation suggested by assoc projectile points.

Richards Village site series, Manitoba

Bone from site near Pembina R between Turtle Mt and Pembina valley, S central Manitoba (49° 03′ N, 99° 42′ W). Early Sonota component and later Blackduck component site. Coll 1973 by E L Syms and 1975 by C Richards; subm 1974 and 1977 by E L Syms.

S-913. Bone (Br-74-1) **920 ± 60**

Upper Blackduck occupation.

S-1338. Bone (Br-77-1) **1430 ± 150**

Level 4 to 5, 16 to 20cm below surface, assoc with Sonota materials.

General Comment (ELS): dates acceptable.

S-921. Hahanudan site, Alaska **770 ± 460**

Calcined bone, primarily mammal (NMC-713) from site (RkIk-4), Hahanudan Lake, near Huslia village, Koyukuk R region, W interior Alaska (65° 41′ 30″ N, 153° 20′ 00″ W). From bone scatter over small area, generally ca 50cm below turf. Artifact assemblage ceramics, delicate end blades suggestive of Norton culture and others not so distinctively placed. Suggests significant inland penetration of Norton culture or influence. Ca 1500 to 2500 yr. Coll and subm 1971 by D W Clark, Natl Mus Canada. *Comment* (DWC): date may indicate younger en-

campment than end blades. Metal pan recovered off site end and group of undated cache pits supports habitation at various times. Large error margin AD 730 to 1640 limits usefulness, tentative assoc with Norton-derivative artifacts (Clark, 1977).

Diana 4A site series, Northwest Territories

Charcoal and carbonized fat from Dorset site (JfEl-4A), 7m asl, S Diana I. (60° 55′ 50″ N, 69° 57′ W). Coll 1973 and subm 1974 by P Plumet, Univ Quebec, Montreal.

S-930. Diana 4A site, black humus 760 ± 100

Charcoal (NMC-721) under gravel slipped from wall. May date occupation or previous occupation assoc with midden between Houses A, B, and C.

S-932. Diana 4A site, Structure C 2180 ± 70

Carbonized fat (NMC-723) from NN43, N end of midden of Structure C.

S-933. Diana 4A site, Structure C 1890 ± 110

Charcoal (NMC-724) from NN43, N midden of Structure C.

General Comment (PP): S-930 inside House A seems to precede occupation dated at AD 1480 ± 90 (Gif-3002: unpub). Date appears to relate to dump of D1A-4C into which D1A-4A was dug. Carbonized fat, S-932, thoroughly mixed with charcoal, S-933. Date difference confirms aging attributed to sea mammal fat. Dates suggest dump in which D1A-4A constructed corresponds to many occupations between dates obtained for D1A 25 (Gif-2969: unpub) and various parts of D1A 1 (Lv-468-471: R, 1971, v 13, p 49) and 560 (Gif-1954-1957, -1352, R, 1974, v 16, p 47; Gif-2967-2970, unpub; Gif-3002-3004, unpub). S-933 may represent average charcoal age over 20 to 40cm depth, same sector as 30cm depth charcoal previously dated AD 870 ± 100 (Gif-3003: unpub). Dates suggest Structure D1A-4A contemporaneous with Diana Bay Sites D1A 25 (JfEm-5) and D1A 1 (JfEl-1).

S-931. Cordeau site, Northwest Territories 1420 ± 100

Carbonized wood (NMC-722) from site (IfEl-1), S Diana I. (60° 56′ N, 69° 57′ W). From Sq 3I, in deposit immediately below humus layer, possibly from House A. Caribou bone and Dorset artifacts. Coll 1973; subm 1974 by P Plumet. *Comment* (PP): sample from 2m NW of Long House D1A 1-A, carbonized fat dated 1170 ± 100 yr BP (Gif-2967: unpub). Deposit contemporaneous with Houses D1A 1-E and F (Lv-469-471: R, 1971, v 13, p 49; Gif-1352: R, 1974, v 16, p 47; Gif-2968: unpub) located on other side of small lake ca 30cm W of D1A 1-A. Artifacts of polished schist analogous to those of D1A 1-F, also assoc with caribou bones.

S-975. Hahanudan 2-House site, Alaska 290 ± 100

Charcoal and carbonized wood (NMC-747) from S side Hahanudan Lake, Melozitna quad, W interior Alaska (65° 43′ 30″ N, 155° 32′ 30″

W). From 6.7 to 7.2m asl Cache Pit A, one of several poles that probably supported birchbark cover. Assoc with Ipiutak-related house but could be later Athapaskan. Ca AD 600 or much more recent. Coll 1971 and subm 1975 by D W Clark. *Comment* (DWC): date indicates cache pit and houses, ca 3m apart, unrelated occupations. Cache pits probably constructed by late prehistoric antecedents of Koyukuk branch of present Koyukon Athapaskans (Clark, 1977).

Migod site series, Northwest Territories

Charcoal and charcoal mixed with sand and clay from site (KkLn-4), at Grant Lake, Dubawnt R, Dist Keewatin (63° 43′ 00″ N, 100° 26′ 50″ W). Site contains nine levels and sublevels. Uppermost (Levels 1, 2a, 2b) Taltheilei Chipawyan tradition; middle sec scattered Arctic Small Tool tradition (Levels 3a, 3b) and bottom Shield Archaic (Levels 4a, 4b, 4c). Coll 1974 by B Gordon, J Sproull, P Kay, C Arnold, D Morrison, and M Gordon; subm 1975 by B Gordon, Natl Mus Canada.

S-977. Migod site, Level 2a **1630 ± 130**

Charcoal in sand (NMC-749), 12N6E. Middle Taltheilei ca AD 400 to 800.

S-978. Migod site, Level 3 **2790 ± 90**

Charcoal and charcoal in clay (NMC-750), combined sample. Arctic Small Tool tradition ca 600 to 1200 BC.

S-979. Migod site, Level 4a **4770 ± 170**

Charcoal in sand (NMC-751), 14N6E. Late Shield Archaic ca 2000 to 4000 BC.

S-980. Migod site, Level 4a **4770 ± 170**

Charcoal in sand (NMC-752), 6N4E. Late Shield Archaic ca 2000 to 4000 BC.

S-1005. Migod site, Level 4b **4950 ± 90**

Charcoal in sand (NMC-753), 14N6E. Middle Shield Archaic ca 3000 to 5000 BC.

S-981. Migod site, Level 4b **5070 ± 80**

Charcoal (NMC-754), 12N4E. Middle Shield Archaic ca 3000 to 5000 BC.

S-1007. Migod site, Level 1 **Modern**

Charcoal in sand (NMC-756), 2N4E. Late Taltheilei ca 200 to 500 yr BP.

S-1008. Migod site, Level 2a **1560 ± 80**

Charcoal in sand (NMC-757), 10N4E. Middle Taltheilei ca AD 400 to 800.

S-1009. Migod site, Level 2a **1050 ± 100**

Charcoal in sand (NMC-758), 12N4E. Middle Taltheilei ca AD 400 to 800.

S-1010. Migod site, Level 4 **1420 ± 70**

Charcoal in sand (NMC-759), 8N2E. General Shield Archaic ca 2000 to 5000 BC.

S-1020. Migod site, Level 1 **1920 ± 80**

Charcoal in sand (NMC-761), 10N4E. Late Taltheilei ca AD 400 to 800.

S-1021. Migod site, Level 1b **1010 ± 70**

Charcoal in sand (NMC-762), 8N6E. Late Taltheilei ca AD 400 to 800.

S-1022. Migod site, Level 2 **2240 ± 80**

Charcoal in sand (NMC-763), 2N0E. Early Taltheilei ca AD 200 to 800.

S-1023. Migod site, Level 2 **3720 ± 80**

Charcoal in sand (NMC-764), 16N6E. Early Taltheilei ca AD 200 to 800.

S-1024. Migod site, Level 2b **2080 ± 120**

Charcoal in sand (NMC-765), 10N4E. Early Taltheilei ca AD 200 to 800.

S-982. Migod site, Level 4 **3680 ± 160**

Charcoal in sand (NMC-766), 8N4E. General Shield Archaic ca 2000 to 5000 BC.

S-1025. Migod site, Level 2c **2610 ± 210**

Charcoal in sand (NMC-767), 20N10E. Earliest Taltheilei ca AD 200 to 400.

S-1026. Migod site, Level 4c **5490 ± 100**

Charcoal in sand (NMC-768), 8N2E. Early Shield Archaic ca 4000 to 6000 BC.

S-1158a. Migod site, Level 1a **1020 ± 230**

Charcoal in sand (NMC-831), 10N6E, immediately overlying 1b and under Level 1. Should be older than protohistoric by several centuries ca AD 800 to 1400.

S-1158b. Migod site, Level 1a **220 ± 110**

Charcoal and sand mixture (NMC-831) included uncertain apparent carbonaceous materials.

S-1159. Migod site, Level 1 **270 ± 90**

Charcoal in sand (NMC-832), 80cm depth, immediately overlying Level 1. Late prehistoric Chipewyan. Should give finite date linking

prehistoric to historic occupation as recorded by Hearne (1771). Ca 200 to 500 yr BP.

General Comment (BG): of 21 dates, only S-1010 and -1023 are unacceptable. S-1010 too late for Shield Archaic as adjoining Sq 8N4E dated 1730 BC (S-982) and other Shield Archaic levels and sublevels within interval 2820 to 3535 BC. Also from below dominant clay level containing Pre-Dorset artifacts (S-978) and projectile point fragment from 8N2E joins fragments from 8N4E. S-1023 from above clay level too old, based on projectile point base from general Level 2 which is Taltheilei, assigned Middle Taltheilei because of apparent incipient shoulder scar. True age of S-1158 probably between two determinations which would agree with Sub-level 16 and Level 1, above. Estimate of Level 1, ca AD 1300 and 1a, ca AD 1100. Some dates earlier than expected based on assumption Taltheilei would be later with approach to Hudson Bay. Earliest date for Taltheilei in E half of barren grounds.

Migod Island site series, Northwest Territories

Charcoal in sand from site (KkLn-13), on island in Grant Lake, Dubawnt R, Dist Keewatin (63° 43′ 40″ N, 100° 26′ 45″ W). Two Taltheilei tradition components based on surface collns and test pits. Level 1 yielded artifacts, Level 2, flakes only. Older surface artifacts may be assoc with Level 2, which should date ca 1500 yr BP. Coll 1974 by C Arnold and B C Gordon; subm 1974 by B C Gordon.

S-1006. Migod Island site, Level 2 **3280 ± 80**

Charcoal in sand (NMC-755) from Test Pit A, 25 to 40cm depth, 10cm below Level 1. Assoc with flakes. Should date earliest evidence of Chipewyan occupation on Migod I., which implies boat travel.

S-1019. Migod Island site, Level 2 **1990 ± 80**

Charcoal in sand (NMC-760), 50cm depth, ca 1000 to 1500 yr BP.

General Comment (BCG): acceptable dates. S-1006 estimate based on simple quartzite flakes, lower level. Pre-Dorset people also used quartzite and probably first occupied site. Middle Taltheilei projectile point on surface fits Middle Taltheilei date.

Cactus Flower site series, Alberta

Bone and charcoal from site (E60p-16), on flood plain of S Saskatchewan R, 625m asl (50° 15′ N, 110° 38′ W). Stratified campsite, 10 defined occupations separated by periodic river flood alluvial deposits. Occupations designated from latest to earliest, I through X. I and II, Pelican Lake phase, III to IX attributed to McKean complex, X undefined. Coll 1974 by L Bitz, R Freeman, and J Brumley; subm 1975 by J Brumley, Univ Calgary.

S-1011. Cactus Flower site, Occupation I **2770 ± 100**

Bone (NMC-784) from Excavation Unit 6. All bones in unit, 8m by 20m area. Should date most recent of 2 Pelican Lake phase components ca 2000 to 3000 yr.

S-1012. Cactus Flower site, Occupation II 3480 ± 70

Bone (NMC-785) from Excavation Unit 6. All bone from Occupation II in unit. Should date earliest of 2 Pelican Lake phase components ca 2000 to 3000 yr.

S-1013. Cactus Flower site, Occupation III 3930 ± 110

Charcoal (NMC-786) from fill of Feature 3, shallow excavated earth pit, Unit 6, Sq 6S0W and 8S0W. Should date most recent McKean phase occupations and provide near terminal date for McKean phase in Plains area, ca 3000 to 3500 yr.

S-1209. Cactus Flower site, Occupation III 3740 ± 100

Charcoal (NMC-852) from fill of Feature 33, shallow earth pit, in XU-6, Sq 16S6W and 18S6W.

S-1210. Cactus Flower site, Occupation VIII 4220 ± 130

Charcoal (NMC-853) from fill of Feature 14, basin hearth in XU-1, Sq 4S10W. Most intensive McKean occupation of site. Should clarify previous dates for occupations VIII and IX (S-782, -783, -821: R, 1975, v 17, p 351-352) ca 4100 yr.

General Comment (JB): S-1013 ca 300 to 400 yr too early for stratigraphic position, other site occupation dates (S-784, -820, -821, -822: R, 1975, v 17, p 352) and dated Pelican Lake phase components elsewhere. S-1011, -1209, -1210 acceptable. Evaluation of 12 dates suggests 7 McKean occupations at site date between 3500 and 4300 yr BP.

Cherry Point site series, Manitoba

Bone from multicomponent site (DkMe-10), near Oak Lake, SW Manitoba (49° 42′ 30″ N, 100° 43′ W). From three living floors, Oxbow-McKean site. Coll 1974 by J Haug; subm 1975 by E L Syms.

S-1029. Bone (Br-1-Cc), lowest occupation 2860 ± 210

S-1030. Bone (Br-1-Ca), lowest occupation 2830 ± 260

S-1031. Bone (Br-1-Cb), central occupation 1850 ± 100

S-1032. Bone (Br-1-Cd), central occupation 2060 ± 130

S-1033. Bone (Br-1-Ce), upper occupation 1020 ± 110

S-1034. Bone (Br-1-Cf), upper occupation 1040 ± 190

General Comment (ELS): dates for each living floor cluster closely and stratigraphically consistent but more recent than anticipated (Haug, 1976; Gibson, 1976).

Kenai 29 site series, Alaska

Charcoal from site, 15.2m asl, near Soldatna on Kenai R, Kenai Peninsula (63° 31′ 20″ N, 151° 07′ 20″ W). Material tentatively indicates affinity to Kachemak II and Old Kiavak. Coll 1971 by D R Reger; subm 1975 by D W Clark.

S-1040. Kenai 29 site, Sq F-7 **2560 ± 300**

Charcoal (NMC-518), N 46cm W 20cm, 8cm depth. Should date uppermost layer, ca 1000 to 1500 yr.

S-1041. Kenai 29 site, Sq E-8 **2250 ± 120**

Charcoal (NMC-519), N 5cm W 61cm, 76cm depth. Should date base of lowermost layer, ca 2500 to 3000 yr.

General Comment (DWC): apparent discrepancy, S-1041 from basal cultural sediments in direct assoc with house floor, hearth and birchbark basket considered most accurate. Sample contents described elsewhere (Reger, 1977).

Cottonwood Creek site series, Alaska

Charcoal from site (Sel 30), 51.2m, Cottonwood Creek, Kachemak Bay, Kenai Peninsula (59° 44′ N, 151° 05′ W). Kachemak tradition of Pacific Eskimoid affiliation. Previously investigated by F Delaguna, reinvestigated by W B Workman (1977). Coll 1974 by J Lobdell, M Clock, and W B Workman; subm 1975 by W B Workman, Alaska Methodist Univ.

S-1042. Cottonwood Creek site, Sec 2-4W, 2-4S **1750 ± 70**

Charcoal from plank (NMC-797), 325cm below surface. From structure at base of midden. Should provide near basal date for occupation which occupies important place in Pacific Eskimo area sequence. Could be from driftwood and older than house, comparable to S-1043. Ca AD 700 ± 200.

S-1043. Cottonwood Creek site, X trench S extension **1750 ± 130**

Charcoal from plank (NMC-798) from Sec X-3, 170 to 180cm below surface. Possibly driftwood.

S-1054. Cottonwood Creek site, Sec 0-2W, 0-2S **1560 ± 80**

Charcoal (NMC-804) from SE quad, directly below Burial 2, 100cm below datum, ca 10cm below top of old midden deposit, major stratigraphic unit at site. Old midden separated from upper component by large culturally sterile deposit. In conjunction with S-1042 and -1043, should bracket main occupation and indicate time interval of overlying sterile layer. Ca AD 1100 ± 200.

S-1055. Cottonwood Creek site, Sec 2-4S, 0-2E **1630 ± 70**

Charcoal (NMC-805) from lower portion Level 2, 20cm N 10cm E, 10 to 20cm below surface. Several triangular slate end blades and rock feature in Level 3 below. Should date upper component with small but distinctive artifacts of late prehistoric culture not previously sampled in Kachemak Bay. Also help bracket sterile level below. Ca AD 1400 ± 300.

General Comment (WBW): S-1042 and -1043 provide near basal date, presumed driftwood and may be one or more centuries older than

occupation. S-1054 tentatively acceptable although older than anticipated, suspect as upper limiting date for main occupation without substantiation. Dates indicate main Kachemak III deposits laid down within a few centuries. S-1055 rejected as dating uppermost Kachemak IV component because significant typologic break between these materials and main deposits. Components separated by sterile silt interbedded with volcanic ash suggest gradual *in situ* accumulation. Intrusive charcoal introduced by Kachemak IV inhabitants.

Bérubé site series, Quebec

Charcoal from site (DdGt-5), E shore of Lake Abitibi, ca 3.2km from mouth of Duparquet R, Palmarolle Municipality (48° 39′ N, 79° 19′ W). Cultural affiliation undetermined. Coll 1972 by P Courbin, 1973 by P Leblanc and P Gauthier, and 1974 by J Dubois and R Wilmeth for R Marois; subm 1975 by R Marois, Natl Mus Canada.

S-1048. Bérubé site, Sq W4 **140 ± 70**

Charcoal (NMC-799) Level 2, Zone A, SW Quad Sec B, 13cm below surface. Assoc with potsherds in SE quad of same sq, decorated with zone of oblique impressions made by notched implement held perpendicular to surface, above zone of oblique impressions by perpendicularly held spatula. Impressions characteristic of Laurel tradition, principal manifestations of which lie to SW and indicate tradition influence in Abitibi region. Ca AD 400.

S-1049. Bérubé site, Sq S7E3 **60 ± 70**

Charcoal (NMC-800) from Level 2, Zone A, NE Quad Sec A, 6cm below surface. Assoc with potsherds decorated by two-strand cord impressions on lip and rim. Date will indicate chronologic variation of materials in terms of horizontal and vertical distributions. Ca AD 800.

S-1050. Bérubé site, Sq S4E7 **540 ± 60**

Charcoal (NMC-801) from Level 2, Zone B, NW and SE Quads Sec A, 12 to 15cm below surface. Assoc with elongated point and potsherds decorated with two-strand cord impressions on lip and rim with exterior punctates and interior nodes. Ca AD 800.

S-1051. Bérubé site, Sq S1E7 **710 ± 60**

Charcoal (NMC-802) from Level 2, Zone B, SW and SE Quads Sec A, 14cm below surface. Assoc with potsherds decorated with zone of oblique impressions above zone of horizontal impressions of two-strand cord. Ca AD 800.

