

Radiocarbon

1968

ANU RADIOCARBON DATE LIST II

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The C¹⁴ measurements reported here were carried out by the Radiocarbon Laboratory, Dept. of Geophysics and Geochemistry, A.N.U., between Jan. and Aug. 1967. Laboratory equipment consists of a *Beckman* methane gas-proportional unit (ANU I) supplemented in Dec. 1966 by an automatic 3-channel *Beckman* model LS-200 liquid scintillation spectrometer. Synthesis of methane and benzene is the same as used in ANU I and described by Polach and Stipp (1967). Treatment of samples remains a 2N hot acid (HCl) wash unless otherwise specified. Where applicable, fractional separation follows procedures reported by Olson (1963), Berger *et al.* (1964), Tamers and Pearson (1965), and Krueger (1966). In the treatment of bone samples, physical or mechanical cleaning could not completely remove sedimentary material often filling the structural pores. This material, if present, was retained with the fraction referred to as "collagen". Since we are not dealing with pure collagen, we prefer to call it "acid-insoluble" bone fraction, a name describing the treatment. These dates are reported as equal to or greater than given age. Table I summarizes all dated fractions.

TABLE I
Dated fractions of samples (ANU II)

| ANU Number | ANU Date | Fraction dated |
|------------|---|------------------------|
| ANU-37a | 910 ± 110 | bone carbonate |
| 37b | ≥2420 ± 110 | acid-insol. bone frac. |
| ANU-38a | 3470 ± 60 | bone carbonate |
| 38b | ≥8230 ± 190 | acid-insol. bone frac. |
| ANU-41a | 6750 ± 100 | bone carbonate |
| 41b | ≥10,730 ± 370 | acid-insol. bone frac. |
| ANU-46a | δ ¹⁴ C+47 ± 5% w.r.t .95 NBS oxalic standard | NaOH-sol. ("humic") |
| 46b | | 495 ± 100 |
| ANU-65a | Too small to date | NaOH-sol. ("humic") |
| 65b | 31,600 + 1100 - 1300 | NaOH-insol. charcoal |
| ANU-77a | 24,800 ± 1600 | NaOH-sol. ("humic") |
| 77b | 22,900 ± 1000 | NaOH-insol. charcoal |
| ANU-81a | Too small to date | NaOH-sol. ("humic") |
| 81b | 24,000 + 3300 - 5700 | NaOH-insol. charcoal |

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The system of interlaboratory cross checks and independent duplicate measurements referred to in ANU I has been continued and results are summarized in Table 2.

TABLE 2
Interlaboratory cross checks and duplicate determinations

| ANU Number | ANU Date | Other Number | Other Date | References |
|------------|--------------|--------------|---------------|---------------------------------|
| ANU-23 | 330 ± 100 | | | ANU I |
| ANU-23/2 | 340 ± 63 | | | ANU II |
| ANU-30/1 | 250 ± 75 | N-294 | 225 ± 110 | ANU II |
| ANU-30/2 | 274 ± 70 | | | Bowler, pers. commun. |
| ANU-69 | >37,000 | | | ANU II |
| ANU-69/2 | >30,000 | | | |
| *ANU-70 | 15,850 ± 320 | GaK-510 | 13,700 ± 270 | ANU II Wright, pers. commun. |
| ANU-92/1 | 3015 ± 140 | | | ANU II |
| ANU-92/2 | 3100 ± 85 | | | |
| ANU-133 | 30,030 ± 810 | W-901 | 30,800 ± 1000 | ANU II USGS VI |
| *ANU-180 | 21,200 ± 700 | V-92 | 19,900 ± 2000 | ANU II Wright, pers. commun. |

* A recollection of samples previously submitted for dating. All others are independent determinations on identical samples.

Ages are relative to A.D. 1950, calculated on the basis of Libby half-life of 5568 yr. We have changed our practice of reporting the error. Since this is based, at 1 standard deviation, solely on statistical counting errors of the Background, Sample and Oxalic modern reference, we now propose to report it as such, instead of enlarging to ± 100 yr minimum as previously. To allow for other sources of error in the dating process (Anderson and Levi, 1952; Tauber, 1958; Libby, 1963; Polach and Golson, 1966), particularly those reported at 2% or less and/or referring to the last few millennia (Stuiver and Suess, 1966; Stuiver, 1967; Suess, 1967) we recommend that readers double the errors quoted in this list. Ages less than 200 yr should be considered modern. All ages in the following list were produced by liquid scintillation counting of benzene samples. One day is equivalent to 1300 min counting time. Benzene dilution means the sample did not produce enough benzene to fill the counting vial and "dead" benzene was introduced to make up the volume.

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ABBREVIATIONS

| | | |
|--------------|---|--|
| A.I.A.S. | : | Australian Institute of Aboriginal Studies, Canberra. |
| Anthropology | : | Department of Anthropology and Sociology, Research School of Pacific Studies, A.N.U. |
| A.N.U. | : | Australian National University, Canberra |
| C.S.I.R.O. | : | Commonwealth Scientific and Industrial Research Organization, Canberra |
| Geography | : | Department of Geography, Research School of Pacific Studies, A.N.U. |
| Geophysics | : | Department of Geophysics and Geochemistry, Research School of Physical Sciences, A.N.U. |

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

*Australia***Echuca series, Victoria**

Samples coll. during project on late Quaternary to Recent alluvial deposition on Riverine plain near Echuca, relating to sequence previously determined by Bowler and Harford (1966) in which late Quaternary neotectonic movement diverted major rivers in area and initiated complex sequence of lake, lunette, and fluvial development.

ANU-29. Goulburn river**13,500 ± 700****11,550 B.C.**

Charcoal from remains of fire in alluvial silts later buried by over-bank deposition to depth 116 in. below present ground surface. Section exposed in left bank of Goulburn R. 9.5 mi ENE of Echuca, (36° 5' S Lat, 144° 54' E Long). Channel geometry of streams which deposited silts (Coonamoidgal II, Pels, 1966) indicates higher discharges than in present hydrological regime. Coll. 1966 by J. M. Bowler and F. Chamaun, A.N.U.; subm. by Geography. Benzene dilution, 1-day count. *Comment* (J.M.B.): with N-296, 13,400 ± 340 (11,450 B.C.) (Hamada, pers. commun.) indicates streams older than previously estimated and correlative with late glacial phase.