S-1151. Bérubé site, Pit 03 **270 ± 60**

Charcoal (NMC-841) from Level 2, Zone A, SW Quad Sec B, 13cm below surface. Assoc with potsherds described for S-1048.

S-1152. Bérubé site, Pit S7E3 **310 ± 60**

Charcoal (NMC-842) from Level 2, Zone A, NE Quad Sec A, 6cm below surface. Assoc with potsherds described for S-1049.

General Comment (RM): Level 2, Zone A dates too recent for assoc ceramics, possible intrusion of younger charcoal from Level 1. At least indicates older occupation of Level 2, Zone B than Level 2, Zone A.

Chugachik (Indian) Island site series, Alaska

Birchbark and charcoal from site (Sel 033), in cove on E side Chugachik I. (59° 44′ 45″ N, 151° 02′ 25″ W). Sea level midden site of Kachemak tradition, probably Kachemak II or Sub III. Older than materials from Cottonwood Creek or Yukon I. (Kachemak III). Deposits *in situ* more than 2m thick and very rich in lithics and artifacts (Workman, 1977). Coll 1974 by C Dye and W B Workman; subm 1975 by W B Workman.

S-1062. Chugachik Island site, N 2-3, E 3-4 2310 ± 70

Birchbark (NMC-806) from thick layer of decayed blue mussel shell above archaeologically sterile peaty black soil of site base, 65cm below surface. Saturated deposits, possibly below storm tide marks. Fragmented birchbark basketry with evidence of stitching and twine, presumably made by first occupants, ca 700 BC ± 300 yr.

S-1063. Chugachik Island site, N 2-3, E 1-2 1705 ± 70

Charcoal (NMC-807) within layer of soil and much fragmented mussel shell, 10cm below contact with overlying dark soil (some shell), 55cm below datum, 80cm below surface. Highest charcoal sample taken, assoc with many artifacts and complete mammal bones. Ca AD 300 ± 300 yr.

General Comment (WBW): S-1062 should approximate true date as birch is short-lived, in accord with cultural assessment. If S-1063 driftwood not more than 300 yr old, it would fall in estimate. S-1063 overlaps two basal dates for Cottonwood Creek, which do not agree with typologic evidence and indicates probably driftwood charcoal. Dates bracket site span as ca 700 yr.

Fletcher site series, Alberta

Unburned butchered bone fragments from site (DjOu-1), S Alberta (49° 36′ N, 111° 50′ W). From two closely spaced levels, presumed Cody complex (Forbis, 1968) possibly assoc with large side-notched points. No diagnostic artifacts with bone, only stratigraphic correlation to Forbis excavation. S-1083 identical to portion dated 5960 ± 170 yr BP (RL-560: unpub) (Quigg, 1976). Coll and subm 1975 by J M Quigg, Archaeol Surv Alberta.

S-1081. Bone, Test 1, Level 8 1680 ± 150

S-1082. Bone, Test 1, Level 9 4470 ± 120

S-1083. Bone, Test 5, Level 11 4130 ± 120

S-1084. Bone, Test 5, Level 12 7660 ± 110

General Comment (JMQ): S-1084 just fits time frame for Cody complex in central and N plains (Wheat, 1972). Dates unreliable because of fluctuating groundwater table and mineral soil.

S-1135. JjNi-2 site series, Northwest Territories

Charcoal in sand (NMC-819) from NE Rennie Lake, SE Dist Mackenzie (61° 37′ 30″ N, 105° 25′ W). From single buried level in blowout exposure, 390 to 450m asl. Surrounding artifacts, Late Taltheilei, ca AD 1200 to 1650. Coll 1975 by M Wright; subm 1975 by B C Gordon.

S-1135. JjNi-2 site **2570 ± 120**

Single buried level in blowout.

S-1157. JjNi-2 site **2150 ± 130**

Single buried level, as above.

General Comment (BCG): estimate based on surface Lake Taltheilei tools dated elsewhere ca AD 1200 to 1650. Blowout also yielded lesser quantities of Shield Archaic and Pre-Dorset material, 3 diagnostic Early Taltheilei points, 1 diagnostic Late Taltheilei point and non-diagnostic both large and small, crude and fine bifacial knives, several point fragments. Crudity suggests Late Taltheilei side-notched points but may be hafted knives dating much earlier. S-1135 probably dates diagnostic Early Taltheilei ca 500 to 100 BC within error. S-1157 may date knives rather than points.

Côteau-du-Lac series, Quebec

Human bone from site (BhFn-1), W bank St Lawrence R, ca 7km from Valleyfield, Soulanges (45° 17′ 20″ N, 74° 10′ 20″ W). From S of Delisle R, on point formed by R with St Lawrence. Recovered in cloverleaf bastion, from ground disturbed by construction ca 1778. Two human femurs found out of position in Sq S4, NW quad, 1.76m below rampart surface. Two burials discovered in place under 2m rampart. 1966 discovery contained a bannerstone; 1975 contained bone knives, 2 elongated net sinkers, and mica sheet. Material exhibits elements common to Laurentian tradition ca 4000 BC. Coll 1975 by F Passchier; subm 1975 by R Marois.

S-1154. Côteau-du-Lac site **6660 ± 150**

Human femur (NMC-844) from Sq S4, NW quad.

S-1263. Côteau-du-Lac site **4900 ± 80**

Human femur (NMC-889) from 1975 grave discovery.

General Comment (RM): no explanation for age difference between disturbed zone femur and grave femur.

Nunguvik Site Series 2, Northwest Territories

Plant material, bone, and charcoal from site (PgHb-1) S of Low Point, W coast Navy Board Inlet, Baffin I. (73° 01′ 30″ N, 80° 38′ 00″ W). N Baffin I., Dorset, and Thule houses site. Coll 1975 and subm 1976 by Fr G Mary-Rousselière.

S-1202. Nunguvik site, House 76 **2090 ± 50**

Charcoal (NMC-845) from Sq 43, 15cm below surface. Previously dated 1310, 1525, and 1515 BP (S-845, -883, and -849). Ca 1250 to 1300 yr BP.

S-1203. Nunguvik site, House 73 **1940 ± 100**

Plant material (mostly willow and *Cassiope tetragona)* (NMC-847) 1m asl, Sq 19, 50 to 60cm below surface under pavement. Should date earliest Dorset house occupation. Previous dates 1490 BP for alcove NE entrance (S-846) and 1320 BP lower level of entrance passage (S-879). Ca 1550 yr.

S-1204. Nunguvik site, House 73 **1470 ± 90**

Plant material (mostly willow and *Cassiope tetragona)* (NMC-847) Sq 19 and 22, 30cm below surface. Should indicate main Dorset occupation, ca 1500 yr.

S-1205. Nunguvik site, House 73 **1090 ± 90**

Caribou bones (NMC-848) Sq 22, contained in surface to 15cm depth. Should date late occupation, perhaps after house abandoned ca 1200 to 1250 yr.

S-1206. Nunguvik site, House 73 **1550 ± 60**

Plant material (mostly *Cassiope tetragona)* (NMC-849) Sq 17, lower layer 60 to 65cm below surface. Should indicate earliest occupation, Sq 17 house complex to NE of entrance, ca 1550 yr.

S-1207. Nunguvik site, House 46 **1280 ± 60**

Caribou bones (NMC-850) 12m asl, three squares outside back wall, mostly from 20cm depth. Should indicate early Dorset occupation. Previous date 1880 yr BP (S-880) too recent. Ca 2200 yr.

*General Comment (*GM-R): S-1204, -1205, -1206 acceptable. S-1202 too old for recent occupation in House 76. S-1203 seems too old for lower level and S-1207 too recent.

S-1221. FbOq-62 site, Alberta **140 ± 60**

Aspen wood (*Populus* sp) from set of plains tipi poles, Neutral Hills, E central Alberta (52° 10′ N, 110° 50′ W). Partially decayed, coll on surface by D Barr (Quigg, 1977). Coll and subm 1976 by J M Quigg. *Comment* (JMQ): date acceptable.

S-1238. FbOr-57 site, Alberta **480 ± 50**

Charcoal from Neutral Hills, E central Alberta (52° 10′ N, 110° 50′ W). From central hearth in tipi ring 2 of 5 tipi ring site, assoc with small side-notched points (Quigg, 1977). Coll and subm 1976 by J M Quigg. *Comment* (JMQ): date appropriate for Late Prehistoric period, Old Women's phase.

FbOv-1 Buffalo Jump and Campsite series, Alberta

Bone from FbOv-1 site, on N valley wall, Battle R, SW of Alliance (52° 20′ N, 110° 36′ W). From kill deposits; presumed assoc with small plains side-notched points recovered in campsite. Coll 1976 by D Barr and D Buchko; subm 1976 by J M Quigg.

S-1239. Bone, Test 4 **380 ± 90**

235 to 260cm below surface.

S-1240. Bone, Test 1 **380 ± 50**

10 to 30cm below surface.

General Comment (JMQ): dates acceptable for Late Prehistoric occupation in parkland, central Alberta.

S-1262. EiBg-20 site, Quebec **6220 ± 70**

Charcoal (NMC-887) from ca 2km N of Blanc Sablon, 30.5m asl terrace W of Blanc Sablon R (51° 26′ 44″ N, 59° 09′ W). Scattered in Sq S1E3, 30 to 50cm below surface, above artifacts and 5cm under paleosol assoc with edged biface. Materials include short contracting stem points and scrapers, mostly of rose quartzite. Site assignable to Maritime Archaic. Should date occupation under paleosol ca 6000 BC. Coll 1976 by M Ferdais; subm 1976 by R Marois. *Comment* (RM): terrace elev and distance to nearest water suggest date is too recent. Assoc not close, hence, date may apply to another phenomenon.

Michipicoten Harbour site series, Ontario

Charcoal from site (ClIf-2), ca 213m from shore of Michipicoten Bay, Lake Superior, Dist Algoma (47° 57′ 25″ N, 84° 51′ 10″ W) 192m asl. Initial Woodland site of Laurel tradition with single living floor. Possible date for introduction of ceramics in Michipicoten area. Coll 1971 by J Reddon and C MacKinnon; subm 1976 by K T Buchanan and M Brizinski, Laurentian Univ.

S-1264. Michipicoten Harbour site, Sq 10N10E **310 ± 110**

Charcoal (NMC-874) from NW quad, depth 45.2cm. From hearth on living floor, ca 2000 to 2500 yr.

S-1265. Michipicoten Harbour site, Sq 10N20E **3120 ± 430**

Charcoal (NMC-875) from 1.7m N by 2.6m W, depth 25.4cm. From hearth on living floor, assoc with Laurel sherds, ca 2000 to 2500 yr.

General Comment (KTB and MB): S-1264 unacceptable in view of artifact evidence. S-1265 probably represents earliest possible date for Laurel culture in Lake Superior area. Provides some idea of subsidence rate of prehistoric Lake Nipissing in Superior Basin. Site at 192m asl, 8.5m above Lake Superior was probably lake level beach used as summer animal procurement-processing site. Minimum time depth correlates with hypothesized date of 700 BC for introduction of Laurel culture by J V Wright.

S-1266. Wawa site, Ontario **2490 ± 250**

Charcoal (NMC-876) from site (ClIf-8), ca 483m upstream from mouth of Michipicoten R, N bank, Dist Algoma (47° 56′ 06″ N, 84° 50′ 33″ W). From balk at junction Sqs A3, A4, B3, B4; depth 17.8cm. Stratified site, 191m asl, from historic Level 1 to Initial Woodland basal cultural layer. Assoc with Laurel sherd cluster. Coll 1971 by C MacKinnon; subm 1976 by K T Buchanan and M Brizinski. *Comment* (KTB and MB): site on elev ledge ca 7.6m above present level of Michipicoten R, probably former shore of large bay. Laurel ceramics are later than ClIf-2 site.

Radiant Lake 3 site series, Ontario

Charcoal from site (CaGn-1), in sandy soil atop knoll, 14m above Radiant Lake, Deacon Twp (46° 00′ 07″ N, 78° 17′ 58″ W). Multicomponent site. Coll 1966-1968, 1971 by P Butler, D Croft, and B M Mitchell; subm 1976 by B M Mitchell, Deep River, Ontario.

S-1267. Radiant Lake 3 site, Sq I19 **310 ± 80**

Charcoal (NMC-864) in hearth feature containing sherds, 15 to 18cm below surface. Should date makers of cord-malleated collarless ceramics, ca 1200 yr.

S-1289. Radiant Lake 3 site, Sq O21 **1300 ± 70**

Charcoal (NMC-867) from 25.5 to 30.5cm below surface. Middle Woodland hearth producing rim sherds decorated with horizontal lines of pseudo-scallop shell, ca 2300 yr.

S-1290. Radiant Lake 3 site, Sq I26 **3010 ± 110**

Charcoal (NMC-868) from 13 to 35.5cm below surface. Hearth producing cord-malleated sherds, ca 1200 yr.

S-1292. Radiant Lake 3 site, Sq J27 **8690 ± 690**

Charcoal (NMC-870) from 28 to 35.5cm below surface, assoc with slate chips and bone. Should date Archaic occupation between 4815 and 4150 yr.

S-1298. Radiant Lake 3 site, Sq H29/I29 **350 ± 60**

Charcoal (NMC-285) from border between Sq H29 and I29, 5 to 10cm below surface, among plain and incised Iroquois body sherds. Side-notched and Black-Necked rim sherds occurred nearby, same level. Approx historic contact.

S-1299. Radiant Lake 3 site, Sq H26 **1290 ± 110**

Charcoal (NMC-873) from 30.5 to 33cm below surface, hearth feature. Should date makers of cord or fabric-malleated pottery, E central Ontario, ca 1200 yr.

General Comment (BMM): S-1298 and -1299 confirm possibility that malleated pottery component divisible into two sub-zones. Fabric-malleated vessels were in use AD 1645 (S-1267) and AD 1620 (GSC-1529:

unpub), cord-malleated vessel in AD 710 (GSC-1351: unpub). Date S-1299 acceptable but S-1290 too early. S-1289 late for Middle Woodland deposits but acceptable. S-1292 very early but possible, previous dates average ca 4500 yr (GSC-1281: unpub; S-1162 and -1163: R, 1979, v 21, p 82). S-1298 good date for assoc Iroquoian ceramics, Ottawa Valley.

CbGj-1 site series, Ontario

Charcoal from sandy beach 1.2m above Ottawa R, near Deep River (46° 10′ 54″ N, 77° 36′ 30″ W), 113m asl. Middle Woodland site with intrusive Iroquoian sherds. Coll 1969, 1970, and subm 1976, 1977 by B M Mitchell.

S-1268. CbGj-1 site, Sq 13 **1240 ± 120**

Charcoal (NMC-865) from depth 19cm, ca 2200 yr.

S-1269. CbGj-1 site, Sq 7F **870 ± 130**

Charcoal (NMC-866) from small hearth containing corn-ear rim sherd, ca 400 yr.

S-1301. CbGj-1 site, Sq 106B **3830 ± 130**

Charcoal (NMC-890) from depth 18 to 25cm, small hearth feature containing many lithic chips and two Iroquoian sherds, ca 400 to 800 yr.

General Comment (BMM): S-1268 later than expected but within range of Middle Woodland. S-1269 appears too early, but rims from Iroquoian component at BlGk-15 site, on Petawawa R, 30km W, dated AD 1270 ± 80 (GSC-2238: unpub) Mitchell *et al,* 1970). S-1301 unacceptable for assoc sherds.

Protection Island site series, British Columbia

Charcoal from site (DhRx-5), NW shore Protection I., E off Nanaimo, Vancouver I. (49° 10′ 50″ N, 123° 55′ 22″ W). Small shallow shelf midden overlying portions of otherwise undisturbed petroglyph pecked into sandstone slab, seaward midden edge. Midden ca 4m above high tide overlooking shallow tidal channel between Protection I. and Newcastle I. Artifacts suggest developed Coast Salish culture common to region. Should be min date for petroglyph and occupation, ca 300 to 1000 yr. Coll 1975 by D Lundy, A McMurdo, D Hutchcroft, B Kennedy, and M Abbott; subm 1976 by D Lundy, Prov Mus, British Columbia.

S-1270. Protection Island site, Level 4 **280 ± 50**

Charcoal (NMC-871) scattered throughout Level 4, 40 to 43cm depth.

S-1271. Protection Island site, Level 1 **350 ± 40**

Charcoal (NMC-872) found in scattered chunks in Level 1, 59 to 80cm depth, Unit 2.

General Comment (DL): oral commun with residents and soil analyses support no recent site disturbance. Recovered artifacts indicate historic and prehistoric cultural components. Minimum date for rock carving.

Stott site series, Manitoba

Bone from site (DlMa-1), large Late Woodland, Blackduck site along Assiniboine R, transition zone between NE Plains and Aspen Parkland, near Brandon (49° 52′ 30″ N, 100° 05′ W). Multicomponent, from base of thick bone bed (Syms, 1976b; 1977; Tisdale, 1978). Coll and subm 1976 by E L Syms.

S-1272. Bone (BU-76-1), Level 6 **1110 ± 60**

S-1273. Bone (BU-76-2), Level 6 **1040 ± 50**

General Comment (ELS): dates acceptable.

Bruce Boyd series, Ontario

Charcoal and deer bone from site (AdHc-4) sand knoll, Lots 8 and 9, Concession B, S Walsingham Twp, Norfolk Co (42° 36′ N, 80° 28′ W). Early Woodland burial site, 171m asl. Closest affiliations appear to be Meadowood, New York. Coll 1976 by M Spence, R Williamson, and J Dawkins; subm 1977 by M Spence, Univ Western Ontario.

S-1287. Bruce Boyd site, Feature 3 **860 ± 70**

Charcoal (NMC-903) from Sq 495-500. Probably Early Woodland ca 700 to 400 BC.

S-1288. Bruce Boyd site, Feature 15 **2470 ± 70**

Deer bone (NMC-904) from Sq 490-500, burial pit, directly above human remains, 10 to 15cm below top soil. Assoc directly as offering with probable Early Woodland burial ca 700 to 400 BC.

General Comment (MS): S-1287 dates minor Late Woodland site use. Ceramic analyses from feature revealed 1 Glen Meyer body sherd and others part of 3 Early Woodland vessels. Date acceptable for Glen Meyer ceramics. S-1288 Early Woodland occupation agrees with three dates from 600 to 470 BC for Early Woodland Dawson Creek site on Rice Lake and dates series for similar New York, Ohio, and Michigan sites. Date suggests Bruce Boyd site contemporary with earlier part of Saugeen focus of Bruce Peninsula, but it is possible that early Saugeen dates from Donaldson site really pertain to distinct Early Woodland (Vinette 1) occupation that became mixed with later dentate-corded stick assemblage.

S-1291. BlGk-15 site, Ontario **2580 ± 170**

Charcoal (NMC-869) from Petawawa R, Algonquin Park, Stratton Twp (45° 49′ 10″ N, 77° 41′ 45″ W). From ca 155m asl, test hole 18 to 25.4cm below surface, near shale blade and pseudo-scallop-shell-decorated rim sherds. Should determine if local Middle Woodland culture dates beyond 490 BC (Gak-1891: R, 1973, v 15, p 57). Ca 2400 yr. Coll 1968 and subm 1977 by B M Mitchell. *Comment* (BMM): date acceptable; probably represents earlier portion of Middle Woodland period.

Nyman site series, Ontario

Charcoal from site (ClIf-11), N shore Lake Superior, 805m upstream from mouth of Michipicotin R, Michipicotin Bay (47° 57′ 00″ N, 84° 54′ 30″ W). Small habitation, 6.1m above R on N bank, Terminal Woodland period, Algonkian culture. Coll 1971 and subm 1976 by K C A Dawson, Lakehead Univ.

S-1293. Nyman site, Level IIB **80 ± 70**

Charcoal (NMC-893) from Sq 30W/0N, Stratum III, Hearth Feature 7, 12.7 to 15.2cm depth. Assoc with Blackduck and Michigan derived ceramics, lithics, but no trade goods. Ca AD 1400 to 1750.

S-1294. Nyman site, Level II **530 ± 90**

Charcoal (NMC-894) from Sq 10W/0N, Stratum II, Hearth Feature 15, 17.8cm depth. Assoc with historic and prehistoric artifacts, ca AD 1700 to 1750.

S-1295. Nyman site, Level IIB **1130 ± 140**

Charcoal (NMC-895) from Sq 30W/0N, Stratum III, Hearth Feature 7, 12.7 to 15.2cm depth. Same assoc as S-1293.

S-1296. Nyman site, Level II **Modern**

Charcoal (NMC-896) from Sq 10W/0N, Stratum II, 5.1 to 12.1cm depth. Ca AD 1750.

General Comment (KCAD): discrepancies consistent with arbitrary excavation of naturally disturbed thin cultural mantle of site. S-1293 and -1296 too recent. S-1295 appears too early. S-1294 acceptable for earlier occupation, complements previous date AD 1575 ± 45 (S-1294: unpub).

S-1297. Cressman site, Ontario **170 ± 90**

Wood and charcoal (NMC-897) from site (DfJn-1), Lac des Milles Lacs, on sand point ca 6.4km SW of Savanne R mouth, Lac des Milles Lacs Indian Reserve 22A-1, Ontario (48° 54′ N, 90° 18′ W). From hearth, Test Pit 2, 25.4cm below surface. Woodland period with Laurel, Blackduck, and historic occupations. Blackduck component ca AD 1000 to 1600. Coll 1976 by M P McLeod; subm 1976 by K C A Dawson. *Comment* (KCAD): date acceptable for terminal Blackduck historic occupation. Depth of recovery suggested early component, but years of water erosion at site may account for overburden.

Montgomery Lake site series, Ontario

Charcoal from site (BlGj-2), on sandy slope 3m above Montgomery Lake, Wylie Twp (45° 56′ 13″ N, 77° 33′ 49″ W). Middle Woodland with Vinette 2 ceramics. Red ocher-stained cremation burial pattern present. Coll 1966, 1967, and subm 1977 by B M Mitchell.

S-1300. Montgomery Lake site, Sq 51 **3360 ± 80**

Charcoal (NMC-888), 25 to 38cm depth, in hearth feature. Ca 2400 yr.

S-1302. Montgomery Lake site, Sq 26 **320 ± 60**

Charcoal (NMC-891), 18 to 23cm depth, in hearth containing sherds, projectile point, beaver jaw bones. Should date latest ceramic use by Iroquoian groups of interrupted-bar motif on collared pottery, ca 400 yr. *General Comment* (BMM): S-1300 later than local Archaic cultures and earliest Middle Woodland but with acceptable limit. S-1302 confirms later part of range of Iroquoian pottery in Ottawa R drainage.

S-1303. Stott Mound, Manitoba **1360 ± 60**

Human bone (NMC-910) from (DlMa-1), on N bank Assiniboine R, near Brandon, Manitoba (49° 52′ N, 100° 05′ W). From Burial XV-A: 97, Mound probably assoc with Blackduck complex site on basis of proximity to Stott Village site. No Blackduck mound in Manitoba ever before dated. Ca AD 700 to 1400 if Blackduck. Coll 1952 by R S MacNeish; subm 1977 by Roscoe Wilmeth at request of E L Syms. *Comment* (ELS): date ca 300 yr earlier than anticipated, earlier than any Blackduck dates in Manitoba and lowest level of Stott site bone bed averaging AD 884 ± 36. Mound lacked diagnostic artifacts but contained Late Woodland sherdlets (Syms, 1976).

S-1319. Moosehide site, Yukon **220 ± 60**

Bone (NMC-911) from site (LaVk-2), bank Yukon R, 4.8km below Dawson City, abandoned village of Moosehide, Yukon (64° 06′ N, 139° 26′ W). Multicomponent site on 18.3m terrace overlooking mouth of Moosehide Creek. From Level 1, Sq 15, SE sec, assoc with concentration of firecracked rock, chert end scraper, and flakes. Late Prehistoric occupation characterized by crude flake industry, chert end scrapers, blunt-bone hunting arrow point, and probable Klo-kut point. Athapaskan, ca 200 to 1400 yr. Coll and subm 1976 by J R Hunston, Univ Calgary. *Comment* (JRH): S-1319 acceptable; fits typologic affinities of Late Prehistoric material with late period at Klo-kut, Late Prehistoric Kutchin site, N Yukon (Morlan, 1973).

Cape Garry site series, Northwest Territories

Wood from site (PeJq-5), max E projection of Cape Garry, Somerset I., Dist Franklin (72° 27′ N, 93° 28′ W). Thule site of 26 winter houses. Occasional artifacts suggestive of nearby Dorset occupation. No European artifacts. Coll 1967 by A Clarke and A P McCartney; subm 1977 by A P McCartney, Univ Arkansas.

S-1320. Cape Garry site, House 7 **1070 ± 70**

Wood (NMC-912) from Sec E-1, lower sod to gravel in permafrost zone, 15 to 30cm depth. Should date house occupation, ca AD 1200 to 1400.

S-1321. Cape Garry site, House 6 **530 ± 80**

Wood (NMC-913) from Sec B-2, floor zone, in permafrost, 50cm depth. Should date earliest occupation and probably construction and apply to adjacent houses, ca AD 1200 to 1400.

S-1322. Cape Garry site, House 18 **910 ± 60**

Wood (NMC-914) from Sec C-2, floor muck, in front of bench ledge below ca 20cm of moss muck, in permafrost zone. Should date earliest occupation and probably construction, ca AD 1200 to 1400.

General Comment (APM): all three houses in same cluster located on same beach ridge. Similarity of artifacts and locality suggests contemporary occupation during classic Thule period. S-1320 appears early, S-1321 too late, S-1322 more closely fits expected early Thule period. Wood probably trade driftwood from mainland, age correction for gap in use important in Canadian Archipelago but difficult to estimate.

Creswell Bay site series, Northwest Territories

Wood from site (PeJr-1), N shore Creswell Bay, ca 14.5km W of Creswell R mouth, Somerset I., Dist Franklin (72° 48′ N, 93° 36′ W). Thule site of 16 winter houses. Dorset artifacts but no Dorset structures, no European material. Ca AD 1200 to 1400. Coll 1976 by D Weetaluktuk, J Sproull, and A Sawicki; subm 1977 by A P McCartney.

S-1323. Creswell Bay site, House 1 **1010 ± 100**

Wood (NMC-915) from Sec C-3, floor zone inside house, 50cm depth in permafrost.

S-1324. Creswell Bay site, House 15 **830 ± 70**

Wood (NMC-916) from Sec C-13, floor zone, 40cm depth in permafrost.

S-1325. Creswell Bay site, House 5 **1130 ± 90**

Wood (NMC-917) from Sec B-3, floor zone inside house, 70cm depth in permafrost.

General Comment (APM): Houses 1 and 5 close together on same beach ridge suggesting contemporary occupation. Although dates are similar they appear too early in view of earliest Canadian Thule estimates at AD 950 to 1050. House 15, isolated at one edge of house cluster, dates closer to expected age. Artifacts suggest cultural continuity and contemporaneity of houses. Possible driftwood older than construction as Cape Garry site suggests (S-1320, -1321, and -1322).

S-1326. MbDq-1 site, Northwest Territories **90 ± 140**

Wood (NMC-918) from N shore Cumberland Sound, 1.6km W of historic settlement of Avatuktoo, Baffin I., Dist Franklin (66° 15′ N, 66° 19′ W). From House 3, Sec S12W2, Level 18, W living area, 99 to 104cm depth in permafrost. Thule site of 9 winter houses, European artifacts present. Should date original occupation, probably house construction but may relate to historic habitation. Ca AD 1200 to 1400. Coll 1976 by H Stewart; subm 1976 by A P McCartney. *Comment* (APM): given lack of boulder and slab rock construction (flagstone floor, doorway, and distinct walls, and benches or platforms) typical of Thule houses in E Canadian Arctic, it is possible house might be *qarmat* structure of

historic period. Whale bone fragments and small number of artifacts present, none distinctively prehistoric period.

S-1327. Qiqitalakjuak site, Northwest Territories 620 ± 80

Mixed vegetation including wood fragments (NMC-919) from site (MhBw-3), S shore Kikitalakdjuak I., E Baffin I., Dist Franklin (63° 30′ N, 67° 16′ W). From House 2, Sec B-2, Quad 2, between slabs and support rock of outside bench. Thule site of 4 winter houses, 2 excavated. House 1 appears to be originally Thule built and re-occupied in late 18th and early 19th centuries; historic artifacts found in upper levels of house. Ca AD 1600 to 1800. Coll 1976 by G Sabo; subm 1977 by A P McCartney. *Comment* (GS): date acceptable for general area occupation by ca AD 1200, Thule Eskimo living in semi-subterranean sod-stone houses.

Gompf site series, Manitoba

Bison bone from site (DkMd-3), on tributary ravine of Assiniboine R valley, W Manitoba (49° 48′ 30″ N, 100° 33′ W). Blackduck killcamp site, Excavation B, Level 3, bottom of bone bed, 20 to 30cm below surface. Coll and subm 1977 by E L Syms.

S-1366. Bone (Br-77-2) 1020 ± 60

S-1367. Bone (Br-77-3) 1140 ± 70

S-1368. Bone (Br-77-4) 990 ± 70

General Comment (ELS): multiple samples believed to represent single event, shows range of variation.

S-1372. EqPt-6 site, Alberta 370 ± 80

Bone from campsite, on N side of Bow R valley just inside mt front, W Alberta (51° 04′ N, 115° 11′ W). From cultural level 31cm below surface, assoc with corner-notched point, biface, end scraper, and lithics (Quigg, 1978). Coll 1977 by D Barr; subm 1977 by J M Quigg. *Comment* (JMQ): date is considerably outside known range of Pelican Lake Phase for NW Plains and termination date AD 500 to 600 for mts (Reeves, 1970). Few sites in area or cultural phase; date is tentative.

S-1373. Dry Island Buffalo Jump site 530 ± 80

Bone from (ElPf-1), N of Drumheller, Alberta (51° 55′ N, 112° 59′ W). Site not excavated, bone recovered from slump block. Coll 1977 by D Barr; subm 1977 by J M Quigg. *Comment* (JMQ): date is reasonable for late occupation.

Nakwantlun site series, British Columbia

Charcoal from site (FdSi-11), E bank of Dean R at Natsedeelya Crossing, just below outlet of lower Anahim Lake (51° 31′ 05″ N, 125° 22′ 15″ W). Multicomponent site, with unknown number of components, ending with late prehistoric or protohistoric Chilcotin. Coll 1977, 1978 by Cohen, F Wilmeth, R Wilmeth, P Stahl, A Barton, J Coates, and D Black; subm 1977, 1978 by Roscoe Wilmeth.

S-1415. Nakwantlun site, House 2, Level 4 2410 ± 100
Charcoal (NMC-930) from test trench, 63 to 80cm below surface.

S-1416. Nakwantlun site, House 5, floor 1870 ± 60
Charcoal (NMC-931) from test trench, floor level.

S-1417. Nakwantlun site, House 6, floor 2410 ± 240
Charcoal (NMC-932) from test trench, floor level.

S-1446. Nakwantlun site, House 8, Level 2 840 ± 60
Charcoal (NMC-961) from test trench, brown soil zone.

S-1589. Nakwantlun site, XU-1, Sq 0-2S, 0-2W 2490 ± 50
Charcoal (NMC-992) in lower red-brown soil zone.

S-1590. Nakwantlun site, XU-1, Sq 0-25, 4-6E 340 ± 50
Charcoal (NMC-993) 53cm below surface, red-brown soil zone.

S-1591. Nakwantlun site, XU-1, Sq 2-4S, 6-8E 430 ± 50
Charcoal (NMC-994) 10cm below surface in humus above red-brown soil zone.

S-1592. Nakwantlun site, XU-1, Sq 2-4S, 6-8E 180 ± 40
Charcoal (NMC-995) 6cm below surface in humus above red-brown soil zone.

S-1593. Nakwantlun site, House 2, Layer 9 3500 ± 70
Charcoal (NMC-996) 45 to 55cm below surface, hearth in gray silt zone.

S-1594. Nakwantlun site, House 2, Layer 9 2480 ± 50
Charcoal (NMC-997) 55 to 65cm below surface, hearth in gray silt zone.

S-1608. Nakwantlun site, House 2, Layer 10 2370 ± 70
Charcoal (NMC-998) 65 to 75cm below surface, hearth in light brown silt.

S-1609. Nakwantlun site, House 2, Layer 10 2530 ± 50
Charcoal (NMC-999) 76 to 81cm below surface, hearth in dark gray silt.

S-1610. Nakwantlun site, House 6 1010 ± 60
Charcoal (NMC-1000) from floor in NW quad, 101cm below surface.

S-1611. Nakwantlun site, House 6 500 ± 45
Charcoal (NMC-1001) from fill in NW quad, in fire-reddened soil, buried root.

S-1612. Nakwantlun site, House 6 880 ± 60
Charcoal (NMC-1002) from red-soil zone, middle of three levels in hearth.

General Comment (RW): dates S-1415, -1417, -1589, -1594, -1608, and -1609 form fairly compact group ranging from 575 to 420 BC. Four samples from House 2, from 2 stratified hearths, with one exception are in proper order. Tight date clustering suggests S-1593 at 1550 BC from upper of 2 hearths in House 2 is too early. These are earliest dates so far obtained at Anahim Lake. S-1416 falls within range of Component Cluster I at Potlach site (FeSi-2), characterized by presence of microblades (Wilmeth, 1978). No microblades yet recovered at Nakwantlun site but parallel house form at 2 sites. S-1446, -1612, and -1610 immediately precede previous dates for Component Cluster III at Goose Point site (FeSi-1), S-1446 comparable to Goose Point (S-1039: R, 1979, v 21, p 82). S-1590, -1591, -1592, and -1611 span period from Late Prehistoric to Protohistoric in Anahim area assoc with small side-notched points, alleged occupation by Chilcotin Indians.

49 Afo-109 site series, Alaska

Charcoal from mouth of Afognak R, Afognak I., Kodiak group (58° 05′ N, 152° 48′ W). Campsite ca 5.8m asl, 2.44m above high tide, early maritime hunters belonging to Ocean Bay II phase. Located within ethnographic Pacific Eskimo territory but not necessarily Eskimo affiliation, lacks cross-ties with N Alaskan sites. Coll 1971 and subm 1977 by D A Clark.

S-1418. 49 Afo-109 site, H sec **4480 ± 160**

Charcoal (NMC-934) from charcoal layers in feature pit, depth 83.8 to 99cm below base of 1912 volcanic ash. Ca 3800 to 4800 yr.

S-1419. 49 Afo-109 site, Sec S60W106 **4480 ± 130**

Charcoal (NMC-935) from trimmed erosion face; depth 50.8cm below base of 1912 volcanic ash. Ca 3800 to 4800 yr.

General Comment (DWC): previous site dates and adjacent Ocean Bay I/I-II site Afo-106 indicated probable overlapping or sequential occupations (Gak-3802, -3803 and -3804: unpub). Previous dates are older (Clark, 1979).

Porden Point Brook series, Northwest Territories

Twigs, leaves, sphagnum, and bone from Porden Point Brook village (RbJr-1), 1km NW of Porden Point tip, Grinnell Peninsula, Devon I., (76° 15′ N, 92° 40′ W). Thule winter village, 9 houses, 120m inland from coast, 4m asl. Artifacts suggest early period of Thule occupation in High Arctic. Coll and subm 1977 by R McGhee, Natl Mus Canada.

S-1420. Porden Point Brook site, House 7 **550 ± 70**

Twigs (NMC-936) from rear of sleeping platform area, beneath flagstones of platform. Sample mixed with moss and leaves, apparent residue from platform mattress. Ca 500 to 1000 yr.

S-1421. Porden Point Brook site, House 7 1380 ± 90

Leaves (*Dryus* sp) (NMC-937) from rear of sleeping platform area, beneath flagstones of platform. Sample mixed with moss and twigs, similar to S-1420.

S-1422. Porden Point Brook site, House 7 1000 ± 110

Sphagnum (NMC-938) from rear of sleeping platform area, beneath flagstones of platform. Sample mixture similar as S-1420 and -1421.

S-1423. Porden Point Brook site, House 7 1340 ± 70

Rib bone sec *(Balaena mysticetus)* (NMC-939), between flagstones of floor area. Ca 500 to 1000 yr.

S-1424. Porden Point Brook site, House 7 1310 ± 70

Rib bones *(Phoca hispida)* (NMC-940), beneath flagstones of sleeping platform area. Ca 500 to 1000 yr.

General Comment (RM): sample series selected for testing relationship between dates on different arctic materials. Four samples from beneath sleeping platform above floor flagstones; whale bone, structural support of house wall, seal bones, apparent refuse, plant materials (mattress residue) picked from single mixed sample found *in situ,* beneath rear of platform. Excellent preservation of samples; appear continuously frozen since house was abandoned. House 7 typical Thule winter house, appears occupied only for a few years; no evidence of earlier occupation found at site. S-1420 local willow twigs, acceptable for artifact style. Other dates unacceptably early. Possibly, sphagnum was dug from old deposit but there are no signs of humification; appears as if recently picked; no explanation for wide range of plant material dates. Whale bone is possibly from old drift-whale and used much later in house construction. Seal bones undoubtedly relate to house occupation but similar date to whale bone; sea mammal dates expected to be unacceptably early (McGhee and Tuck, 1976) but not as early as S-1423 and -1424. Findings suggest that arctic material dates other than local wood should be treated with some skepticism.

Garden Island site series, British Columbia

Human bone from site (GbTo-23), Venn Passage, Prince Rupert (54° 19′ 05″ N, 130° 23′ 15″ W). Shell midden covering small island in coast Tsimshian area. Coll 1967 by G F MacDonald; subm 1977 by J S Cybulski, Natl Mus Canada.

S-1428. Garden Island site, Burial 165 1750 ± 70

Human ribs (NMC-944) from Sq 4AA1, 51.8cm below surface, 1.9m below datum. Headless skeleton, "discarded" burial position. Crippled condition in life suggested by pelvic and vertebral anomalies. Ca AD 1000.

S-1429. Garden Island site, Burial 178 **2490 ± 70**

Human ribs (NMC-945) from Area 5, Level 1. Burial position suggests other than prepared burial. Labret wear on lower teeth. Temporomandibular joint arthritis. Ca AD 1000 to 1500.

S-1595. Garden Island site, Burial XVII-B-158 **2800 ± 50**

Human ribs (NMC-1003) from Test Area 5, below humus line. Ca 2000 to 2500 yr.

S-1596. Garden Island site, Burial XVII-B-197 **6230 ± 80**

Right human innominate and head of femur (NMC-1004) from Sq 2B, ca 2.6m below datum. Part of multiple burial; should date lowest cultural level in square.