ANU-30. Campaspe prior stream**260 ± 51****A.D. 1690**

Charcoal from narrow vertical concentration (1 in. x 8 in.) in stream bed gravels beneath 78 in. of younger sediments exposed in gravel pit 6.5 mi NE of Rochester, (36° 17' S Lat, 144° 47' E Long). Sample, apparently truncated by cross-bedded gravels, first assumed from tree growing *in situ* while stream activity deposited bedload. Stream now inactive with mature red-brown earth soil profile developed on alluvium over gravels. Coll. 1966 by J. M. Bowler; subm. by Geography. Result is

average of 2 independent determinations, both benzene, 1-day counts: ANU-30/1, 250 ± 75 and ANU-30/2, 274 ± 70 . *Comment* (J.M.B.): date confirmed by N-294, 225 ± 110 (A.D. 1725) (Hamada, pers. commun.). Too young to permit soil profile development; sample must be regarded as intrusive.

ANU-69. Khancoban, New South Wales **>37,000**

Lignitized wood coll. 22 ft below surface in fresh water alluvium of old creek meander beneath torrential gravel deposits derived from Khancoban Creek, alt 962 ft ($36^{\circ} 13' S$ Lat, $148^{\circ} 7' E$ Long). Coll. 1963 by K. R. Sharp, Snowy Mts. Hydro-electric Authority; subm. by Geophysics. Benzene, 3-day count. Result at 95% level of confidence. Another independent determination, ANU-69/2, benzene dilution, 1-day count, gave $>30,000$ B.P. *Comment* (K.R.S.): alluvium in area almost 250 ft thick, highly weathered in lower parts. Upper 30 ft contains evidence of geologically recent flood(s) bringing enormous amounts of debris and causing major stream derangement. Dates this as $>37,000$ B.P., though there may have been later events.

1600
35,200 \pm 2150

ANU-76. Toolong Range, Upper Tumut Valley **33,250 B.C.**

Partly carbonized wood augered from depth 190 cm from quartz gravels beneath basalt blockstream, alt 5300 ft ($36^{\circ} 9' S$ Lat, $148^{\circ} 22' E$ Long). Blockstreams are regarded as periglacial phenomena, implying more rigorous climate than present. Sample provides *terminus post quem* for such climatic phase. Coll. 1967 by J. N. Jennings, A.N.U.; subm. by Geography. Benzene, 1-day count. *Comment* (J.N.J.): accords well with date of Costin's Munyang soil humus beneath solifluctional valley fill, NZ-596, $31,300 \pm 2300$ (29,350 B.C.) (Costin, pers. commun.); valuable addition to meager chronology of Pleistocene and Recent climatic events in this part of Australia.

Grove Creek series, Geary's Gap, New South Wales

Charcoal and decomposed plant remains (some highly mineralized) from base of 3 terrace deposits of Grove Creek ($35^{\circ} 06' S$ Lat, $149^{\circ} 22' E$ Long), 23 mi NE of Canberra. Coll. 1967 by R. J. Coventry, A.N.U.; subm. by C.S.I.R.O.

6770 \pm 75
4820 B.C.

ANU-91. K₃ terrace

Decomposed twigs and/or charcoal, highly mineralized, from K₃ terrace (well-differentiated yellow podzolic soil), overlain by K₂ terrace (gray minimal prairie soil). Coll. from ca. 3 sq ft, 6 in. back from exposed face. Benzene, 2-day count. *Comment* (R.J.C.): younger than expected. Walker (1962) reports $29,000 \pm 800$ (27,050 B.C.), NZ intralaboratory reference CR563, for similar terrace at Nowra, New South Wales. ANU-91 agrees with 2 other dates from K₃ terraces in NSW, V-13, 6425 ± 130 B.P. (4475 B.C.) (Walker, pers. commun.) at Kempsey, and GrN-3119,

6250 \pm 90 (4300 B.C.) (Costin, pers. commun.) at Berridale. Without further dates from different regions, only tentative age-correlations may be implied.

ANU-92. K₂ terrace **3065 \pm 80**
1115 B.C.

Decomposed twigs and/or charcoal of high ash content from base of K₂ terrace (gray minimal prairie soil) above and 10 ft N of ANU-91. Result is weighted mean of 2 independent determinations. ANU-92/1, 3015 \pm 140 (dilution) and ANU-92/2, 3100 \pm 85, both benzene, 1-day counts.

ANU-93. K₂ terrace **2460 \pm 75**
510 B.C.

Charcoal fragments from base of exposed face of K₂ terrace, 7 ft below surface and 500 m NE of ANU-91 and 92. Benzene, 1-day count.

ANU-94. K₂ terrace **1775 \pm 85**
A.D. 175

Charcoal fragments of high ash content from base of exposed face of K₂ terrace, 6 ft below surface and 1000 m NE of ANU-93. Benzene, 1-day count.

General Comment (R.J.C.): ANU-92 and 93 agree with ages for base of K₂ terrace at Nowra, New South Wales, 3740 \pm 100 (1790 B.C.), New Zealand intralaboratory reference CR564, (Walker, pers. commun.) and Kempsey, New South Wales, V-12A, 3225 \pm 140 (1275 B.C.), and V-12B, 3300 \pm 100 (1350 B.C.), (Walker, pers. commun.). Also with solifluction deposits at Mt. Kosciusko, New South Wales, ranging from Y-1096, 1540 \pm 160 (A.D. 410) to Y-1092, 2910 \pm 130 (960 B.C.), (Yale VIII), attributed to colder conditions.