General Comment (JSC): part of human bone series from five shell midden sites in Prince Rupert Harbour region, British Columbia, for clarification of burial sequence in relation to ^{14}C dated (charcoal and shell) stratigraphy and bracket of possible temporal groups to known or estimated time span of sites. S-1428, -1429, and -1595 agree with chronologic distribution of bone dates from other sites. S-1428 and -1595 agree closely with stratigraphic position estimate. S-1429 suggests need for strata review in Area 5 as field record is not directly connected to other site areas. S-1596 appears wrong, 3000 yr older than any other bone-dated burial from sites. Left humerus of same skeleton produced corrected age 2620 ± 70 ($\delta^{13}C = -14.3‰$) and a second skeleton (left femur) in same multiple burial produced corrected age 2660 ± 260 ($\delta^{13}C = -16.9‰$) (GSC-2888 and -2886: unpub).

KeNi-4 site series, Northwest Territories

Charcoal in sand, 10.36m above shoreline Whitefish Lake, SE Dist MacKenzie (62° 46′ N, 106° 58′ W). Sand knob 500m long, 366m asl, adjacent to caribou water crossing. Five levels and several sub-levels. Levels 1 to 4, Late Middle and Early Taltheilei tradition; Level 5, mixture of Plains and Shield Archaic. Previous dates range from 1670 BC to AD 1545 (S-1261 and -1259: R, 1979, v 21, p 90). Coll 1977 by B C Gordon, J Thomsen, L Jackson, D Jackson, and M Barlow; subm 1977 by B C Gordon.

S-1434. KeNi-4 site, Level 5 **2940 ± 210**

Charcoal in sand (NMC-950) from Area C, 0S6W, assoc with Duncan point, scrapers, biface fragments, and flakes. Plains Archaic ca 2000 BC.

S-1435. KeNi-4 site, Level 5 **4040 ± 130**

Charcoal in sand (NMC-951) from Area C, Sqs 2S10W, 2N10W, 0S10W, and 1N1E. Plains Archaic ca 2000 BC.

S-1436. KeNi-4 site, Level 4 **2390 ± 110**

Charcoal in sand (NMC-952) from Area C, 3N2E. Early Taltheilei ca 600 BC to AD 100.

S-1437. KeNi-4 site, Level 4 **2390 ± 170**

Charcoal in sand (NMC-953) from Area C, 2N1E and 1N1E. Early Taltheilei ca 600 BC to AD 200.

S-1438. KeNi-4 site, Level 4 **1550 ± 60**

Charcoal in sand (NMC-954) from Area C, 0N4W. Early Taltheilei ca 600 BC to AD 200.

S-1440. KeNi-4 site, Level 4 **2480 ± 60**

Charcoal in sand (NMC-956) from Area C, 2S4-6W, 2S6W. Early Taltheilei ca 600 BC to AD 200.

S-1441. KeNi-4 site, Level 2 **1040 ± 70**

Charcoal in sand (NMC-957) from Area C, 0N4W. Ca 500 to 1000 yr.

S-1529. KeNi-4 site, Level 1 **1060 ± 60**

Charcoal in sand (NMC-976) from Area A, 2S4W and 2S1W. Late Taltheilei, only a few centuries old.

S-1530. KeNi-4 site, Level 2 **1040 ± 80**

Charcoal in sand (NMC-977) from Area A, 0N1W, 1S0W, 1S3R, 2S2W, 4S1W. Middle Taltheilei ca AD 400 to 1000.

S-1531. KeNi-4 site, Level 3 **2580 ± 80**

Charcoal in sand (NMC-978) from Area A, 1S0W, 1S1W, 2S2W. Early Taltheilei, possibly Pre-Dorset, ca 500 BC to AD 500.

General Comment (BCG): with two exceptions, all dates fall within temporal range based on point typology and stratigraphy. S-1434 and -1435 wrong as bottom level dated 1670 and 2090 BC (S-1261: R, 1979, v 21, p 90). S-1434, small sample, also included charcoal from Sub-level 4b, falls during barrenland Pre-Dorset occupation also in site. Level 4 gives three acceptable dates; S-1428 appears late. It is unlikely that Early Taltheilei (Hennessey) points persist until Middle Taltheilei ca AD 500, considering respective temporal clusters at 500 to 100 BC and 100 BC to AD 500 in other sites. S-1441 indicates presence of small underground-stem points by ca AD 900 at tree line. Stemmed points are present throughout Late Taltheilei Chipewyan but are outnumbered by side-notched points. S-1531 and -1530 acceptable; S-1529 appears too old.

Evergreen site series, Northwest Territories

Charcoal and calcined bone from site (KeNi-5), ca 4.6m above Whitefish Lake, SE Dist MacKenzie (62° 48′ 50″ N, 106° 57′ 40″ W). Small blowout with predominantly Taltheilei tools. Dates will correlate site with KeNi-4 site, 1.6km SE. Coll 1977 by L Jackson and C Thompson; subm 1977 by B C Gordon.

S-1439. Evergreen site, Feature 1 **1860 ± 130**

Charcoal and calcined bone (NMC-955), numerous tools, no projectile points.

S-1528. Evergreen site, Level 1b **1350 ± 80**

Charcoal in sand (NMC-975). Several tools found on blowout floor below wall of excavation.

General Comment (BCG): multicomponent site, four sub-levels. Tools definitively Middle Taltheilei in Sub-level 1. Feature 1 had no traceable sub-levels. Dates acceptable.

S-1442. Weiser site, Ontario **1550 ± 70**

Carbonized wood (NMC-933) from site (AdHo-1), Chatham, Kent Co (42° 36′ N, 82° 23′ W). From Units 50 and 52, S16, in midden below sand. Middle Late Woodland/Mississippian Fort Ancient affiliation, with palisade and internal circular enclosure. Assoc with maize kernels and two large grain sheaths. Ca 1000 yr. Coll and subm 1977 by E L Kroon, Univ Windsor. *Comment* (ELK): carbonized remains id. as "grain-like". Quantity of maize from midden deposits suggests Weiser peoples had agriculture confirming that maize agriculture in Ontario sites antedates those in SE Michigan (Stothers, 1973). Date earlier than Mississippian but lithic assemblage fits range and ceramic traits (shell tempering, strap handles, and applique elements) compatible with other Mississippian sites and N to S influence. One of earliest "Mississippian-like" sites exhibiting characteristic Woodland base blended with minor "Mississippianisms" termed Intermediate Period AD 400 to 900 (Stoltman, 1978).

S-1447. Greenwater Lake site, Saskatchewan **4390 ± 110**

Bone fragments (GWL-1) from site (FcMv-1), E central Saskatchewan (52° 29′ 45″ N, 103° 32′ 10″ W). Partially disturbed burial representing a primary interment recovered from back slope of road cut. Assoc with red ocher and Oxbow projectile point. Coll 1973 by Royal Canadian Mounted Police and E G Walker, Univ Saskatchewan; subm 1977 by I G Dyck, Saskatchewan Nat Hist Mus. *Comment* (EGW): date consistent with other Oxbow occupations on N Plains.

Gowen site series, Saskatchewan

Charcoal and unburned bone fragments from site (FaNq-25) on terrace of S Saskatchewan R, within city limits of Saskatoon (52° 05′ 45″ N, 106° 42′ 20″ W). From 480.4m asl processing area, large herbivores and smaller mammals, assoc with chipped stone tools and lithic debris. Early Middle Prehistoric affiliation (Schroedl and Walker, 1978), ca 6000 yr. Coll 1977 by E G Walker and A R Schroedl; subm 1978 by E G Walker.

S-1448. Gowen site, S main excavation **5760 ± 140**

Charcoal (GOW-1) from paleosol occupation layer, 1.5m depth, sterile sands above and below zone.

S-1457. Gowen site, main excavation **6150 ± 110**

Unburned bone from same layer as S-1448.

S-1526. Gowen site, W margin **4730 ± 130**

Unburned bone (NMC-990) from extreme W margin, profile showed two thin buried Soil A horizons sealed above and below by sterile sands. Lower horizon prehistoric living floor.

S-1527. Gowen site, disturbed area **5670 ± 140**

Unburned bone (NMC-991) recovered in salvage excavation of area disturbed by heavy equipment.

General Comment (EGW): S-1526 inconsistent and rejected as too recent.

S-1506. Lewis site, Saskatchewan **1270 ± 70**

Bone (NMC-981) from site (FkNc-32), S bank of Saskatchewan R, opposite Thomson I., 45km downstream from Saskatchewan R forks (53° 14′ N, 104° 28′ W). Mammal bone from various locations in four contiguous test pits, 24 to 55cm depth. Site has 2 occupations; partially destroyed by plowing near surface and at 40 to 60cm depth. Surface occupation yielded 1 Avonlea and 1 Duncan projectile point. Lower level had no diagnostic tools. Should date lower occupation. Coll 1977 by D Meyer, J Carter, J Light, and S Pattison; subm 1978 by D Meyer, Saskatchewan Research Council. *Comment* (DM): date could apply to either Besant or Avonlea phase occupation. Two projectile point preforms from lower level appear too robust for Avonlea; site probably component of Besant phase.

S-1522. EhPp-1 site, Alberta **1980 ± 90**

Bone from buried stone circle site N of Calgary (51° 06′ N, 114° 15′ W). From Ring B, assoc with cultural material and tipi rings id. as Besant phase of Middle Prehistoric period. Coll 1977 and subm 1978 by J M Quigg. *Comment* (JMQ): date acceptable for assoc Besant points.

Washout site series, Yukon Territory

Charcoal and charred fat from site (NjVi-2), Pauline Cove, Hershel I., N of historic settlement along beach (69° 34′ N, 138° 48′ W). Early W Thule winter house, planked driftwood construction. Extensive occupation suggested by midden accumulation, sealing primary subsistence activity, multi-family occupation (Walker-Yorga, 1979). Coll 1979 by B Yorga and R Higgins; subm by B Yorga, Univ Toronto.

S-1532. Washout site, Sq N2E3 **1570 ± 60**

Charcoal (NMC-967) from NW quad in basal midden, outside main chamber of house. Area has evidence of extensive manufacturing activity. Ca 900 yr.

S-1533. Washout site, Sq N5E3 **990 ± 100**

Charcoal (NMC-968) from NE quad in basal midden, adjacent to wooden dolls below house floor. Ca 900 yr.

S-1534. Washout site, Sq N1E1 **1510 ± 90**

Charred fat (NMC-969) from NW quad in basal midden, outside main chamber, assoc with pottery lamp fragments. Ca 900 yr.

General Comment (BY): S-1533 acceptable. S-1532 and -1534 both obtained from oil-soaked deposits and may account for similarity, if 400-yr sea mammal adjustment applied dates are comparable to other Thule sites in Beaufort Sea area. Absence of Birnirk sites and early dates on Thule sites may require revision of accepted Thule chronology in W Arctic. Washout site interpreted as evidence of early W Thule occupation.

Benson site series, Ontario

Charcoal from site (BdGr-1), Bexley Twp, Victoria Co (44° 48′ N, 78° 55′ W). Palisaded Huron village, 1.5ha, occupied during time of initial introduction of European items into area, after destruction of St Lawrence Iroquois. Coll and subm 1977 by P Ramsden, McMaster Univ.

S-1535. Benson site, House 10 **430 ± 80**

Charcoal (NMC-962) from Sq 215-380, Feature 5, Layer 2, ca 350 to 370 yr.

S-1539. Benson site, House 14 **620 ± 70**

Charcoal (NMC-966) from Sq 295-330, Feature 2, ca 350 to 370 yr.

General Comment (PR): S-1535 acceptable. S-1539 seems much too early, with no apparent explanation.

Coulter site series, Ontario

Charcoal from site (BdGr-10), Bexley Twp, Victoria Co (44° 36′ N, 78° 54′ W). Palisaded Huron village, 3.5ha, occupied during time of initial introduction of European items in area, after destruction of St Lawrence Iroquois. Coll and subm 1977 by P Ramsden.

S-1536. Coulter site, Sq 310-335 **530 ± 80**

Charcoal (NMC-963) from Sub-sq 7, Midden 62, 20 to 30cm level, ca 375 to 399 yr.

S-1537. Coulter site, Sq 310-355 **800 ± 60**

Charcoal (NMC-964) from Sub-sq 3, Stratum B, Midden 62, 20 to 30cm level, ca 375 to 399 yr.

General Comment (PR): undisturbed midden deposit, unexplained discrepancy between dates of samples only a few m apart. S-1536 earlier than expected but later end of range acceptable for initial occupation that underwent several expansions. S-1537 far too early.

S-1538. Kirche site, Ontario **400 ± 80**

Charcoal (NMC-965) from site (BcGr-8), Fenelon Twp, Victoria Co (44° 30′ N, 78° 53′ W). From Sq 295-300, feature 10, Layer 2, House 1. Palisaded Huron village, 1.2ha, 274m asl, antedates introduction of European items into Victoria area and destruction of St Lawrence

Iroquois. Coll and subm 1977 by P Ramsden. *Comment* (PR): date is acceptable. Site has produced European material and satisfactory introduction date. Marks first immigration of foreign Iroquoian groups into Trent valley, probably postdates Emerson's Hardrock site which lacks this influence.

HdDe-5 site series, Quebec

Charcoal and calcined bone on beach terrace between two interfluves of paleo-delta ca 200m from present shores of Indian House Lake (56° 39′ N, 64° 45′ W). Oval to rectangular tent ring with large central depression serving several functions including hearth. Closest comparisons with Rattler's Bight complex of Maritime Archaic tradition. Coll 1976, 1977 by I Badgley, A Bergeron, and J L Pilon; subm 1978 by J L Pilon, Univ Toronto.

S-1540. HdDe-5 site, Sq 0-2E **5000 ± 100**

Charcoal (NMC-970) in fill of large central depression, ca 2000 to 3000 yr.

S-1541. HdDe-5 site, Sq 0-2E **3540 ± 60**

Calcined bone (NMC-971) in fill of large central depression, ca 2000 to 3000 yr.

S-1542. HdDe-5 site, Sqs 6N-6W, 6N-2W **920 ± 70**

Charcoal (NMC-972) from charcoal layer immediately below humus, which covered entire site area assoc with tundra fire. Should postdate occupation of structure, ca 1000 to 2000 yr.

S-1543. HdDe-5 site, central depression **Modern**

Calcined bone (NMC-973) from Sqs 8N-2W, 8N-4W, 6N-4W, and 6N-2W, in fill of large central depression, ca 2000 to 3000 yr.

General Comment (JLP): S-1540 and -1541 should give similar date; evidence suggests only one occupation. Typologic analogies tentatively to late manifestation of Maritime Archaic tradition. Both dates within proper time period; recent date more acceptable. S-1542 in line with dated artifact bearing buried humus (980 yr BP) obtained 4m above lake level near HdDe-5 by G Samson.

S-1544. Bull Frog site, New Brunswick **1860 ± 70**

Charcoal (NMC-974) from site (BlDo-4), W bank, mouth of Oromocto R, St John R valley, central New Brunswick (45° 51′ 20″ N, 66° 31′ 30″ W). From floor, Test Unit 1, 55cm depth. Test unit ca 1.5m above high tide, ca 2m inland from R bank with annual flooding. Hence, stratified silt and sand deposits. Historic materials in upper 20cm, prehistoric ceramics and flakes to 1m depth. Assoc with concentration of rocker-stamped dentate ceramics, ca 2000 yr. Coll 1975 by P Allen; subm 1978 by C J Turnbull, Prov Archaeol New Brunswick. *Comment* (CJT): date as expected.

Renard site series, Ontario

Charcoal from site (CbHs-5), NE shore Fox I., Mississagi Delta, Cobden Twp (46° 11′ 12″ N, 83° 01′ 57″ W). Prehistoric Terminal Woodland site of Algonkian affiliation, at 183m asl. Coll 1977 by K Sewayze and C Sénéchal; subm 1978 by K Buchanan, Laurentian Univ.

S-1547. Renard site, Sq S91W25 430 ± 80

Charcoal (NMC-982) from NE corner Sq S91W25, 8cm depth in B horizon, assoc with probable hearth feature. Ca AD 1300 to 1500.

S-1548. Renard site, Sq N6W2 1060 ± 70

Charcoal (NMC-983) from NW corner of Sq N6W2, Level 3, 8 to 12cm depth, assoc with pit feature. Ca AD 1300 to 1500.

General Comment (KB): S-1548 probably too early, as at this period, Mississagi delta was very swampy and unsuitable for occupation (Lewis, 1970). Based on pottery evidence, site was probably seasonally occupied more or less continuously from AD 1300 to 1500.

Patrick Point Rock Structure series, Ontario

Charcoal from (CbHs-14), on land point, E bank where Mississagi R enters N channel of Lake Huron, Cobden Twp (46° 10′ 08″ N, 83° 00′ 34″ W). Rock mound 183m asl, on promontory with little assoc cultural material. Cultural deposits on beach, ca 40 to 50cm depth. Algonkian affiliations. Coll 1977 by M Brizinski and K Swayze; subm 1978 by K Buchanan.

S-1549. Patrick Point Rock Structure, Test Pit 1 300 ± 60

Charcoal (NMC-984) on beach.

S-1552. Patrick Point Rock Structure, Test Pit 600 ± 40

Charcoal (NMC-987), 50cm depth.

General Comment (KB): no cultural material other than miniscule potsherds assoc with actual rock structure. If rock structure assoc with archaeol carbon-bearing deposit, then dates bracket structure.

S-1550. Boom Camp site, Ontario 90 ± 60

Charcoal (NMC-985) from site (CbHs-15), on extinct bay of Lake Huron, ca 1km E of Mississagi R, Cobden Twp (46° 10′ 30″ N, 83° 00′ 17″ W). From NW corner of Sq S38W1, 15cm depth, assoc with pottery concentration. Prehistoric Terminal Woodland site of Algonkian affiliation, 183m asl. Ca AD 1400 to 1500. Coll and subm 1977 by K Buchanan. *Comment* (KB): Huron pottery indicates site probably dates to AD 1500 to 1600. Late date is probably late historic disturbance.

S-1551. Chiblow-3 site, Ontario 290 ± 40

Charcoal (NMC-986) from site (CbHs-4), just S of railway bridge, E bank Mississagi R, Cobden Twp (46° 11′ 37″ N, 83° 01′ 44″ W). From Sq W8N1, 8cm depth, S end of portage and fishing camp, 183m asl. Protohistoric-Historic, Algonkian affiliation. Coll 1977 by M Bertulli;

subm 1978 by K Buchanan. *Comment* (KB): date fits with other temporal evidence.

JjL1-1c site series, Northwest Territories

Charcoal and bone from SE shore of Oftedal Lake, Keewatin Dist (61° 38′ N, 97° 54′ W). Small stratified site, 192m asl with three occupations; Taltheilei (Zone 1), Arctic Small Tool tradition (Zone A) and Shield Archaic (Zone B) (Morrison, 1978). Coll and subm 1977 by D Morrison, Natl Mus Canada.

S-1553. JjL1-1c site, Zone A 1450 ± 50

Charcoal (NMC-988) from hearth in Sq 4. Should date Pre-Dorset component ca 3000 yr.

S-1554. JjL1-1c site, Zone B 470 ± 70

Calcined bone (NMC-989) from cemented sand with calcined bone floor, Sq 4, ca 3700 to 5000 yr.