ANU-95. K₁ terrace **255 \pm 64**
A.D. 1695

Charcoal fragments from base of K₁ (regosol) with little or no pedological differentiation, ca. 5 ft above ANU-94 and 1 ft below surface. Coll. over wide area way from exposed face. Benzene, 1-day count.

Comment (R.J.C.): ANU-95 may correlate with youngest solifluction deposits at Mt. Kosciusko dated at 170 \pm 100 (Y-1090, Yale VIII) as well as with 390 \pm 60 (A.D. 1560), New Zealand intralaboratory reference CR566, (Walker, pers. commun.) for K₁ terrace at Nowra. Lack of pedological differentiation implies last phase of landscape instability of region was initiated prior to arrival of Europeans.

General Comment (R.J.C.): above samples represent 1st series for K-cycle (Butler, 1959) deposits on S. Tablelands; results consistent with terrace stratigraphy.

II. VEGETATION HISTORY

New Guinea

Lake Birip series, Wabag Subdistrict, Western Highlands District

Swamp at edge of crater lake, alt 6200 ft (50° 34' S Lat, 143° 50' E

Long) worked by J. R. Flenley, A.N.U., during vegetation history project. All samples coll. with peat borer 1964 by J. R. Flenley; subm. by Geography.

ANU-63. A14, 67 to 72 cm deep **2930 ± 140**
980 B.C.

Soft brown coarse detritus mud with gray silt believed to be volcanic ash. Benzene dilution, 1-day count.

ANU-64. A14, 72 to 77 cm deep **275 ± 70**
A.D. 1675
Same as ANU-63.

ANU-79. A14, 62 to 67 cm deep **305 ± 90**
A.D. 1645
Soft brown coarse detritus mud. Benzene dilution, 2-day count.

ANU-80. A14, 77 to 82 cm deep **140 ± 70**
Modern
Same as ANU-79.

General Comment (J.R.F.): ANU-63 and 64 subm. to date sharp decline in forest pollen and complementary rise in pollen of *Casuarina*. ANU-79 and 80 subm. when ANU-63 gave discordant result. ANU-63, 64, and 80 might indicate stratigraphic inversion. However, ANU-64 and 80 do not differ significantly. ANU-63 is older than samples taken over depths from 215 to 285 cm in same sequence and dated between 1520 ± 100 (A.D. 430) and 2440 ± 90 (490 B.C.), (GaK-825 to 828 and GaK-665 to 667, Gakushuin VI). Perhaps ANU-63 contains material dug out during construction of pools for cultivation of *Eleocharis elegans* Willd., such construction stratigraphically postdating ANU-80. *Casuarina* sp. planted on dry ground around lake but also occurs naturally along watercourses. Rise in *Casuarina* pollen, dated by samples, may be important in interpreting effects of human disturbance of vegetation around lake.

III. ARCHAEOLOGIC SAMPLES

A. Australia

Graman Area B series, New England, New South Wales

Samples from 2 rock shelter sites, Site 1 (29° 24' S Lat, 150° 44' E Long) and Site 4 (29° 25' S Lat, 150° 46' E Long), on Girrawheen Sta., 8 mi NW of Graman, excavated by Isabel McBryde, Univ. of New England, as part of long-term project on archaeology of N New South Wales (McBryde, 1962). Coll. 1966 by I. McBryde; subm. by A.I.A.S.

ANU-54. Site 1, Trench 2, Zone (d), **2760 ± 65**
810 B.C.
Level II, Spit I

Scattered charcoal from N end of trench, 16 to 19 in. below surface of deposit, upper part of Level II. Associated with industry of backed

blades. Charcoal from Spit 2, Level II in same area of trench (Zone (d)), 19 to 28 in. below surface, is dated by GaK-1188, 3950 ± 50 (2000 B.C.) (McBryde, pers. commun.). Level I, Zone (d), at depth 10 to 13 in. below surface dated by GaK-1187, 2040 ± 70 (90 B.C.) (McBryde, pers. commun.). Dates for levels in Trench 1, on parallel alignment 72 in. away, are Level I, 4 to 5 in. below surface, GaK-805, 4640 ± 100 (2690 B.C.) and for Level II, 18 in. below surface, GaK-806, 5450 ± 100 (3500 B.C.), (Gakushuin VI). Benzene, 1-day count. *Comment* (I. McB.): dates from A.N.U. and Gakushuin for samples from Zone (d), Trench 2 are consistent but more recent than 2 dates from stratigraphic levels of Trench 1 (GaK-805 to 806).

2050 \pm 55
100 B.C.

ANU-55. Site 4, Trench 1, Zone (a), Level I

Sample from concentration of charcoal 6.5 in. below surface of deposit at base of Level I, associated with industry of backed blades, also bone artifacts. Another date for Level I, Zone (c) Trench 1, ca. 72 in. away and 13 in. below surface, is GaK-1189, 1750 ± 80 (A.D. 200), (McBryde, pers. commun.). Benzene, 1-day count. *Comment* (I. McB.): ANU-55 agrees with GaK-1189. Though closer to surface, ANU-55 was at base of Level I, whereas GaK-1189 was higher in that level.

2290 \pm 62
340 B.C.

ANU-56. Site 4, Trench 1, Zone (b), Level II

Concentration of charcoal 18.5 in. below surface of deposit in lower part of Level II, associated with rich collection of bone and stone implements (including backed blades). Another date for Level II, 60 in. away in Zone (d), 13 in. below surface, is GaK-1190, 2480 ± 80 (530 B.C.), (McBryde, pers. commun.). Benzene, 1-day count. *Comment* (I. McB.): ANU-56 and GaK-1190 agree.

General Comment (I. McB.): samples provide additional data on chronology of backed blade industries in E New South Wales, early dates for these industries at Site 1 being of particular interest. For details of backed blade chronology see introduction to Lapstone Creek series in A.N.U. I.

Oenpelli series, Northern Territory

Samples coll. during 2nd season of archaeological project during which 5 rock shelters in vicinity of Oenpelli mission were excavated, 2 (Tyimede 1 and 2) in Arnhem Land escarpment, 3 (Malangangerr, Nawamoy, and Padyadi) in sandstone residuals on alluvial plains of East Alligator R. Besides differences of ecological adaptation in plain and plateau sites, excavation documented technological change in region as a whole. Later industry occurs at all sites, characterized by stone points and edge-ground axes. Early industry occurs at Malangangerr, Nawamoy, and Tyimede 2, characterized by chunky scrapers and edge-ground axes (C. White, 1967) (cf. Ingaladdi series, ANU-57, 58, and 60).

Dates previously available are

Later industry

| | | | |
|--|---------|--------------|-------------|
| Malangangerr, upper level (Gakushuin V) | GaK-626 | 370 ± 80 | (A.D. 1580) |
| Malangangerr, lower level (Gakushuin V) | GaK-627 | 5980 ± 140 | (4030 B.C.) |
| Padypadiy, lower level (ANU I) | ANU-17 | 3120 ± 100 | (1170 B.C.) |
| Tyimedede 1, upper level (Gakushuin V) | GaK-630 | <230 | (Modern) |
| Tyimedede 1, middle level (Gakushuin V) | GaK-631 | 1900 ± 90 | (A.D. 50) |
| Tyimedede 1, lower level (Gakushuin V) | GaK-632 | 10,790 ± 200 | (8840 B.C.) |

Earlier industry

| | | | |
|--|---------|--------------|---------------|
| Malangangerr (Gakushuin V) | GaK-628 | 19,600 ± 550 | (17,650 B.C.) |
| Malangangerr (Gakushuin V) | GaK-629 | 22,700 ± 700 | (20,750 B.C.) |
| Malangangerr (ANU I) | ANU-19 | 18,000 ± 400 | (16,050 B.C.) |
| Tyimedede 2, presumably later stage (ANU-1) | ANU-18 | 6650 ± 500 | (4700 B.C.) |

Two problems were presented by these dates: (1) age of GaK-632 from Tyimedede 1 compared with other dates for later industry and final stage of earlier industry. ANU-52 from Tyimedede 1 and ANU-50 from neighboring site of Tyimedede 2 subm. to investigate this problem. ANU-53 also relevant here; (2) unexpectedly but consistently old dates (GaK-628 to 629, ANU-19) for edge-ground axes. ANU-51 contributes to this question at another site. ANU-77a and 77b are lab's investigation of possibility of sample contamination at original site.

All samples coll. 1965 by Carmel White, A.N.U.; subm. by A.I.A.S.

4770 ± 150
2820 B.C.

ANU-50. Tyimedede 2

Charcoal from hearths? in sand at 29 to 34 cm depth dating earliest phase of later stone point industry at site (12° 26' S Lat, 133° 15' E Long). Benzene, 1-day count.

21,450 ± 380
19,500 B.C.

ANU-51. Nawamoy, Cannon Hill station

Charcoal ca. 80 cm deep, in upper levels of sand below shell midden containing ANU-53. Dates earlier scraper and edge-ground axe industry at site (12° 23' S Lat, 132° 56' E Long). Benzene, 1-day count. *Comment* (H.A.P.): originally reported 21,450 ± 600 (C. White, 1967).

ANU-52. Tyimede I**3820 ± 100
1870 B.C.**

Charcoal 50 to 55 cm deep at same general level as GaK-632 in adjacent square. Dates earliest phase of stone point industry at site (12° 24' S Lat, 133° 15' E Long). Benzene, 1-day count.

ANU-53. Nawamoyn, Cannon Hill station**7110 ± 130
5160 B.C.**

Charcoal 42 to 48 cm deep, in base of shell midden above sand containing ANU-51. Dates early phase of stone point industry at site (12° 23' S Lat, 132° 56' E Long). Benzene dilution, 1-day count. *Comment* (H.A.P.): originally reported 7110 ± 160 (C. White, 1967).

ANU-77b. Malangangerr**22,900 ± 1000
20,950 B.C.**

Charcoal in sand at 134 to 144 cm depth, 30 cm directly below ANU-19, dating early scraper and edge-ground axe industry at site (12° 27' S Lat, 132° 57' E Long). Age based on NaOH-insoluble fraction, benzene dilution, 2-day count. ANU-77a, NaOH-soluble fraction, benzene dilution, 1-day count, dated 24,800 ± 1600 (22,850 B.C.) *Comment* (H.A.P.): lack of significant difference between the 2 determinations indicates no intrusive carbon, young or old, in site.

General Comment (C.W.): ANU-51 and 77b confirm high antiquity of ground stone tools in Australia, suggested by GaK-628 to 629 and ANU-19. Dates now available for early phase of stone point industry, ANU-53 and GaK-627 on plains, and ANU-50 and 52 on plateau, suggest early date GaK-632 refers not to stone points but to pre-point phase which cannot be recognized through artifacts. ANU-18 would then fall into place as dating late stage of earlier industry on plateau (cf. C. White, 1967.)

Ingalladdi rockshelter series, Willeroo station, Northern Territory

Excavations at sandstone rockshelter (15° 11' S Lat, 131° 24' E Long) begun in 1963 by D. J. Mulvaney, then of Univ. of Melbourne. Occupation extends over depth 2 m and comprises upper industry of stone points, adze flakes, and edge-ground axes in sandy deposit in top 90 cm, overlying core and flake tool industry in stony deposit in bottom 110 cm. GX-103 dates later industry 37 to 48 cm below surface at 1545 ± 75 (A.D. 405); GX-104 dates earlier industry 85 to 98 cm below surface at 6255 ± 135 (4305 B.C.), (Geochron I). Renewed work in trench at 90° to 1963 trench produced samples that follow, coll. 1966 by D. J. Mulvaney, A.N.U.; subm. by A.I.A.S.

ANU-57. 84 to 90 cm below surface**2890 ± 73
940 B.C.**

Charcoal from base of sandy layer and beginning of later industry at site. Benzene, 1-day count. *Comment* (D.J.M.): GX-103 is relatively higher than ANU-57, which dates appearance of points and adze flakes at site.