General Comment (DM): dates unacceptable. Zone A at least 1300 yr too recent, 90 BC date from same level of site (Irving, 1968) also seems incorrect for Pre-Dorset affiliation. S-1554 inconsistent with stratigraphy and Shield Archaic affiliation.

S-1574. Graham site, Saskatchewan 3250 ± 50

Bone (NMC-1011) from site (FaNq-30), S Saskatchewan valley, S of Saskatoon (52° 04′ 45″ N, 106° 45′ 15″ W). From cremated burial, sand dune area, 10cm depth. Human bone fragments, lithic, and bone artifacts assoc uncertain. Coll and subm 1977 by E G Walker, Univ Saskatchewan. *Comment* (EGW): single burned projectile point recovered from same hearth as human remains similar to Duncan point of late Plains Archaic. Date supportive of McKean complex affiliation and consistent with other known McKean complex region dates.

S-1575. Bethune site, Saskatchewan 1390 ± 40

Bison bone (NMC-1012) from site (EeNg-6) near Bethune (50° 46′ 50″ N, 105° 07′ 10″ W). From shallow pit, stratigraphy disturbed by cultivation. Human remains assoc with faunal remains. Probable Woodland affiliation ca AD 1000. Coll 1972 by R Tillie, Natl Hist Mus Saskatchewan; subm 1978 by E G Walker. *Comment* (EGW): in absence of diagnostic material, date considered reliable.

S-1583. Crown site, Saskatchewan 1070 ± 40

Burned and unburned mammal bone fragments (NMC-1010) from site (FhNa-86), S side Saskatchewan R at mouth of Creek, 9.5km SW of Nipawin (53° 18′ N, 104° 09′ W). From occupation level covered by 13cm river sediments; probably continuously damp in river bottom clay deposits. Clearwater Lake phase site few km downstream in same microenvironment. Ca AD 1400 to 1600. Coll 1976 and subm 1978 by D Meyer. *Comment* (DM): no diagnostics recovered, too old for Clearwater Lake phase, must relate to other earlier occupation.

S-1600. Adelaide Island-2 site, Ontario **2340 ± 60**

Charcoal (NMC-1008) from site (BcFx-4), E point of Adelaide I., St Lawrence R (44° 26′ 15″ N, 75° 50′ 18″ W). From Test Sq 2, 10 to 15cm level. Multicomponent site ranging from early Point Peninsula culture to historic. Should date major level pertaining to Middle Point Peninsula culture, ca AD 200 ± 300. Coll and subm 1978 by J V Wright. *Comment* (JVW): date pertains to early Point Peninsula occupation of site. Early Point Peninsula material occurred mainly in subsequent 15 to 20cm level and since superimposed probability charcoal erroneously assigned to latter occupation.

S-1601. Squaw Island South site, Ontario **1160 ± 70**

Charcoal (NMC-1009) from site (BcFx-5), S point of Squaw I., St Lawrence R (44° 24′ 55″ N, 75° 52′ 45″ W). From Test Sq 1, hearth floor resting on 10cm level in NW corner. Multicomponent site ranging from Middle Point Peninsula culture to historic. Should date Middle Point Peninsula ca AD 200 ± 300. Coll and subm 1978 by J V Wright. *Comment* (JVW): hearth and assoc charcoal apparently pertains to later occupation that rests directly upon earlier Point Peninsula material. Deposits directly superimposed responsible for assoc error of feature.

Cox/Swanson site series, Nova Scotia

Charcoal and marine shell from site (BkCq-10), 9km NNW of Pictou, on headbank at mouth of Caribou R, W bank (45° 45′ N, 62° 45′ W). Late prehistoric shell midden at 1 to 3m asl, seasonally occupied. Probably ancestral Micmac. Ceramics similar to other late sites in Maritimes from AD 900 to 1400. Coll and subm 1978 by D L Keenlyside, Natl Mus Canada.

S-1602. Cox/Swanson site, Test Pit 2 **1420 ± 70**

Charcoal (NMC-1013) from Level 4, 22 to 24cm depth.

S-1603. Cox/Swanson site, Test Pit 3 **840 ± 60**

Charcoal (NMC-1014) from central hearth area, 54cm depth.

S-1604. Cox/Swanson site, Test Pit 3 **700 ± 45**

Marine shell (NMC-1015) from Level 2, 40 to 42cm below surface.

General Comment (DLK): other dated shell midden sites in Nova Scotia and New Brunswick with similar cord-marked ceramics and lithics generally ca AD 900 to 1400 period. S-1603 acceptable for site. S-1602 probably too early according to typologic comparisons. S-1604 acceptable comparison within error to charcoal date.

Oxbow site series, New Brunswick

Charcoal from site (CfDl-1), on 1 to 2m terrace, N side of Little Southwest Miramichi R, above Red Bank Community, Red Bank Indian Reserve (46° 57′ 25″ N, 65° 51′ 30″ W). Site culturally stratified by layers of sands and silt to over 2m depth. Majority of cultural deposits appear to lie within period of ceramic occupations. Coll 1978 by P Levi, A

Emin, and A Ferguson; subm 1978 by D L Keenlyside for P Allen, Hist Research, Fredericton.

S-1605. Oxbow site, Unit 78-11 **2640 ± 50**

Charcoal (NMC-1016) assoc with elongated hearth area and small expanding stemmed projectile point.

S-1606. Oxbow site, Unit 78-12 **2150 ± 70**

Charcoal (NMC-1017) assoc with bi-pointed quartz projectile point.

S-1607. Oxbow site, Unit 78-11 **1680 ± 50**

Charcoal (NMC-1018) assoc with charcoal-stained pit connected to area containing slightly contracting stemmed projectile point.

General Comment (PA): dates combined with other Oxbow dates and stratigraphy contribute to 3000-yr projectile point chronology of site and region of New Brunswick. S-1605 and -1653 at 2600 ± 60 BP (unpub) directly assoc with dentate stamp, pseudo-scallop shell and plain surface pottery. Lowest levels of site, below straight-stemmed Archaic-like points still produced dentate stamped pottery. S-1607 recovered below cord-wrapped stick-decorated ware but assoc with organically tempered plain sherds; date just prior to similar ceramic assoc for Savoie site (S-713: R, 1975, v 17, p 328). S-1607 also assoc with circular house structure.

S-1631. Tschetter site, Saskatchewan **920 ± 45**

Bison bone (NMC-1035) from site (FbNr-1), E edge of Dunfermline sand hills (52° 12′ 50″ N, 106° 55′ 52″ W). From FbNr-1-81, Level 3, 40 to 50cm below datum. Communal bison kill site, 506m asl, probably corral or pound. Dated to Late Prehistoric period with Prairie side-notched points. Will date major bone-bed layer and supports previous date of AD 945 ± 75 (S-669: R, 1975, v 17, p 342). Coll 1976 and subm 1979 by U Linnamae, Univ Saskatchewan. *Comment* (UL): confirms previous date, acceptable for cultural horizon.

S-1637. QjLd-21 site, Northwest Territories **2210 ± 120**

Muskox bone (NMC-1022) from Karluk I., Dist Franklin (75° 30′ N, 97° 16′ W). From Loc 6, 11 to 12m asl, possibly early Dorset, ca 800 to 400 BC. Coll and subm 1978 by J W Helmer, Univ Calgary. *Comment* (JWH): comparable to Level I date of Tyara site (Taylor, 1968) and several dates from T-1 and T-3 (Collins, 1956a; 1956b; 1957). S-1673 expected to be earlier than Ballantine site of 2220 ± 140 BP and 2450 ± 220 BP (GSC-640 and GSC-658: R, 1969, v 11, p 39). Comparable dates.

Melhagen site series, Saskatchewan

Buffalo bone from site (EgNn-1), 19.3km E of Elbow (51° 04′ N, 106° 20′ W). Buffalo kill and butchering site consisting of four large bone beds. Sonota complex, previously dated 10 ± 90 BC (S-491: R, 1973, v 15, p 204). Coll 1971 by D Robinson and T S Phenix; subm 1979 by T S Phenix, Saskatchewan Archaeol Soc, Saskatoon.

S-1640. Melhagen site, Sq 5E5S **1910 ± 70**

Buffalo bone (NMC-1036) from Bed 4 single bone layer.

S-1641. Melhagen site, Sq 100W65N **1710 ± 40**

Buffalo bone (NMC-1037) from Bed 3.

General Comment (TSP): on basis of proximity, four bone beds and level believed to be contemporaneous. S-1640 close to previous Bed 1 date. Assoc point type originally thought to be Besant, now assigned to Sonota complex.

Port Refuge site series, Northwest Territories

Bone from site (RbJu-1), on beach ridges at 22 to 24m asl, N end of Port Refuge, Devon I., Dist Franklin (76° 19′ N, 94° 38′ W). Cold Component consists of 31 features, many dwelling structure remains; artifacts suggest affiliations with Independence I variant of Arctic Small Tool tradition. Gull Cliff Component consists of 36 features, many appear to be dwelling remains, artifacts suggest affiliation with Pre-Dorset variant of Arctic Small Tool tradition (McGhee, 1979). Coll 1972, 1977, and subm 1979 by R McGhee.

S-1660. Port Refuge site, Cold component **4450 ± 60**

Phoca hispida long bones (NMC-1025) from midden area S of Feature 19 on 24m beach, on and in limestone gravel, 0 to 10cm below surface, under sparse *Saxifraga* cover. Bones derive from Feature 19. Ca 3500 to 4000 yr.

S-1661. Port Refuge site, Gull Cliff component **3430 ± 60**

Phoca hispida long bones (NMC-1026) from midden extending E of Feature 9, on and in limestone gravel, 0 to 15cm depth, under dense *Saxifraga* cover. Bones derive from Feature 9. Ca 3400 to 3700 yr.

S-1662. Port Refuge, Gull Cliff component **3790 ± 60**

Phoca hispida long bones (NMC-1027) from midden extending E of Feature 9, on and in limestone, 0 to 15cm depth, under dense *Saxifraga* cover. Bones derive from Feature 9. Ca 3400 to 3700 yr.

S-1689. Port Refuge, Cold component **2070 ± 50**

Phoca hispida long bones (NMC-1024) from midden area S of Feature 19 on 24m beach, on and in limestone gravel, 0 to 10cm below surface, under sparse *Saxifraga* cover. Bones derive from Feature 19. Ca 3500 to 4000 yr.

General Comment (RM): recent radiocarbon dates on seal and whale bones from nearby Thule site at Porden Point suggest local reservoir effect up to +700 yr on marine material from Grinnell Peninsula area. If correct, then all dates except S-1660 are more recent than expected. S-1661 and -1662 are single sample split, as well as S-1660 and -1689; differences greater than 3σ must be pretreatment error.

S-1674. QjLd-22 site, Northwest Territories 3000 ± 70

Burned driftwood (NMC-1023) from Karluk I., Dist Franklin (75° 30′ N, 97° 16′ W). From Loc 1, 8 to 9m asl, interior of structure, hearth within oval stone outline, ca 0 to 5cm below surface. Possibly early Dorset ca 800 to 400 BC. Coll and subm 1978 by J W Helmer. *Comment* (JWH): date is too early. Typologic considerations and site elev suggest more recent occupation than adjacent QjLd-21 Loc 6 (S-1637) of 2205 ± 120 BP. Probably relates to driftwood and not structure.

S-1723. DcGt-2 site, Quebec 620 ± 45

Charcoal (NMC-1071) from W region of Lake Duparquet on 9m escarpment, Abitibi area (49° 29′ 15″ N, 79° 16′ 50″ W). Lake ca 274m asl. From Pit N1 ca 30cm below surface in depression consisting of charcoal layers and sand with flakes. Trees on site were cut, trunks left in place; ground surface irregular because of tree roots. Forest humus ca 8 to 10cm thick covered with fine sand layer containing prehistoric material. Cultural affiliation undetermined. Coll 1977 by P Gauthier; subm 1979 by R Marois. *Comment* (RM): absence of ceramics and site location suggest much earlier occupation.

S-1724. Tyendinaga Indian Reserve, Ontario 400 ± 35

Wood (*Pinus strobus* L) (NMC-1072) from Deseronto (44° 12′ 25″ N, 77° 08′ 10″ W). From apparent prehistoric dugout canoe recovered from bog. Reserve presently Mohawk Indian but in perhistoric period it was Huron terr. Coll 1979 by C Hett and C McCauley, Canadian Conservation Inst; subm 1979 by G F MacDonald, Natl Mus Canada. *Comment* (GFM): since date fits 400 yr, estimate may indicate that form, material, and related features can provide approx age of canoe as they usually are found out of stratigraphy or other dateable context. Efforts to date dugout canoes in Florida, Scandinavia, Japan, Switzerland, and USSR indicate specimens are up to 8000 yr old, but they have changed little in form almost to present in same areas. Date is part of ongoing series in E Canada.

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[RADIOCARBON, VOL 23, NO. 1, 1981, P 136-144]

UNIVERSITY OF MIAMI RADIOCARBON DATES XX

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The following radiocarbon dates are a partial list of samples measured for a variety of projects and materials since May 1980. Chemical and counting procedures remain the same as indicated in R, v 20, p 274-282.

Calculations are based on the 5568-year Libby ^{14}C half-life. Precision is reported as one standard deviation based only on statistical counting uncertainties in the measurement of the background, NBS modern standard, and sample activities. $\delta^{13}C$ values are measured relative to PDB and reported ages are corrected for isotopic fractionation by normalizing to $-25‰$.

SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES

Florida

Lake Okeechobee series

Peat, organic muck, and freshwater gastropods taken from core from Lake Okeechobee, Florida. Dated to study depositional change from peat to organic muck along with formation of Torrey I. Coll June 1979 and subm Feb 1980 by P Gleason, S Florida Water Management.

UM-2028. VIAL 1 (56-61cm) **3070 ± 80**
$\delta^{13}C = -27.6‰$
Organic muck from Torrey I. (26° 42′ 50″ N, 80° 43′ 4″ W).

UM-2029A. VIAL 2 (62-64cm) **2830 ± 120**
Organic muck from Torrey I. (26° 42′ 50″ N, 80° 43′ 4″ W).

UM-2029B. VIAL 2 (62-64cm) **1370 ± 80**
Freshwater gastropod shells from same context as UM-2029A.

UM-2030. VIAL 3 (64-71cm) **2560 ± 80**
$\delta^{13}C = -27.7‰$
Peat sample from Torrey I. (26° 42′ 50″ N, 80° 43′ 4″ W).

UM-2031. VIAL 6 (38-43cm) **2350 ± 90**
Organic muck from Torrey I. (26° 42′ 50″ N, 80° 43′ 4″ W).

UM-2032. VIAL 5 (160-170cm) **4790 ± 150**
$\delta^{13}C = -23.0‰$
Basal peat from Torrey I. (26° 42′ 50″ N, 80° 43′ 4″ W).

Sanibel Island series

Samples of beach rock coll from Sanibel I., Florida (26° 22′ N, 82° 5′ W). Samples dated to substantiate present interpretation of beach

ridge development. Samples coll and subm 1980 by T Messimer, Sanibel I.

UM-2021. MC1 **1230 ± 90**
Carbonate cement.

UM-2022. CS1 **1840 ± 110**
$\delta^{13}C = -3.0‰$
Chione cancellata removed from beach rock.

UM-2023. MV1 **109.0% modern**
$\delta^{13}C = -6.9‰$
Vermicularia sp.

UM-2024. MC2 **1360 ± 100**
Carbonate cement.

UM-2025. FS1 **2400 ± 130**
Chione cancellata shells removed from beach rock.

UM-2026. CC1 **1590 ± 90**
Carbonate cement.

UM-2027. FC1 **960 ± 110**
Carbonate cement.

Corkscrew Swamp series

Peat and marl samples coll via vibra-core from Corkscrew Swamp Sanctuary, Florida. Samples dated to determine extent of lateral expansion in Corkscrew Swamp. Samples coll and subm 1979 by J Taylor, Univ Miami, and P Stone, Univ South Carolina, Columbia.

UM-2005. CSS 5 Willow **5210 ± 120**
$\delta^{13}C = -21.3‰$
Basal peat from depth 143 to 158cm (26° 21′ 57″ N, 81° 37′ 0″ W).

UM-2006. CSS 9 (53-66cm) **1510 ± 80**
$\delta^{13}C = -26.5‰$
Brown fibrous peat (26° 21′ 22″ N, 81° 37′ 33″ W).

UM-2007. CSS 9 (116-122cm) **3860 ± 130**
Basal peat sample (26° 21′ 22″ N, 81° 37′ 33″ W).

UM-2008. CSS 9 (122-127cm) **8030 ± 160**
Sample from marl layer immediately below UM-2007 (26° 21′ 22″ N, 81° 37′ 33″ W).

UM-2009. CSS 10 (38-50cm) **540 ± 80**
$\delta^{13}C = -26.7‰$
Basal peat sample (26° 21′ 57″ N, 81° 36′ 51″ W).

UM-2072. CSS 5 Willow **6210 ± 120**
Sample taken from top of marl layer (26° 21′ 57″ N, 81° 37′ 0″ W).

UM-2074. LT 1 **8290 ± 150**
Calcitic marl (26° 25′ 20″ N, 81° 29′ 25″ W).

UM-2075. CSS 7 **9770 ± 160**
Basal calcitic marl (26° 21′ 22″ N, 81° 37′ 26″ W).

Ten Thousand Island series

Marine shells removed from flood delta in small bay at Ten Thousand I., SW Florida. Shells were in well-defined sandy layers of probable hurricane origin. Samples were dated for determinations of sedimentation rates caused by hurricane deposition. Coll and subm 1980 by M Perlmutter, Rosenstiel School Marine & Atmos Sci, Miami.

UM-2135. 3-19-3; 18-23 **900 ± 130**
Marine shells mostly fragmented or bored, some whole and bored *Macoma constricta.* Also abundant *Crassotrea virginica, Parastarte triquetra,* and *Nassarius vibex* (22° 55′ N, 81° 40′ W).

UM-2136. 11-17-6; 62-69 **1320 ± 90**
Primarily worn and fragmented *Crassostrea virginica* with common corbula *Swiftiana, Cyclinella tenuis, Nassarius vibex, Parastarte triquetra,* and *cyclinchnella bidentata.*

UM-2223. 3-19-2; 50-53 **990 ± 80**
Marine shells from flood delta.

UM-2224. 3-19-4; 12-24 **920 ± 110**
Marine shell from coarse layer in flood delta.

Elliot Key series

Caliche and limestone bedrock sample from Elliot Key, Miami, Florida (25° 26′ 40″ N, 80° 12′ 6″ W). Coll 1979 by S M Crabtree and D Robbin, USGS, Fisher I., Miami, Florida. Subm 1980 by S M Crabtree and D Robbin. Samples dated for use as stratigraphic markers.

UM-2071. Top laminae **390 ± 190**
Top laminae of caliche crust.

UM-2011. Middle laminae **2540 ± 90**
Middle laminae of caliche crust.

UM-2010. Bottom laminae **2160 ± 130**
Bottom laminae of caliche crust.

UM-2012. Top bedrock **18,700 ± 400**
Top cm of limestone bedrock.

UM-2014. Middle bedrock **18,600 ± 310**
Middle cm of limestone bedrock.

UM-2013. Bottom bedrock **24,000 ± 450**
Bottom cm of limestone bedrock.