ANU-58. 109 to 116 cm below surface **4920 ± 100**
2970 B.C.

Charcoal ca. 23 cm below ANU-57 towards top of stony accumulation and its contained core and flake tool industry. Benzene, 1-day count. *Comment* (D.J.M.): GX-104 stratigraphically lower in 1963 trench than ANU-58 in 1966 trench. Between ANU-58 and 57 important changes, both depositional (stony to sandy) and technological (core and flake tools to points and adze flakes), took place at site.

ANU-60. 168 to 175 cm below surface **6800 ± 270**
4850 B.C.

Charcoal towards base of stony accumulation. Benzene dilution, 1-day count. *Comment* (D.J.M.): relatively lower in deposit than GX-104, it represents early stage of core and flake tool industry at site. *General Comment* (D.J.M.): highly satisfactory agreement between all radiocarbon dates. 1966 excavations produced engraved art on rocks in rubbly layer, associated with core and flake tool industry.

ANU-61. Anuru Bay, Arnhem Land, Northern Territory **125 ± 57**
Modern

Ash and charcoal ca. 25 cm below surface in stone fireplace on coastal beach (11° 45' S Lat, 133° 21' E Long). Lines of stone fireplaces, remains of smokehouses, and abundant pottery mark preparation campsites of Macassan trepangers. Activities historically dated from mid-18th to early 20th century and confirmed by Aboriginal tradition. Coll. 1966 by C. C. Macknight, A.N.U.; subm. by Anthropology. Benzene, 1-day count. *Comment* (C.C.M.): accords with historical dating of Macassan activity.

ANU-62. Port Essington, Coburg Peninsula, **550 ± 57**
Northern Territory **A.D. 1400**

Charcoal from 45 to 50 cm deep in Aboriginal shell midden 55 cm depth, adjacent to English military settlement (11° 22' S Lat, 132° 9' E Long) established 1838 and abandoned 1849 (Allen, 1967). European material occurs top 10 to 15 cm of midden. Coll. 1966 by F. J. Allen, A.N.U.; subm. by A.I.A.S. Benzene, 1-day count. *Comment* (F.J.A.): confirms conclusion reached on archaeological grounds that site occupied before settlement of Europeans and substantiates hypothesis that its function altered with that settlement.

Keilor series, near Melbourne, Victoria

Keilor terrace of Maribyrnong R. in vicinity of Keilor township has produced important information, especially skeletal, on late Pleistocene and early post-Pleistocene Aboriginal occupation of Australia (Gill, 1966; Bowler *et al.*, 1967). Gill reports 18,000 ± 500 (16,050 B.C.), (NZ-207, New Zealand I-V), for lower part of terrace, on charcoal from what he has interpreted as small Aboriginal midden (bones of food animals, no stone work).

Recent excavations in area (37° 52' S Lat, 144° 50' E Long) into alluvial clays beneath Keilor terrace by A. Gallus and Victorian Archaeol. Soc., with discovery of strata (1a, 1, 2, 3) of broken bones (including extinct marsupials) and some stone, assumed result of Aboriginal occupation. Samples coll. 1965 (ANU-81) and 1966 (ANU-65) by A. Gallus; subm. by A.I.A.S.

31,600 + 1100
— 1300

ANU-65. Trench 2, Stratum 2 29,650 B.C.

Charcoal from 3rd of 4 strata ca. 40 in. beneath base of Keilor terrace. Age based on NaOH-insoluble fraction, benzene dilution, 2-day count. NaOH-soluble fraction too small for dating.

24,000 + 3300
— 5700

ANU-81. Trench 2, beneath Stratum 2 22,050 B.C.

Charcoal ca. 40 in. from ANU-65, where, due to recent river erosion, present surface is only ca. 4 in. above sample. Two isolated occurrences combined to make 1 sample: i) 2 in. below deepest level of Stratum 2; ii) at same level as and ca. 36 in. from Stratum 3, 6 to 7 in. lower than Stratum 2. Age based on NaOH-insoluble fraction, benzene dilution, 2-day count. Sample yielded only 1/10th of full requirement, hence large errors. NaOH-soluble fraction too small for dating.

General Comment (A.G.): ANU-65, if interpretation is upheld, significantly extends chronology of Aboriginal occupation of Australia, since it would be earliest date yet recorded. Also important for history of pre-Keilor Arundel terrace formations. Overlapping occurs at 2 standard deviations between ANU-65 and ANU-81, considered, on stratigraphic grounds, to be earlier. Alternatively ANU-81 may in part be younger carbon that has moved down through clays which are notoriously liquid when wet. High antiquity of formation confirmed.

Koonalda cave series, Nullarbor Plain, South Australia

Koonalda cave (31° 25' S Lat, 129° 53' E Long) is extensive system in limestone, ca. 225 ft underground, entered by collapsed doline. Bands of chert in walls provided raw material for stone tool manufacture. Two trenches excavated by A. Gallus in 1956 and 1963: Trench III 450 ft from entrance in dim light, Trench I 42 ft further on in darkness. Trench III revealed undisturbed sequence of hearths in limestone rubble, one of which at depth ca. 24 in. was dated GaK-510, 13,700 ± 270 (11,750 B.C.) (Gallus, pers. commun.). In Trench I loose charcoal in limestone rubble at depth ca. 80 in. dated GaK-511 at 18,200 ± 550 (16,250 B.C.), (Gallus, pers. commun.). Renewed excavation by Gallus in 1966 provided ANU-66 from Trench I and in 1967 ANU-180 from "Squeeze" area 460 ft further into cave system.

Further work was organized for early 1967 by Koonalda Project Committee of Australian Inst. of Aboriginal Studies under direction of R. V. S. Wright, Univ. of Sydney, for whom ANU-70 and 71 were dated

while in field, because of problem posed by ANU-66. ANU-148 and 149 are samples from Wright's excavation beneath limestone rubble from which all other dates derive, into water-lain, laminated red gravels, silts, and clays, 10 to 14 ft thick at point of excavation and underlain by white limestone rubble. Red deposits, which were washed into cave, contain some artifacts and rich Pleistocene fauna. Ca. 4 ft below their surface there is stratigraphic disconformity, ANU-148 being below, ANU-149 above this.

ANU-66. Trench I, ca. 170 to 185 in. deep **9400 ± 1500**
7450 B.C.

Charred twigs in limestone rubble 91 to 103 in. below level of GaK-511. Coll. 1966 by A. Gallus; subm. by A.I.A.S. Benzene dilution, 1-day count. *Comment* (A.G.): stratigraphic inversion of ANU-66 and GaK-511 might be explained by intrusion of younger charcoal down cracks between rubble before they were filled with limestone dust (ANU-66) or by similar intrusion of older charcoal from rock fall in cave (GaK-511).

ANU-70. Trench III, Area C, ca. 24 in. deep **15,850 ± 320**
13,900 B.C.

Charred twigs from same zone of charcoal hearth(s)? as GaK-510. Coll. 1967 by R. V. S. Wright; subm. by A.I.A.S. Benzene, 1-day count. *Comment* (R.V.S.W.): significantly older than GaK-510 from same hearth, 13,700 ± 270 (11,750 B.C.), but general antiquity of level substantiated.

ANU-71. Trench III, Area C, ca. 60 in. deep **19,300 ± 350**
17,350 B.C.

Charcoal from hearth 36 in. below ANU-70. Coll. 1967 by R. V. S. Wright; subm. by A.I.A.S. Benzene, 1-day count.

ANU-149. Trench III, Area C, ca. 108 in. deep **>10,000**

Charcoal of high ash content apparently from single burnt stick washed into place and found in silt-clay band in red deposits, without evidence of hearth or surrounding charcoal. Since silt-clay band is part of graded sequence of 75 to 100 sequential bands and charcoal is scarce, any charcoal incorporated within them could date their deposition fairly closely. Sample 30 in. below top of red deposits and 15 in. above disconformity within them. Coll. 1967 by R. V. S. Wright; subm. by A.I.A.S. Benzene dilution, 4-day count. *Comment* (H.A.P.): count rate 1.8 sigmas above background. Result calculated by Callow's formula (NPL III) for minimum age. Count rate based on 0.13 g benzene which is 1/27th of full requirement.

ANU-148. Trench III, Area B, ca. 220 to 225 **19,400 ± 450**
in. deep **17,450 B.C.**

Charcoal from notable concentration in single band of silt in deep red deposits with rare charcoal. Though sample was doubtless washed into cave, circumstances described for ANU-149 suggest relation to event

shortly before deposition. Sample is ca. 160 in. below level of ANU-71 and 10 ft S of it and ca. 3 ft from unexposed wall of cave at this level. It also lies ca. 95 in. below disconformity in red deposits, 1 to 2 ft above underlying limestone rubble and 2 ft below lowest pieces of flint acceptable as artifacts. Coll. 1967 by R. V. S. Wright; subm. by A.I.A.S. Benzene dilution, 1.5-days count.

General Comment (R.V.S.W.): GaK and ANU sequence of dates forms consistent depositional series where, because of random roof falls, depth is no measure of depositional rates. ANU-148 for bottom of excavation under graded red gravels and silts, although younger than expected, is acceptable as graded beds possibly accumulated in relatively short period, perhaps 300 yr (Jennings and Frank, A.N.U., pers. commun.).

21,200 ± 700
19,250 B.C.

ANU-180. Area 5, ca. 8 in. deep

Two combined samples of fragmented charcoal of high ash content from excavation at chert mining site in "Squeeze" area located in total darkness 850 ft from cave entrance. Scattered roof fall rests on ca. 3 in. surface layer of dust covering rock and dust infilling of unknown depth, in which sample lay at ca. 5 to 8 in. below top of surface dust. Coll. 1967 by A. Gallus; subm. by A.I.A.S. Benzene dilution, 2-day count. *Comment (A.G.):* Wright (pers. commun.) reports V-92, 19,900 ± 2000 (17,950 B.C.), for sample coll. 1966 in same area. Both samples confirm antiquity of human activity within Koonalda cave system and near surface of its deposits.

B. New Guinea

Batari cave series, Tairora Census Division, Eastern Highlands District

Site in calcarenite in Lamari R. valley 5 mi S of Obura Patrol Post, alt 4200 ft (6° 36' S Lat, 145° 56' E Long). Excavations 1.6 m deep produced evidence similar to that of Aibura cave 13 mi N in same valley. Aibura is dated GaK-623, 3800 ± 110 (1850 B.C.) to later than GaK-622, 770 ± 100 (A.D. 1180) (Gakushuin V). At Batari flaked stone tool industry essentially homogeneous and hunting environment apparently stable throughout occupation (White, 1965 and 1967). Circumstances questioned validity of ANU-40 dating lowest cultural material; therefore ANU-38 from same horizon was dated. Samples coll. 1965 by J. P. White, A.N.U.; subm. by Anthropology.

≥ 8230 ± 190
6280 B.C.

ANU-38b. Horizon IV

Unidentifiable bones of food animals from lowest horizon in deposit at 70 to 100 cm depth. Age based on acid-insoluble bone fraction, benzene dilution, 2-day count. ANU-38a, bone carbonate, benzene, 2-day count, dated 3470 ± 60 (1520 B.C.). *Comment (J.P.W.):* ANU-38b probably dates earliest occupation at Batari (see ANU-40).

850 ± 53**ANU-39. Horizon I****A.D. 1100**

Charcoal from lower part of large hearth forming topmost undisturbed level of occupation. Provides last date for all archaeological material at site and correlates with only domesticated animal bones found. Benzene, 1-day count. *Comment* (J.P.W.): upper horizon of flaked tools just below this date shows no evidence of technological change found at Aibura from 800 B.P.