North Carolina

Cape Lookout Bight series

Organic-rich muds dated to geochemically trace source of organic matter into interior of Cape Lookout Bight, North Carolina (34° 37′ N, 76° 33′ W). Coll 1979 by F J Samsone and subm 1980 by C S Martins.

UM-2053. FJS-1, 10-25cm **360 ± 90**
$\delta^{13}C = -20.3‰$

UM-2054. U-5-E **2580 ± 90**
$\delta^{13}C = -21.9‰$

UM-2055. U-5-C **1630 ± 90**
$\delta^{13}C = -20.1‰$

UM-2056. U-5-A **2840 ± 170**
$\delta^{13}C = -20.8‰$

UM-2057. U-5-B **2700 ± 130**

UM-2058. U-5-D **2270 ± 80**

Roanoke River series

Wood samples dated as stratigraphic markers showing Holocene development of meander belt of Roanoke R near Albemarle Sound, North Carolina. Samples are from subsurface cores, and were taken laterally from NE to SW banks of river flood plain. Coll and subm 1980 by R N Erlich, Univ North Carolina, Chapel Hill.

UM-2093. H18-S7-12-13 **1860 ± 130**
Wood (35° 56′ N, 76° 41′ W).

UM-2095. H18-S5-16-17 **3780 ± 100**
Wood (35° 56′ N, 76° 41′ W).

UM-2097. H19-S4-8-8.5 **2560 ± 110**
Wood (35° 56′ N, 76° 39′ W).

UM-2098. H20-S2-16-17 **4100 ± 90**
Wood (35° 54′ N, 76° 44′ W).

UM-2099. H20-S3-17.5-18.5 **4670 ± 90**
Wood (35° 54′ N, 76° 44′ W).

UM-2100. H21-S3-9-10 **1550 ± 100**
Wood (35° 55′ N, 76° 43′ W).

UM-2103. H21-S16-24.5-25 **5410 ± 170**
Wood (35° 55′ N, 76° 43′ W).

UM-2104. H22-S5-23.5 **4780 ± 90**
Wood (35° 56′ N, 76° 42′ W).

UM-2105. H23-S2-9-10 **5000 ± 560**
Wood (35° 54′ N, 76° 44′ W).

UM-2106. H23-S4-13-14.5 **4360 ± 100**
Wood (35° 54′ N, 76° 44′ W).

UM-2107. H25-S2-12-13 **3760 ± 80**
Wood (35° 56′ N, 76° 43′ W).

UM-2108. H26-S5-10.5-11 **2930 ± 90**
Wood (35° 57′ N, 76° 43′ W).

California

Brown's Island series

Peaty mud and plant fragments from Brown's I. in E Contra Costa Co, California. Dates aid in determining botanical history of Suisun Bay tidal marshes. Coll and subm 1980 by B F Atwater, USGS, Menlo Park.

UM-2078. BW-10, z=20-25cm **540 ± 120**
Rhizomes *(Distichlis spicata)* coll 20 to 25cm from tidal marsh surface (38° 02′ 35″ N, 121° 51′ 49″ W).

UM-2079. BW-10, z=20-25cm **890 ± 80**
Bulk peaty mud or peat coll 20 to 25cm below ground surface of pristine tidal marsh (38° 02′ 38″ N, 121° 51′ 49″ W).

Roe Island series

Peaty mud and bark from Roe I., Solano Co, California. Samples were coll as part of study of shoreline changes and sedimentation in tidal marshes of central Suisun Bay. Coll and subm by B F Atwater.

UM-2080. ROE-0 **690 ± 70**
Bark exposed in wave-cut bank taken at low tide shoreline (38° 04′ 14″ N, 122° 02′ 30″ W).

UM-2081. ROE-2, z=6.0-6.2m **4150 ± 100**
Peaty mud containing rhizomes (*Distichlis spicate* and *Scirpus* sp) coll 4.62m N of low-tide shoreline (38° 04′ 14″ N, 122° 02′ 30″ W).

UM-2082. ROE-2, z=3.3-3.6m, bulk **2090 ± 120**
Peaty mud containing rhizomes (*Distichlis spicata* and *Scirpus* sp) coll 4.62m N of low-tide shoreline (38° 04′ 14″ N, 122° 02′ 30″ W).

Morro Bay series

Plant material coll 1979 and subm 1980 by R L Phillips, USGS, Menlo Park, California. Samples from Morrow Bay, San Luis Obispo Co, California dated to determine stratigraphic history and depositional environments in modern and ancient sediments within Morro Bay.

UM-2118. M78 PMB-33 **27,300 ± 570**

Large wood branch (35° 20′ 7″ N, 120° 50′ 45″ W) from vertical exposures of resistant sand beds cut into basal mudstone. Coll at 10m below mean low water depth.

UM-2119. M78 PMB-40 **>31,200**

Twigs and small plant fragments (35° 20′ 7″ N, 120° 50′ 45″ W) from peaty bed exposed at 12.1m depth below mean low water in main tidal channel of Morro Bay.

Siuslaw series

Wood samples from Siuslaw Natl Forest State Park, Coos Co, Oregon (43° 35′ 30″ N, 124° 11′ 30″ W). Dated to determine depositional history and age of latest onset of dune migration, and to confirm existing dune migration rates. Coll 1980 by M L Swisher; subm 1980 by R E Hunter, USGS, Menlo Park.

UM-2120. ODO380 **350 ± 60**

Solid tree branch.

UM-2121. ODO380-5 **360 ± 100**

Wood fragments.

Redwood Canyon series

Charcoal and wood samples obtained from cave at Redwood Canyon, Kings Canyon Natl Park, California (36° 40′ N, 118° 54′ W). Dated to establish age, rate of accumulation, and stratigraphic controls on debris cone from which speleothems are growing. Coll 1977 and subm 1980 by J C Tinsley, USGS, Menlo Park.

UM-2124. C-Lil-1 **1350 ± 90** $\delta^{13}C = -24.3‰$

Tree root, conifer.

UM-2125. C-Lil-2 **1670 ± 90** $\delta^{13}C = -22.0‰$

Charcoal, partly burned wood.

UM-2126. C-Lil-3 **1020 ± 90** $\delta^{13}C = -24.2‰$

Charcoal and carbonized wood. Unknown sp.

UM-2127. C-Lil-4 **1350 ± 90** $\delta^{13}C = -24.3‰$

UM-2128. LA-10 **11,400 ± 240** $\delta^{13}C = +29.2‰$

Organic-rich soil and debris retrieved 60m E of SE corner of San Gabriel Blvd and Huntington Dr, Pasadena, California. Property of Sunnyslope Water Co (34° 7′ 48″ N, 118° 5′ 6″ W). Coll 1978 by R Hill, California Division Mines & Geol, California Inst Technol. Subm 1980 by J C Tinsley.

San Bernardino series

Peaty, organic-rich sediments from water well in San Bernardino Valley, San Bernardino Co, California (34° 5′ 19″ N, 117° 17′ 47″ W). Coll 1978, subm 1980 by D M Morton, USGS, Menlo Park. Samples dated to determine rate of alluvial accumulation.

UM-2129. LA-20 **>29,400**
$\delta^{13}C = -30.3‰$

UM-2132. LA-23 **>34,600**
$\delta^{13}C = -26.4‰$

UM-2133. LA-24 **2930 ± 100**
$\delta^{13}C = -26.6‰$

Peat samples from alluvium, Lytle Creek, San Bernardino Co, California (34° 10′ 23″ N, 118° 26′ 51″ W). Coll 1976 and subm 1980 by D M Morton.

UM-2134. LA-25 **26,300 ± 560**
$\delta^{13}C = -23.0‰$

Wood deposit from well in San Jacinto Valley, Riverside Co, California (33° 50′ 10″ N, 117° 0′ 30″ W). Coll and subm 1980 by D M Morton.

UM-2141. EF-2 **1490 ± 170**

Charcoal from Pasadena, Los Angeles Co, California (34° 9′ 18″ N, 118° 4′ 36″ W). Dated for max age of soil from area. Sample date to be used in studying latest faulting event. Coll 1980 by R Crook, Jr, California Inst Technol. Subm 1980 by J Tinsley.

UM-2143. 80RC2 **22,200 + 1630 − 1360**

Carbon from Pacific Palisades area, Los Angeles Co, California (34° 3′ 4″ N, 118° 59′ 0″ W). Sample coll 1979 from alluvial environment by R Hill. Subm 1980 by USGS, Menlo Park.

Benicia series

Three peat samples from Benicia State Recreation Area, Colano Co, California (38° 4′ 0″ N, 122° 11′ 30″ W). Dated to determine relative sea level changes at Coraquinez Strait. Coll 1980 by B Atwater and T Yocum, Natl Marine Fisheries Service, California. Subm 1980 by B Atwater.

UM-2144. BEN-1 z 25-30cm **840 ± 70**
Peaty mud with *Distichilis* rhizomes.

UM-2145. BEN-2 z 155-160cm **2160 ± 90**
Peaty mud with *Distichilis* rhizomes. Coll 30.8m NE of UM-2144.

UM-2146. BEN-3 z 75-80cm **1510 ± 90**
Peaty mud with *Distichilis* rhizomes. Coll 15.4m NE of UM-2144.

Dry Creek series

Wood and carbonized wood from N Bank of Dry Creek, Sacramento Co, California (38° 15′ 0″ N, 122° 13′ 45″ W). Dated for min ages on alluvium derived from Sierra Nevada foothills. Coll 1980 by D Marchand and B Atwater. Subm 1980 by B Atwater.

UM-2147. Dry Creek 3 M2f **2220 ± 110**

Wood with most of interior missing. Age is almost certainly younger than deposit.

UM-2148. Dry Creek 2 pM2f **400 ± 100**

Carbonized wood (possibly twigs and branches) with growth rings. Age may be younger than deposit.

UM-2149. RC 125 **610 ± 80**

Carbonized wood from S Bank of Hancat Creek, Sacramento Valley, California (39° 18′ 0″ N, 121° 35′ 0″ W). Coll 1980 by A Busacca, M J Singer, and D Marchand, USGS, Menlo Park. Subm 1980 by D Marchand. Date to be used as age control on late Holocene depositional units.

Bahamas

Joulters Cay series

Carbonate reef samples coll from Joulters cay on NE margin of Grand Bahama Bank, Bahamas (25° 10′ N, 78° 10′ W). Samples dated to study development of Bryozoan patch reefs in tidal channel. Samples coll Nov 1979 and subm Dec 1979 by R Cuffey, Pennsylvania State Univ, University Park.

UM-2051. S-4 **3720 ± 150**

Coral-lithothamnioid reef rock.

UM-2052. E-10 **21,000 ± 640**
$\delta^{13}C = +0.4‰$

Consolidated oolitic sediments.

UM-2061. I-2 **20,200 ± 550**
$\delta^{13}C = -0.3‰$

Consolidated oolitic sediments.

UM-2069. F-0 **1610 ± 160**

Coral reef rock.

UM-2076. F-24 **24,800 ± 910**

Tidal channel limestone bedrock.

UM-2077. F-21 **20,300 ± 490**

Tidal channel limestone bedrock.

San Salvador series

Marine shell dated for sedimentologic history of San Salvador I., Bahamas. Coll and subm by D Gerace, CCFL Bahamian Field Sta, San Salvador.

UM-2114. **23,700 ± 650**

Shell removed from eroded wall of tidal cave (75° 26′ 64.75″ N, 24° 31′ 06″ W).

Antractic Ocean

Antarctic Foraminifera series

Foraminifera samples taken from two cores coll in Antarctic Ocean by *SS Eltanin*. Samples dated to check validity of matching deep-sea *Eltanin* cores with master cores. Samples subm 1980 by M G Dinkelman, Florida State Univ, Tallahassee. Ages appear to be consistently too young with respect to paleontologic information.

5950 ± 210

UM-2015. E49-3 (4-7cm) $\delta^{13}C = -0.7‰$

Eucampia balaustium and *Cyclodophora davisiana* (45° S, 110° W).

UM-2016. E49-3 (24-27cm) **>16,900**

Identical species and location as UM-2015.

UM-2017. E49-3 (54-57cm) **24,400 ± 870**

Identical species and location as UM-2015.

3200 ± 140

UM-2018. E49-24 (5-8cm) $\delta^{13}C = -0.5‰$

Eucampia balaustium and *Cyclodophora davisiana* (48° S, 96° W).

UM-2019. E49-24 (25-27cm) **7530 ± 130**

Identical species and location as UM-2019.

UM-2020. E49-24 (54-57cm) **10,300 ± 310**

Identical species and location as UM-2019.

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[RADIOCARBON, VOL 23, No. 1, 1981, P 145-161]

UNIVERSITY OF WISCONSIN RADIOCARBON DATES XVIII

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Procedures and equipment have been described in previous date lists. Except as otherwise indicated, wood, charcoal, and peat samples are pretreated with dilute NaOH-$Na_4P_2O_7$ and dilute H_3PO_4 before conversion to the counting gas methane; marls and lake cores are treated with acid only. Very calcareous materials are treated with HCl instead of H_3PO_4.

The dates reported have been calculated using 5568 as the half-life of ^{14}C. The standard deviation quoted includes only the 1σ of the counting statistics of background, sample, and standard counts. Background methane is prepared from anthracite, standard methane from NBS oxalic acid. The activities of the dated samples for which $\delta^{13}C$ values are listed have been corrected to correspond to a $\delta^{13}C$ value of $-25‰$.

Sample descriptions are based on information supplied by those who submitted samples.

ACKNOWLEDGMENTS

This research is supported by the National Science Foundation under grants ATM74-23041 and ATM79-26039. We thank the Chemistry Department for the use of the RMS 6-60 mass spectrometer.

I. ARCHAEOLOGIC SAMPLES

A. Illinois

Cahokia site

Excavations at Cahokia's Woodhenge structures (Wittry, 1969) Madison Co (38° 39′ 35.7″ N, 90° 04′ 28″ W) July 1978 by W L Wittry, Univ Illinois at Chicago Circle. Subm by W L Wittry. Earlier dates on wood from Woodhenge Circle No. 2 were reported (WIS-948 and -969) (R, 1979, v 21, p 121). Post from Feature 601 showed less disintegration than that of Feature 618 but bark was not visible in either sample.

940 ± 60

WIS-1128. Cahokia site $\delta^{13}C = -27.3‰$

Outer rings of *Juniperus* post from Feature 601, post pit of Circle No. 2. Post apparently broke in removal attempt.

920 ± 60

WIS-1130. Cahokia site $\delta^{13}C = -24.7‰$

Dup'icate sample from Feature 601.

890 ± 60

WIS-1133. Cahokia site $\delta^{13}C = -26.6‰$

Outer rings of Eastern red cedar *(Juniperus)* post from Feature 618, post pit of Circle No. 2. Post apparently broke during attempt to remove post.

990 ± 60

WIS-1136. Cahokia site $\delta^{13}C = -27.0‰$

Duplicate sample from Feature 618.

B. Iowa

4100 ± 70

WIS-1083. Brassica Bench site (13PK251) $\delta^{13}C = -26.7‰$

Wood charcoal, ISU Cat No. 1471, from Feature 10, cultural fill of basin-shaped pit, 0.43 to 0.55m below orifice of feature. Sample should date earliest habitation of site and was thought to provide date for one Middle Woodland occupation within central Des Moines R valley in Polk Co (41° 44′ N, 93° 43′ W). Coll 1976 and subm by D M Gradwohl, Iowa State Univ, Ames, Iowa.

C. North Dakota

South Cannonball Village (32SI19) site

Uncarbonized wood from prehistoric site at confluence of Cannonball and Missouri Rivers in N Sioux Co (46° 24′ 30″ N, 100° 35′ 15″ W). Site is component of Extended Middle Missouri tradition. Coll 1967 by J J Hoffman; subm by W R Wood, Univ Missouri, Columbia, Missouri.

570 ± 70

WIS-1097. South Cannonball Village (32SI19) $\delta^{13}C = -26.3‰$

Catalogue No. 5584, Feature 16, Post 50.

600 ± 70

WIS-1104. South Cannonball Village (32SI19) $\delta^{13}C = -28.3‰$

Cat No. 5546, Feature 16, Post 1.

750 ± 60

WIS-1098. South Cannonball Village (32SI19) $\delta^{13}C = -26.5‰$

Cat No. 3009, Post 1, Feature 93.

760 ± 70

WIS-1011. South Cannonball Village (32SI19) $\delta^{13}C = -26.5‰$

Cat No. 3010, Post 3, Feature 93.

740 ± 60

WIS-1100. South Cannonball Village (32SI19) $\delta^{13}C = -27.6‰$

Cat No. 2472, Feature 74.

510 ± 70

WIS-1102. South Cannonball Village (32SI19) $\delta^{13}C = -28.3‰$

Cat No. 4133, Post 29, Feature 13.

560 ± 60

WIS-1103. South Cannonball Village (32SI19) $\delta^{13}C = -26.6‰$

Cat No. 866, Post 27, Feature 15.

630 ± 60

WIS-1105. South Cannonball Village (32SI19) $\delta^{13}C = -26.8‰$

Cat No. 3874, Post 33, Feature 7.

680 ± 70

WIS-1110. South Cannonball Village (32SI19) $\delta^{13}C = -27.4‰$

Cat No. 3896, Post 75, Feature 7.

660 ± 70

WIS-1106. South Cannonball Village (32SI19) $\delta^{13}C = -26.2‰$

Cat No. 3587, Post 79, Feature 5.

D. Oklahoma

Jones site (34Lf69

Wood charcoal from Jones site, LeFlore Co (35° 19′ N, 94° 35′ 30″ W) Ft Coffee quad. Coll 1939 by K G Orr (1946); subm by C L Rohrbaugh, Univ Wisconsin-Madison. Samples dated to establish time range of variation of house orientation in Early Fort Coffee focus phases.

400 ± 70

WIS-1109. Jones site (34Lf69) $\delta^{13}C = -25.7‰$

Charcoal from House 4, two-center-post rectangular house pattern with baked clay fireplace. House oriented with center posts along azimuth 8° off E-W axis.

630 ± 70

WIS-1116. Jones site (34Lf69) $\delta^{13}C = -25.4‰$

Charcoal from House 1, two-center-post rectangular house pattern. House oriented with center posts along azimuth 10° off E-W axis.

Moore site (34Lf31)

Wood charcoal coll 1969 by by D G Wyckoff from site in LeFlore Co (35° 16′ 30″ N, 94° 36′ 30″ W). Site correlated with latest Caddoan occupation of Arkansas Valley in Oklahoma, Fort Coffee phase. Subm by C L Rohrbaugh.

580 ± 70

WIS-1111. Moore site (34Lf31) $\delta^{13}C = -26.1‰$

Sample from exterior rings of N center post of House 3. House is rectangular two-center-post house oriented roughly N to S and assoc with Fort Coffee phase ceramics and other artifacts.

560 ± 60

WIS-1112. Moore site (34Lf31) $\delta^{13}C = -26.5‰$

Samples from S center post of House 3.

370 ± 70

WIS-1113. Moore site (34Lf31) $\delta^{13}C = -25.9‰$

Wood charcoal and charred nut fragments from Feature 8, roughly circular trash pit containing artifacts typical of Fort Coffee phase.

570 ± 70

WIS-1114. Spencer Littlefield IV site (34Lf82) $\delta^{13}C = -24.6‰$

Wood charcoal from site in LeFlore Co (35° 17′ N, 94° 33′ W). Coll 1939 by K G Orr; subm by C L Rohrbaugh. Material from House 1, two-center-post rectangular house pattern with baked clay fireplace, oriented with center posts only 1° off N-S axis. Dates beginning of Fort Coffee focus in Spiro locality.

490 ± 70

WIS-1118. Spencer Littlefield I site (34Lf60) $\delta^{13}C = -26.4‰$

Wood charcoal from site in LeFlore Co (35° 17′ 30″ N, 94° 33′ W). Coll 1938 by K G Orr; subm by C L Rohrbaugh. Samples from House 1, two-center-post rectangular house with baked clay fireplace with center axis oriented directly E to W.

650 ± 70

WIS-1119. Spencer Littlefield III site (34Lf64) $\delta^{13}C = -26.8‰$

Wood charcoal from site in LeFlore Co (35° 16′ 30″ N, 94° 31′ 30″ W). Coll 1938 by K G Orr; subm by C L Rohrbaugh. Sample from House 2, of three superimposed houses, all oriented considerably away from cardinal axes. Houses have no fireplaces.

Garrett Ainsworth site (34Lf80)

Wood charcoal from single component site in LeFlore Co (35° 15′ N, 94° 36′ 30″ W) coll 1939 by K G Orr. Site represents early phase within Fort Coffee focus (Orr, 1946), probably contemporary with Spiro phase at Spiro. Subm by C L Rohrbaugh.

480 ± 70

WIS-1117. Garrett Ainsworth site (34Lf80) $\delta^{13}C = -25.8‰$

Sample from House 1, two-center-post rectangular house pattern with central baked clay fireplace. Center posts oriented 8° off E-W axis.

WIS-1132. Garrett Ainsworth site (34Lf80) **480 ± 90**

Humic acids extracted from WIS-1117 were dated to check reliability of date.

470 ± 60

WIS-1115. Garrett Ainsworth site (34Lf80) $\delta^{13}C = -25.8‰$

Sample from House 2, two-center-post rectangular house pattern with central fireplace. Center posts oriented directly along E-W axis. Dates earliest phase of Fort Coffee focus.

E. South Dakota

George Hey site (39FA302)

Charcoal from excavations in 1977 at McKean Complex site (Tratebas and Vagstad, 1979) in Fall River Co (43° 26′ N, 103° 48′ W). Coll and subm by A M Tratebas, South Dakota Archaeol Research Center, Ft Meade, South Dakota.

3930 ± ±70

WIS-1085. George Hey site (39FA302) $\delta^{13}C = -24.3‰$

Charcoal *(Pinus)* from Feature 9, hearth in lower of two main cultural horizons. Features in lower horizon appear to represent single occupation and are earliest occupation within excavated area. Date places this horizon within McKean complex.

3520 ± 70

WIS-1086. George Hey site (39FA302) $\delta^{13}C = -24.5‰$

Charcoal *(Pinus)* from Feature 6, 50cm diam, basin-shaped, slab-lined hearth in upper of two main cultural horizons. Assoc artifacts included pitted mano and Duncan point. This horizon is actually series of overlapping occupations with hearth belonging to uppermost occupation within excavated area. Site was apparently occupied repeatedly by small groups of people belonging to McKean complex.

1030 ± 60

WIS-1084. Lost Bumper Tipi-Ring site (39FA392) $\delta^{13}C = -23.6‰$

Charred log (*Pinus* sp) from Feature 2, straight-walled pit hearth, 70cm deep, which formed central hearth of tipi ring. Scattered within hearth were remains of infant, adult sternum fragment, bone awl, and charred or semi-charred logs. Tipi-rings containing deep central pit hearths are rare. Pit hearths with burials and assoc bone awls were found at one nearby site (39FA71) during River Basin Survey at Angostura Reservoir but hearths were not inside tipi rings. Coll 1978 from site in Fall River Co (43° 22′ N, 103° 46′ W). Subm by A M Tratebas.

F. Tennessee

2350 ± 80

WIS-1147. Sakti Chaha site (40HR100) $\delta^{13}C = -26.1‰$

Charred nut fragments (*Juglans, Carya*) and wood charcoal coll 1978 by D H Dye, Washington Univ, from Sakti Chaha site on S bank of Tennessee R, Hardin Co (35° 03′ 14″ N, 88° 16′ 98″ W). Sample from 1×2m test excavation of small, single component Late Gulf Formational (Alexander culture, Hardin phase) site. In direct assoc were Alexander series sherds (Futato, 1979, p 19-20).

1990 ± 80

WIS-1148. Hatley Creek site (40HR236) $\delta^{13}C = -26.4‰$

Charred nut fragments (*Juglans, Carya* sp) and wood charcoal coll 1978 by D H Dye from Hatley Creek site on E bank of Tennessee R, Hardin Co (35° 06′ 41″ N, 88° 17′ 45″ W). Sample 50cm below surface from 1x2m test excavation of multicomponent midden. In direct assoc were Wheeler series sherds (Dye, 1977; Futato, 1979, p 18-19).

2910 ± 80

WIS-1149. Walker site (40HR212) $\delta^{13}C = -26.6‰$

Charred nut fragments (*Juglans, Carya*) *and* wood charcoal coll 1978 by D H Dye from Walker site on N bank of Tennessee R, Hardin Co (35° 03′ 57″ N, 88° 16′ 13″ W). Sample immediately below plow

zone in small shallow shell midden in 1×1m excavation unit of small, single component Late Archaic (Lauderdale culture, Perry phase) midden. In direct assoc were Late Archaic (Little Bear Creek and McIntire) projectile point/knives (Webb and DeJarnette, 1942; Futato, 1979).

G. Ecuador

La Ponga site (OGSE-186)

Excavations at Parroquia de Colonche, Canton de Santa Elena, Guayas Prov (1° 53′ S, 80° 40′ W) undertaken Oct-Nov 1978 by R D Lippi, Univ Wisconsin-Madison; subm by R D Lippi. Site is first large inland Machalilla site to be excavated. *Comment* (RL): it is suggested, if dates are taken at face value, that entire Machalilla occupation was quite short, perhaps about 200 to 300 yr.

2790 ± 80

WIS-1140. La Ponga site (OGSE-186) $\delta^{13}C = -25.4‰$

Charcoal (R-14) from sealed early Machalilla context (roughly Machalilla 2 as defined by Bischof (1975)), stratigraphically separated from overlying Machalilla material which, in turn, is stratigraphically separated from overlying Engoroy or Chorrera and Guangala components.

2880 ± 80

WIS-1141. La Ponga site (OGSE-186) $\delta^{13}C = -25.0‰$

Charcoal (R-16) from ashy layer containing mixed early to middle Machalilla ceramics. Evidently aboriginal mixing of ash and soil resulted in temporary loss of stratigraphy in unit.

2920 ± 70

WIS-1125. La Ponga site (OGSE-186) $\delta^{13}C = -24.4‰$

Charcoal (R-25). Presence of several Ayangue Incised sherds plus late form of Machalilla Red Banded suggests deposit is mostly late Machalilla (Machalilla 4 as defined by Bischof, 1974). Some earlier and later ceramics (later material of Engoroy or Chorrera phase) are also present, however.

Samborondon site (OG Sb Sb 5 and OG Sb Sb 3)

Excavations at sites in Canton Samborondon, Prov Guayas (2° 10′ S, 79° 50′ W) Aug 1979 under direction of R G Whitten, Univ South Dakota, Vermillion.

1350 ± 70

WIS-1145. Samborondon site (OG Sb Sb 5) $\delta^{13}C = -24.8‰$

Sample FNS-5, carbon in burial urn. May date use of continuous relict raised fields.

1270 ± 70

WIS-1150. Samborondon site (OG Sb Sb 3) $\delta^{13}C = -26.6‰$

Ash lens in regional and late ceramic complex called "Milagro" 30 to 40cm beneath surface. Sample assoc with raised field farmers of Guayas basin.

H. Egypt

Hierakonpolis site

Excavations in Feb 1978 and March 1979 under direction of J F Harlan at Hierakonpolis, S Upper Egypt, Markaz, Edfu (25° 7′ N, 32° 48′ E). Subm by M A Hoffman, Univ Virginia, Charlottesville. Wood samples are probably *Tamarix* sp (Hoffman, 1973; 1980).

4900 ± 70

WIS-1152. Hierakonpolis site $\delta^{13}C = -27.4‰$

Wood charcoal from Level 6, 50 to 60cm below modern surface in Mound A of Loc 11C, trash mound 2m high of thin discontinuous lenses of charcoal, ash, and midden with well-preserved organic remains. Late Amratian to early Gerzean affiliation.

4750 ± 80

WIS-1151. Hierakonpolis site $\delta^{13}C = -27.4‰$

Wood charcoal from Level 14, 130 to 140cm below modern surface near center of trash Mound A, Loc 11C. Late Amratian to early Gerzean.

4820 ± 80

WIS-1153. Hierakonpolis site $\delta^{13}C = -29.2‰$

Wood from small post assoc with Feature 1, mud structure, possibly manger, in Loc 11C, Sq 0N-6E, Level 3. Late Amratian to early Gerzean.

4710 ± 80

WIS-1168. Hierakonpolis site $\delta^{13}C = -29.0‰$

Wood from large post remnant, 27cm diam and 25cm long, assoc with what is believed to be latest occupational component of Loc 11C. Late Amratian to early Gerzean. Acid treatment only.

4760 ± 80

WIS-1169. Hierakonpolis site $\delta^{13}C = -28.5‰$

Carbonized wood from ash and charcoal midden above floor of kiln, Structure 1, Loc 29, Sq 10L10, Level 2. Early Amratian.

4300 ± 80

WIS-1180. Hierakonpolis site $\delta^{13}C = -21.7‰$

Wood from large circular post, ca 24cm diam, part of superstructure over royal Predynastic Tomb 1, Loc 6. Constitutes earliest forerunner to Protodynastic royal tombs known from Abydos and, thus, may date inception of Egyptian state. Late Gerzean, early Protodynastic or early Dynasty O (Hoffman, 1976).

4570 ± 80

WIS-1181. Hierakonpolis site $\delta^{13}C = -27.5‰$

Carbonized wood from undraught kiln, Loc 11C, Sq 6.5N-21W, Level 7. Late Amratian to early Gerzean.

4680 ± 80

WIS-1182. Hierakonpolis site $\delta^{13}C = -27.9‰$

Wood charcoal from wall post of semi-subterranean house, Structure II, Loc 29, Sq 17L13, Level 1B, Feature 5. This early Amratian house

dates earliest substantial architecture yet unearthed in Egypt (Hoffman, 1980).

4800 ± 80

WIS-1183. Hierakonpolis site $\delta^{13}C = -27.0‰$

Wood charcoal from Structure II, Sq 17L13, Level 3, Feature 5. Should provide check on date given by WIS-1182 since sample is believed to come from burned corner post.

4670 ± 80

WIS-1184. Hierakonpolis site $[\delta^{13}C = -27.9‰]$

Wood charcoal from Feature 1, simple pottery kiln, Loc 29, Sq 10L10, NW quad 20cm from modern surface of Structure I. Average δ value for nine other samples used.

II. GEOLOGIC SAMPLES

A. Alabama

WIS-1186. Goshen Springs site **8330 ± 90**

Silt from two adjacent lake-sediment cores 1976A and B coll Nov 1976 by Paul and Hazel Delcourt from center of basin in Goshen Springs, Pike Co (31° 44′ N, 86° 08′ W). Depth 205 to 212cm below water surface. Sample intermediate between WIS-956 and -957 which were dated at 5620 ±70 and 26,000 ±380 BP, respectively (R, 1979, v 21, p 125) (Delcourt, 1980). Subm by H E Wright, Univ Minnesota, Minneapolis. Acid treatment only.

B. Idaho

400 ± 70

WIS-1167. Lemhi Range site $\delta^{13}C = -22.9‰$

Pinus flexilis (id tentative) from S facing slope near ridgetop in Targhee Natl Forest, Butte Co (44° 13′ N, 113° 02′ W). Specimen represents period when tree line was ca 61m higher than at present. Dated to determine whether tree line fluctuations in Idaho are synchronous with those in White Mts of California (La Marche, 1973) and, thus, whether past climatic variation has been broadscale enough to affect these disparate locations. Coll and subm by W Dort, Jr and W C Johnson, Kansas Univ, Lawrence, Kansas.

C. Iowa

Smokey Hollow site

Samples coll by Dean Thompson from Smokey Hollow Subwatershed, Woodbury Co (42° 15′ N, 95° 57′ W) with CME flight auger.

2160 ± 70

WIS-1146. Smokey Hollow site $\delta^{13}C = -28.4‰$

Sample SH-2, fragments of uncarbonized wood coll near base of Soetmelk alluvium (De Forest formation) and should provide max age for Soetmelk alluvium in valley (Daniels and Jordan, 1966). This is oldest Holocene alluvium in W Iowa, base marks Late Pleistocene-Holocene boundary.

3400 ± 70

WIS-1144. Smokey Hollow site $\delta^{13}C = -27.1‰$

Sample SH-3, carbonized materials from prehistoric culture site (13WD32); cultural assoc unknown, possibly Middle Woodland on Plains (Johnson, 1973). Sample coll within A horizon of paleosol developed on Hatcher alluvium (De Forest formation) (Daniels and Jordan, 1966). Date is min for Hatcher alluvium and max for Mullenix alluvium.

D. Massachusetts

Titicut Swamp and Swamp Margin

Cores coll Dec 1978 from *Acer rubrum* swamp, Bristol Co (41° 57′ N, 71° 02′ W) by R Bradshaw, A Peters, and D Goldsmith, Brown Univ, Providence, Rhode Island and from swamp margin Feb 1979 by R Bradshaw and T Webb, III. Subm by T Webb, III.

7250 ± 80

WIS-1179. Titicut Swamp $\delta^{13}C = -31.4‰$

Gyttja 367 to 382cm below surface. Dates rise of *Nyssa* and *Fagus* pollen percentages.

5170 ± 80

WIS-1178. Titicut Swamp $\delta^{13}C = -31.3‰$

Gyttja 270 to 272cm below surface. Dates decline of *Tsuga* pollen percentages.

3170 ± 70

WIS-1107. Titicut Swamp $\delta^{13}C = -29.6‰$

Herbaceous peat with some detritus 228 to 234cm from surface. Dates transition from gyttja to peat and assoc decline in *Alnus* pollen percentages.

8720 ± 80

WIS-1171. Titicut Swamp Margin $\delta^{13}C = -30.4‰$

Peat 99 to 101cm from surface. Dates decline of *Pinus* pollen percentages.

1070 ± 70

WIS-1170. Titicut Swamp Margin $\delta^{13}C = -29.9‰$

Peat 36cm from surface. Dates rise in Tubuliflorae pollen percentages.

Duck Pond site

Core, 253cm, obtained with Livingstone sampler from Duck Pond sediments in South Wellfleet, Barnstable Co (41° 50′ N, 70° 00′ W). Coll Aug 1979 and subm by Marjorie Winkler, Univ Wisconsin-Madison. Samples treated with both base and acid.

6540 ± 80

WIS-1120. Duck Pond site $\delta^{13}C = -28.8‰$

Sample was sandy, silty 1654.5 to 1659.5cm from lake surface, 12.5cm from base of core. Pollen diagram shows abundance of spruce.

WIS-1185. Duck Pond site **10,170 ± 100**

Lake sediment 1591 to 1597cm from lake surface. Spruce pollen at this level may indicate profound climatic change in area.

Nunket's Pond

Core coll Feb 1979 from small pond in Plymouth Co (41° 58′ N, 71° 03′ W). Coll and subm R Bradshaw. Depths reported from water surface. Samples treated with acid only.

WIS-1177. Nunket's Pond **11,500 ± 170**

Clay with some organic material 819 to 825cm sec. Dates rise in *Picea* pollen. (One 3-day count.)

9800 ± 100

WIS-1108. Nunket's Pond $\delta^{13}C = -29.4‰$

Lake mud 701 to 704cm below surface. Dates rise in pollen percentages of *Pinus* and *Quercus*.

6700 ± 80

WIS-1172. Nunket's Pond $\delta^{13}C = -30.7‰$

Lake mud 349 to 351cm below surface. Dates rise in *Fagus* pollen percentages.

3510 ± 70

WIS-1176. Nunket's Pond $\delta^{13}C = -30.2‰$

Lake mud 204.2 to 207.7cm below surface. Dates break or hiatus in sedimentary record.

6980 ± 90

WIS-1127. Pamet Cranberry Bog $\delta^{13}C = -30.8‰$

Humified peat, 738 to 743.5cm below surface of bog in North Truro, Barnstable Co (42° 00′ N, 70° 02′ W). Coll June 1979 by W A Patterson, III and subm by M Winkler. Sample represents basal sec Pamet Bog core. Date will provide information on start of peat accumulation and may correlate with sea level rise in area.

5230 ± 80

WIS-1129. Altantic White Cedar Swamp site $\delta^{13}C = -29.2‰$

Fibrous peat with wood particles from bottom 25cm of 7m core taken with Hiller corer from Atlantic White Cedar Swamp, Barnstable Co (41° 54′ 30″ N, 69° 59′ W). Coll Aug 1979 and subm by M Winkler. Treated with both base and acid.

Hawley Bog Pond site

Core coll from Hawley Bog Pond in Franklin Co (42° 34′ N, 72° 53′ W) Feb 1979 by W A Patterson, III, Univ Massachusetts, Amherst. Sample depths reported from water surface, water depth 1m.

7520 ± 80

WIS-1124. Hawley Bog Pond site $\delta^{13}C = -25.6‰$

Limnic sediments 530 to 539cm below surface. Pollen percentages for *Pinus* reach low values of 10%, *Tsuga* increases to 20%.

8970 ± 90

WIS-1121. Hawley Bog Pond site $\delta^{13}C = -28.6‰$

Limnic sediments 665 to 655cm below surface. Dates decline of *Pinus* pollen and arrival of *Tsuga* in area.

10,290 ± 100

WIS-1123. Hawley Bog Pond site $\delta^{13}C = -30.1‰$

Limnic sediments 703.5 to 692.5cm below surface. Sample includes peak in *Betula* pollen prior to increase in haploxylon pine pollen.

WIS-1122. Hawley Bog Pond site **14,000 ± 130**

Limnic sediments 741 to 753cm below surface. Sample marks start of deposition of organic sediments and includes rise in spruce pollen marking arrival of forest in area.

2930 ± 70

WIS-1126. No Bottom Pond site $\delta^{13}C = -31.9‰$

Dark fibrous peat 11cm above bottom of 237cm core obtained with Livingstone sampler Aug 1979 by M Winkler from No Bottom Pond, Barnstable Co (41° 45′ N, 70° 04′ 30″ W). Subm by M Winkler.

E. Michigan

Chippewa Bog site

Core coll June 1977 from Chippewa Bog, LaPeer Co (43° 07′ N, 83° 15′ W) by P J Ahearn and R E Bailey, Central Michigan Univ, Mt Pleasant, Michigan. Subm by R E Bailey and Thompson Webb, III.

1200 ± 70

WIS-1076. Chippewa Bog site $\delta^{13}C = -28.3‰$

Peat with coarse organics 2.22 to 2.31m below mat surface. Dates late Holocene increase of *Pinus* from 15 to 55%.

4130 ± 70

WIS-1077. Chippewa Bog site $\delta^{13}C = -31.1‰$

Black algal gyttja with plant debris 4.77 to 4.86m below bog mat surface. Dates *Fagus* decline in mid-Holocene and major *Ulmus* decline from 16.3 to 4.2%.