16,850 ± 700**ANU-40. Horizon IV****14,900 B.C.**

Scattered charcoal found in soil with artifacts below ANU-38; only carbon beneath ANU-39. Benzene dilution, 1-day count. *Comment* (J.P.W.): since sample only 20 cm laterally from culturally sterile riverine deposit containing spicules of carbon, date may not refer to human occupation. If carbon comes from natural sources, date documents 25 m of riverine downcutting since this time.

**Kafiavana rockshelter series, S Asaro valley,
Eastern Highlands District**

Site (6° 14' S Lat, 145° 25' E Long) described in ANU I. Striking feature is ground stone tools by 9500 B.P. (ANU-20, ANU I). Samples coll. 1965 by J. P. White; subm. by Anthropology.

≥10,730 ± 370**ANU-41b. 260 to 310 cm below surface****8780 B.C.**

Unidentifiable bones of food animals associated with ground stone tool fragments and marine shells. Sample, from area of 6m² over depth 50 cm, subm. to confirm ANU-20, immediately above. Age based on acid-insoluble bone fraction, benzene dilution, 2-day count. ANU-41a, bone carbonate, benzene, 1-day count, dated 6750 ± 100 (4800 B.C.). *Comment* (J.P.W.): ANU-41b in stratigraphically consistent series of 3 with ANU-20, not less than 9500 B.P. (ANU I), and New Zealand intra-laboratory reference R1894B, 9290 ± 140 (7340 B.C.), (Rafter, pers. commun.). All confirm antiquity of ground stone axe/adzes (White, 1967).

4690 ± 170**ANU-42. Base of Horizon II, 50 cm below surface****2740 B.C.**

Charcoal from creamy white matrix of hearth², just above upper of 2 main concentrations of artifacts. Benzene dilution, 2-day count. *Comment* (J.P.W.): sample comes from phase of high humus content, when site probably largely abandoned. Above it utilized flakes become common. Pig first appears below (cf. Bulmer, 1966). Date provides *terminus ante quem* for main occupation of Kafiavana.

Manton plantation series, Mt. Hagen, Western Highlands District

Site is superimposed series of former agricultural systems marked by digging of water-control ditches on alluvial flats of Wahgi R., 6 mi E of Mt. Hagen township, alt ca. 5200 ft (5° 51' S Lat, 144° 19' E Long).

Rescue excavations conducted 1966 by R. J. Lampert, W. R. Ambrose, and J. Golson, and palynological investigations carried out by Jocelyn M. Wheeler, all A.N.U. Coll. 1966 by R. J. Lampert and W. R. Ambrose; subm. by Anthropology.

ANU-43. Trench M, Zone II

**2300 ± 120
350 B.C.**

Waterlogged wood from long pointed digging stick found in earliest of 3 superimposed drainage channels in zone of disturbed peat of prehistoric horticultural activity. Benzene dilution, 1-day count.

ANU-44. Trench N, Zone III

**4560 ± 72
2610 B.C.**

Waterlogged wood from branch in thin zone of undisturbed peat immediately above basal clay and below zone of disturbed peat with drainage channels. Benzene, 1-day count.

General Comment (R.J.L.): pattern of ditches, agricultural implements, and stone tools dated by ANU-43 identical with those associated with dry-land sweet potato agriculture in modern times (Lampert, 1967). Date is well before introduction of sweet potato to New Guinea; 1st direct dating of horticulture there (Golson *et al.*, 1967).

Watom Island series, New Britain, Bismarck Archipelago

Pottery from Rakival village on island's NE coast (4° 5' S Lat, 152° 5' E Long), reported 1909 (Meyer) and 1936 (Casey), now attributed to early and widespread tradition in SW Pacific, called Lapita (Golson, 1961; Poulsen, 1964; Solheim, 1964). Samples coll. 1966 by J. R. Specht, A.N.U.; subm. by Anthropology.

Complex situation involves possibly interconnected factors: burial of site by volcanic ash rapidly redistributed after ashfall, derangement of local drainage, coastal progradation, and transformation of coast locally from muddy embayment to open beach. Different aspects of situation registered in stratigraphy of 11 excavated trenches (9 at Site 6 near present church, 2 at Site 8, 50 m away near present cemetery).

**ANU-37b. Site 8, Trench 1, 150 to 180 cm
below surface**

**≥2420 ± 110
470 B.C.**

Bone from at least 3 burials in discolored sand above white sterile coral beach sand. Sand, 20 to 25 cm thick, containing shells and Lapita sherds, overlain by 20 to 35 cm thick black-to-brown clayey loam, containing sherds, representing period of stabilization and overlain by 70 to 80 cm volcanic ash. Age based on acid-insoluble bone fraction, benzene dilution, 1-day count. ANU-37a, bone carbonate, benzene dilution, 1-day count, dated 910 ± 110 (A.D. 1040). *Comment* (J.R.S.): on grounds of ceramic style Lapita occupation of Watom expected to predate settlement of S Melanesia, where, however, Fiji produces earlier and Tonga equally early dates (cf. ANU-24, ANU I). Sample may not date earliest occupation of site.

720 ± 57

ANU-72. Site 6, Trench VII, ca. 180 cm below surface **A.D. 1230**

Charcoal from hearth or oven dug into top of redistributed volcanic ash and sealed by narrow zone of silts overlain by thick light brown material (possibly also ash). No associated pottery. Benzene, 1-day count. *Comment* (J.R.S.): since ash redistribution apparently rapid, should provide close *terminus ante quem* for ash fall, as well as date post-ash occupation apparently unaccompanied by pottery.

1595 ± 60

ANU-73. Site 6, Trench VII, 310 cm below surface **A.D. 345**

Waterlogged root or stem wood, probably *Alstonia spathulata*, growing *in situ* in clay ca. 70 cm thick at base of trench. Sample from bottom, ca. 50 cm below ground water level. Clay contains shells, Lapita-style potsherds, stone artifacts, and bone. Separated from overlying ash of ANU-72 by banded gritty ash containing sherds. Benzene, 1-day count. *Comment* (J.R.S.): lack of knowledge about clay formation and associated material prevents archaeological discussion of sample, which dates vegetational phase and approx. age of formation from which it was collected.