8410 ± 80

WIS-1080. Chippewa Bog site $\delta^{13}C = -27.3‰$

Black algal gyttja 7.42 to 7.51m below bog mat surface. Dates first appearance of *Fagus* (2.4%) in pollen profile. Acid treatment only.

9540 ± 100

WIS-1079. Chippewa Bog site $\delta^{13}C = -27.1‰$

Black algal gyttja with wood chip 8.57 to 8.60m below bog mat surface. Dates near basal organic sediment and *Picea* max. Acid treatment only.

F. Minnesota

Myrtle Lake site

Core taken in 1971 from Myrtle Lake, Koochiching Co (47° 58′ N, 94° 23′ W) by H E Wright. Subm by H E Wright. Samples from levels

in core at which pollen concentration or pollen percentages change. Dated to calculate annual pollen influx and to provide further information concerning vegetation history (Janssen, 1968). Depths are below water surface. Acid treatment only.

6830 ± 80

WIS-1155. Myrtle Lake site $\delta^{13}C = -27.5‰$

Organic lake sediment from 745 to 750cm depth.

7400 ± 80

WIS-1157. Myrtle Lake site $\delta^{13}C = -27.2‰$

Lake sediment from 721 to 729cm depth.

5800 ± 80

WIS-1165. Myrtle Lake site $\delta^{13}C = -29.6‰$

Lake sediment from 687 to 695cm depth.

5430 ± 70

WIS-1156. Myrtle Lake site $\delta^{13}C = -29.0‰$

Lake sediment from 643 to 651cm depth.

1470 ± 80

WIS-1158. Myrtle Lake site $\delta^{13}C = -25.4‰$

Peat from 256 to 266cm depth.

G. New York

Brandreth Lake Inlet site

Eight cores sampled Sept 1978 from bog 2km up Brandreth Lake Inlet in Adirondack Mts, Hamilton Co, New York (44° 55′ N, 74° 41′ W). Dates in conjunction with pollen analysis to aid in study of paleoecologic and paleoclimatologic history of Central Adirondack Mts. Coll by J T Overpeck, Brown Univ, and R R Kautz, Hamilton Coll, New York; subm by J T Overpeck. Previous dates from site have been reported, WIS-1050, -1051, -1052 (R, 1980, p 119-120). Acid treatment only.

4570 ± 70

WIS-1096. Brandreth Lake Inlet site $\delta^{13}C = -33.4‰$

Gyttja, 501 to 525cm interval of 10.52m core through homogeneous peat and into underlying varved clays.

3120 ± 70

WIS-1098. Brandreth Lake Inlet site $\delta^{13}C = -30.7‰$

Gyttja, 161 to 179cm interval of 10.52m core.

H. Wisconsin

Lima Bog site

Core coll Jan 1979 from Lima Bog, Rock Co (42° 48′ N, 88° 5′ W) by Kent Van Zant, Earlham Coll, Richmond, Indiana. Subm by Kent Van Zant. Samples were very calcareous, required lengthy acid treatment.

8960 ± 110

WIS-1134. Lima Bog $\delta^{13}C = -29.7‰$

Calcareous gyttja, 1184 to 1194cm sec of core. Oak and elm pollen were ca 50% of pollen rain. (One 3-day count.)

7090 ± 80

WIS-1135. Lima Bog $\delta^{13}C = -27.0‰$

Calcareous gyttja, 990 to 1000cm sec of core. Sample at base of core into early postglacial sediments. Oak and elm pollen decreasing in abundance, Gramineae, *Artemisia,* and *Ambrosia* type pollen percentages increasing. Date will be used to correlate this core with one coll in previous year (WIS-1045, R, 1980, v 22, p 121).

3970 ± 80

WIS-1131. Lima Bog site $\delta^{13}C = -20.5‰$

Organic gyttja, 435 to 445cm sec of core. Hardwood forests occupied uplands around depression. Gramineae pollen increased dramatically in abundance in pollen rain, due apparently to establishment of aquatic grass around or in water of lake.

Wood Lake site

Cores coll from Wood Lake, Taylor Co (45° 20′ N, 90° 05′ W) Jan and March 1979 by Kathleen Heide, subm by K Heide and T Webb. WIS-1089 is basal date on core coll in March.

13,000 ± 110

WIS-1089. Wood Lake site $\delta^{13}C = -33.0‰$

Fine-grained, black lacustrine sediment 1434.5 to 1455.5cm below water-sediment interface. Dates beginning of lacustrine sedimentation succeeding proglacial sedimentation.

10,710 ± 100

WIS-1137. Wood Lake site $\delta^{13}C = -30.3‰$

Black gyttja with trace of vivianite 1284 to 1296cm below water-sediment interface. Sample dates decline in *Picea* pollen percentages.

7210 ± 100

WIS-1143. Wood Lake site $\delta^{13}C = -32.5‰$

Black gyttja 1036 to 1044cm below water-sediment interface. Sample dates transition to predominantly haploxylon type *Pinus* pollen. (One 3-day count.)

4200 ± 70

WIS-1138. Wood Lake site $\delta^{13}C = -31.2‰$

Gyttja 787 to 795cm below water-sediment interface. Dates transition in pollen sedimentation from high percentages of *Pinus* to high percentages of *Betula* and *Quercus.*

2520 ± 70

WIS-1142. Wood Lake site $\delta^{13}C = -30.9‰$

Black gyttja 538 to 542cm below water-sediment interface. Dates beginning of *Tsuga* pollen at site.

1040 ± 70

WIS-1139. Wood Lake site $\delta^{13}C = -30.7‰$

Black gyttja 231 to 239cm below water-sediment interface. Dates dramatic increase in percentage values of *Tsuga* pollen.

Kelly's Hollow site

Core coll Aug 1978 from small within-woodland basin in Taylor Co (45° 18′ N, 90° 21′ W). Site is important because of small size and inherent pollen catchment properties. Pollen record reflects vegetational history of nearby stand of woodland. Coll and subm by K Heide, Brown Univ, Providence, Rhode Island.

9590 ± 100

WIS-1069. Kelly's Hollow site $\delta^{13}C = -28.1‰$

Peat, fragments of ligneous and herbaceous plants 317.5 to 322cm below surface. Dates start of peat formation.

7700 ± 70

WIS-1090. Kelly's Hollow site $\delta^{13}C = -30.4‰$

Decomposed organic matter, ca 66% coarse detritus and 34% *Substantia humosa* from 189 to 192cm below surface. Dates transition in pollen sedimentation from high percentages of *Abies, Betula, Quercus, Ulmus* pollen to high percentages of *Pinus, Acer,* and *Ostrya-Carpinus.*

4380 ± 70

WIS-1088. Kelly's Hollow site $\delta^{13}C = -28.2‰$

Peat, fragments of ligneous and herbaceous plants 59 to 62cm below surface, 15cm below drastic increase in percentages of *Betula* pollen and decrease in percentage of *Pinus* pollen.

Lower Mud Lake Wetlands

Peat samples were obtained at several locations on wetlands of Lower Mud Lake, Dane Co (42° 59′ 30″ N) as part of study to determine rates of lake-edge wetland formation. Samples were taken just above transition between fibrous peat and lake sedimentary peat. Results will be used to test and refine mathematical model of wetlands formation previously developed for South Waubesa Wetlands (Friedman and DeWitt, 1978; Friedman, ms). Model investigates effect of spatial interrelationships, nutrients, and climate on wetland ecosystem dynamics. Coll May 1979 and subm by T K Kratz, Univ Wisconsin-Madison.

1630 ± 70

WIS-1082. Lower Mud Lake Wetlands $\delta^{13}C = -28.4‰$

Sample 2m below surface.

2530 ± 60

WIS-1087. Lower Mud Lake Wetlands $\delta^{13}C = -26.4‰$

Sample 1.4m below surface.

8280 ± 100

WIS-1091. Lower Mud Lake Wetlands $\delta^{13}C = -31.0‰$

Sample 2.2m below surface.

2910 ± 70

WIS-1092. Lower Mud Lake Wetlands $\delta^{13}C = -30.0‰$

Sample 1.8m below surface.

2380 ± 80

WIS-1093. Lower Mud Lake Wetlands $\delta^{13}C = -28.2‰$

Sample 3m below surface.

1160 ± 60

WIS-1094. Lower Mud Lake Wetlands $\delta^{13}C = -28.2‰$

Sample 1.35m below surface.

1990 ± 70

WIS-1095. Lower Mud Lake Wetlands $\delta^{13}C = -30.6‰$

Sample 2.3m below surface.

Fallison Lake Bog

Samples from base of mat peat taken from varying locations in small unnamed kettle hole bog near Fallison Lake in Vilas Co (46° 00′ N, 89° 37′ W). Results will be used to help determine rate of kettle-hole bog development in N Wisconsin. Effects of climatic fluctuations during entire postglacial period on rate of development are of primary interest (Friedman, DeWitt, and Kratz, 1979). Coll Oct 1979 and subm by T K Kratz.

2750 ± 70

WIS-1159. Fallison Lake Bog $\delta^{13}C = -27.8‰$

Woody stems of *Chamaedaphne calyculata* from base of mat peat 215 to 220cm below surface of peat.

1140 ± 70

WIS-1160. Fallison Lake Bog $\delta^{13}C = -29.3‰$

Ericaceous and sphagnum peat from base of mat peat 90 to 100cm below surface of peat.

7690 ± 90

WIS-1161. Fallison Lake Bog $\delta^{13}C = -30.3‰$

Ericaceous and sphagnum peat from base of peat 260 to 270cm below surface of peat.

1970 ± 80

WIS-1162. Fallison Lake Bog $\delta^{13}C = -28.6‰$

Woody stems of *Chamaedaphne calyculata* from base of mat peat 200 to 230cm below surface of peat.

3400 ± 70

WIS-1173. Fallison Lake Bog $\delta^{13}C = -28.6‰$

Woody stems of *Chamaedaphne calyculata* from base of mat peat 290 to 320cm below surface of peat.

4420 ± 80

WIS-1174. Fallison Lake Bog $\delta^{13}C = -27.3‰$

Woody stems of *Chamaedaphne calyculata* from base of mat peat 315 to 345cm below surface of peat.

WIS-1175. Fallison Lake Bog **3310 ± 70**

Woody stems of *Chamaedaphne calyculata* from base of mat peat 205 to 235cm below surface.

I. Russia

Orshinskii Mokh Bog site

Core coll July 1979 from peat bog 3km S of Ozero Svetloe, Kalininskaia Oblast', USSR (56° 57′ N, 36° 20′ W) by G M Peterson, Univ Wisconsin-Madison and M I Neustadt, Inst Geog, Moscow.

9050 ± 90

WIS-1196. Orshinskii Mokh site $\delta^{13}C = -28.3‰$

Hypnum peat 6.5m deep. *Comment* (GMP): date may be too young. Pollen assemblage suggests Pre-Boreal rather than Boreal age.

5110 ± 80

WIS-1194. Orshinskii Mokh Bog site $\delta^{13}C = -27.9‰$

Scheuchzeria, Sphagnum spp, and Ericaceae peat 3.5m deep.

1290 ± 80

WIS-1195. Orshinskii Mokh Bog site $\delta^{13}C = -26.8‰$

Sphagnum and *Eriophorum* spp, 1.5m deep.

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NOTES AND COMMENTS

[RADIOCARBON, VOL 23, NO. 1, 1981, P 165-166]

"QUICKIE" ^{14}C DATES

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The extension of the bristlecone pine chronology, which is, thus far, the only complete tree-ring-dated series that extends beyond 6000 BC and which is used for the calibration of radiocarbon dates, has been going on over the past 22 years, that is, ever since Schulman (1956; 1958) established the extremely old ages of the bristlecone pine. The few people in this world who search for very old wood samples to extend a dendrochronology may appreciate a method of establishing quickly the approximate ages of the samples.

Normally, in order to date a sample of bristlecone pine wood, one obtains a core or cross-section of it—usually a run of several hundred rings. In the laboratory the wood is polished, the widths of the rings are carefully measured and plotted (indexed). The plot of the samples is then compared (cross-indexed) with a master chart, and if it fits into the master chart, its age is established. This type of fitting can be attempted in the field, if one has the skills and space to work with a chart 15 meters long. C W Ferguson (1970) at the Laboratory of Tree-Ring Research, University of Arizona, who compiled the master chart, has been successful in dating precisely many samples in this manner.

Difficulties arise when the sample has an abberrant set of rings which cannot be readily fitted to the master chart, or when the rings of the sample reach beyond those of the master chart (*ie,* are older than 5500 BC).

Over the past seven years we, at the Radiocarbon Laboratory, University of Pennsylvania, have used the radiocarbon process to date quickly many of the samples picked up in the field just a few days before. The samples are sent by air mail from the White Mountains area in California to the laboratory in Philadelphia. They are processed immediately and counted. About 275 samples have been dated during the past seven years.

After a few dozen minutes the counter indicates whether the sample is "young" (up to, say, 3000 years) or has a promise of being old. Since we are interested in collecting bulk samples of wood more than 6000 years old, we stop the counting of young samples and discard the gas. We continue to count the older samples for about 100 to 150 minutes, after which time we can calculate the approximate age of the samples. Of course, the tolerance of such a date is large—typically ± 200 to 300 years. We have come to call these "quickie" dates. (The oldest samples are counted again for 1000 to 3000 minutes and, thus, the standard deviation is reduced). Fortunately, these samples do not contain radon.

The field worker is informed of the "quickie" dates that seem significant to extending the bristlecone pine dendrochronology, so that

he can pick up bulk wood and send it to the Laboratory of Tree-Ring Research for detailed analysis.

We feel that this coordination between field worker and laboratory, although 3000 miles apart, has saved valuable time and has accelerated the extension of the bristlecone pine chronology, which soon, we hope, will reach 10,000 years.

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RADIOCARBON

Editor: MINZE STUIVER
Managing Editor: RENEE S KRA
Published by
THE AMERICAN JOURNAL OF SCIENCE
Editors: JOHN RODGERS, JOHN H OSTROM, PHILIP M ORVILLE, ROBERT A BERNER
Managing Editor: MARIE C CASEY

Published three times a year, in Winter, Spring, and Summer, at Yale University, New Haven, Connecticut 06511.

Subscription rate $60.00 (for institutions), $40.00 (for individuals), available only in whole volumes. Volume 22, 1980 (nos. 1-4) is available for $80.00 (for institutions) and $60.00 (for individuals). The Proceedings of the Tenth International Radiocarbon Conference, vol 22, nos. 2 and 3, are available as a set for $60.00.

All correspondence and manuscripts should be addressed to the Managing Editor, RADIOCARBON, Kline Geology Laboratory, Yale University, 210 Whitney Ave, PO Box 6666, New Haven, Connecticut 06511.

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* Suggestions to authors of the reports of the United States Geological Survey, 5th ed, Washington, DC, 1958 (Government Printing Office, $1.75).

NOTICE TO READERS

Half life of ^{14}C. In accordance with the decision of the Fifth Radiocarbon Dating Conference, Cambridge, 1962, **all dates published in this volume (as in previous volumes) are based on the Libby value, 5570 ± 30 yr,** for the half life. This decision was reaffirmed at the 9th International Conference on Radiocarbon Dating, Los Angeles/La Jolla, 1976. Because of various uncertainties, when ^{14}C measurements are expressed as dates in years BP the accuracy of the dates is limited, and refinements that take some but not all uncertainties into account may be misleading. The mean of three recent determinations of the half life, 5730 ± 40 yr, (**Nature,** v 195, no. 4845, p 984, 1962), is regarded as the best value presently available. Published dates in years BP, can be converted to this basis by multiplying them by 1.03.

AD/BC Dates. In accordance with the decision of the Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, the designation of AD/BC, obtained by subtracting AD 1950 from conventional BP determinations is discontinued in Radiocarbon.

Authors or submitters may include calendar estimates as a comment, and report these estimates as AD/BC, citing the specific calibration curve used to obtain the estimate.

Meaning of $\delta^{14}C$. In Volume 3, 1961, we endorsed the notation Δ (Lamont VIII, 1961) for geochemical measurements of ^{14}C activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of $\delta^{14}C$ that entered the calculation of Δ was defined by reference to Lamont VI, 1959, and **was corrected for age.** This fact has been lost sight of, by editors as well as by authors, and recent papers have used $\delta^{14}C$ as the **observed** deviation from the standard. At the New Zealand Radiocarbon Dating Conference it was recommended to use $\delta^{14}C$ only for age-corrected samples. Without an age correction, the value should then be reported as percent of modern relative to 0.95 NBS oxalic acid. (Proceedings 8th Conference on Radiocarbon Dating, Wellington, New Zealand, 1972). The Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, recommended that the reference standard, 0.95 times NBS oxalic acid activity, be normalized to $\delta^{13}C = -19‰$.

In several fields, however, age corrections are not possible. $\delta^{14}C$ and Δ, uncorrected for age, have been used extensively in oceanography, and are an integral part of models and theories. For the present, therefore, we continue the editorial policy of using Δ notations for samples not corrected for age.

Citations. A number of radiocarbon dates appear in publications without laboratory citation or reference to published date lists. We ask that laboratories remind submitters and users of radiocarbon dates to include proper citation (laboratory number and date-list citation) in all publications in which radiocarbon dates appear.

Radiocarbon Measurements: Comprehensive Index, 1950-1965. This index covers all published ^{14}C measurements through Volume 7 of RADIOCARBON and incorporates revisions made by all laboratories. It is available to all subscribers to RADIOCARBON at $20.00 US per copy.

Publication schedule. Beginning with Volume 15, RADIOCARBON has been published in three issues: Winter, Spring, and Summer. Contributors who meet our deadlines will be given priority but publication is not guaranteed in the following issue.

List of laboratories. The comprehensive list of laboratories at the end of each volume now appears in the third number of each volume.

Index. All dates appear in index form at the end of the third number of each volume. Starting with Volume 22, RADIOCARBON is publishing a new type of index, which is organized in chronologic order, according to sample type and by geographic distribution. The editors of RADIOCARBON believe that this practice will serve a more useful function. Our readers are encouraged to make further suggestions.

ELEVENTH INTERNATIONAL RADIOCARBON CONFERENCE

June 20-26, 1982

Seattle, Washington, USA

The Eleventh International Radiocarbon Conference will be held from June 20 to 26, 1982 on the campus of the University of Washington in Seattle.

PROGRAM

The scientific program includes the following topics:

- ^{14}C and archaeology
- Mass spectrometric dating with accelerators and enrichment of ^{14}C samples. We invite also the discussion of other radioisotopes
- Natural ^{14}C variations, with special consideration of the influence of climate change on past atmospheric ^{14}C and CO_2 levels
- General technique
- The influence of man on ^{14}C levels in our environment
- ^{14}C and overlapping dating methods
- Special topics: to be announced

PAPERS

Acceptance of papers will be decided on the basis of extended summaries (about 2 pages). Depending on the number of papers accepted, parallel sessions and/or poster sessions may be scheduled. Apart from the paper presentations one or more working sessions may be planned during the conference. The conference proceedings will be published in RADIOCARBON.

AMQUA

A meeting of AMQUA, the American Quaternary Association, has been scheduled in Seattle following the Radiocarbon Conference (June 28-30). It may be possible to take part in the AMQUA preconference field trips on June 26 and 27.

Write for more information to:

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