780 ± 100

ANU-74. Site 6, Trench V, ca. 250 cm below surface **A.D. 1170**

Soil and charcoal at ground water level towards top of clayey soil containing shell and Lapita pottery with pumice pellets in upper part. Clayey soil at base of trench and considered equivalent to clay of ANU-73. Trenches are 10 m apart and stratigraphically different. Trench V, seaward of VII, has no layer of redistributed ash or underlying banded gritty ash *in situ* and much crab disturbance. Sample from beneath level of redistributed ash of Trench VII. Benzene dilution, 1-day count. *Comment* (J.R.S.): absence of clearly defined ash and sand layers, though pumice present, may reflect crab disturbance and explain closeness of result to ANU-72. Alternatively date may indicate, with ANU-73, period of basal clay formation, whatever relationship of included archaeological material may prove to be.

315 ± 53

ANU-75. Site 6, Trench III, ca. 250 cm below surface **A.D. 1635**

Shells of *Canarium* (food) nuts from silty clay at base of trench, containing Lapita pottery and shells, just below pumice layer. No *in situ* layer of redistributed ash; evidence of old stream courses subsequently infilled. Benzene, 1-day count. *Comment* (J.R.S.): pumice layer slopes steeply; sample may have been deposited on surface but later sunk through it. Tentatively dates start of last phase of aggradation in old

stream course or embayment. Associated archaeological material is almost certainly not in primary position.

General Comment (J.R.S.): formation of deposits at Site 6 are being investigated; interpretations for individual dates are provisional. ANU-37b provides only direct date for Lapita pottery on Watom.

C. Pacific Islands

ANU-23/2. Site Tonga 5, near Veitongo village, Tongatapu, Tonga **340 ± 63**
A.D. 1610

Charcoal from Fire Hollow D on site (21° 11' S Lat, 175° 13' E Long). Repeat of ANU-23 at collector's request, since date critical for interpretation of Tongan ceramic sequence. ANU-23 reported as 330 ± 100, physical measurement ± 80 (ANU I). Coll. 1964 by J. I. Poulsen, A.N.U.; subm. by Anthropology. Benzene, 3-day count. *Comment* (J.I.P.): confirmation of late date expected on archaeological evidence.

Naïa Bay series, New Caledonia

Two major excavated sites, 400 m apart, on W coast ca. 25 km NW of Noumea (22° 10' S Lat, 166° 15' E Long) provide pottery sequence in which major elements established by Gifford and Shutler (1956) are represented. Samples coll. 1966 by C. D. Smart, A.N.U.; subm. by Anthropology.

ANU-96. TON-7, oven ca. 90 cm deep **3165 ± 120**
1215 B.C.

Solid charcoal mass from thick deposit across base of large oven, Layer III, overlying white coral sand. Fill of oven contains few sherds, some with applied, some with stamp-impressed (Lapita-style) decoration. Benzene, 1-day count.

ANU-97. TON-7, oven ca. 50 cm deep **2065 ± 110**
115 B.C.

Charcoal from one of small ovens associated with lines of postholes within and under Layer IV, which contains paddle-impressed pottery. Benzene, 1-day count.

ANU-98. TON-6, ca. 90 cm deep **1745 ± 115**
A.D. 205

Charcoal from localized area in Layer II, deepest in sequence of 11 horizons, containing pottery with handles. Benzene dilution, 2-day count.

ANU-99. TON-6, 25 to 30 cm deep **1635 ± 110**
A.D. 315

Charcoal from oven sealed by Layer VII, associated with pottery with handles and incised decoration. Benzene, 1-day count.

General Comment (C.D.S.): results agree with those of Gifford and Shutler (1956, p. 89) who reported M-341, 2800 ± 350 (before 1954, 846 B.C.) and M-336, 2435 ± 400 (before 1954, 481 B.C.) for Lapita ware

(cf. ANU-96) and M-333, 1700 ± 300 (before 1954, A.D. 254) for paddle-decorated ware (cf. ANU-97), and series of later dates for poorly understood handled and incised wares (see Michigan I for 1st publication of these dates). Problem of almost identical dates ANU-98 and 99 is under investigation.

D. New Zealand

ANU-46b. Kauri Point, western Bay of Plenty, North Island **395 ± 53**
A.D. 1555

Charcoal from 2nd of series of shell lenses laid down following construction of 1st defenses at fortified settlement ($37^{\circ} 30'$ S Lat, $175^{\circ} 58'$ E Long) described in ANU I. Coll. 1962 by W. R. Ambrose, A.N.U.; subm. by Anthropology. Age based on NaOH-insoluble fraction, benzene, 2-day count. ANU-46a, NaOH-soluble fraction, commonly called "humic" and generally thought contaminant, gave $\delta^{14}\text{C} = +47 \pm 5\%$, benzene dilution, 1-day count, showing it to be more active than ^{14}C Modern reference standard. *Comment* (W.R.A.): with ANU-25, 495 ± 100 (A.D. 1455), (ANU I), date brackets construction of first defenses at site. *Comment* (H.A.P.): $\delta^{14}\text{C}$ is *observed* deviation from standard (Editorial Statement, Radiocarbon, 1966, v. 8).

Waitaki Gorge series, South Canterbury, South Island

During 1958 to 1960 and 1962, supported by grant from New Zealand Nat. Historic Places Trust, W. R. Ambrose, A.N.U., then of Univ. of Auckland, with Janet Ambrose and F. W. Davis, made records of rock paintings subsequently submerged by Benmore Hydroelectricity Scheme dam (Ambrose *et al.*, 1958-1960). Sites are 60 mi from sea, where Waitaki and tributary gorges afford most direct routes to interior. Excavations made at 3 decorated shelters and samples coll. in hope that, despite lack of direct association of rock art and very thin archaeological occupation, possible order of magnitude for age of art might be given. Only other evidence for this age is conflicting dates from Te Anau, W Otago (Duff, 1956, p. XII), NZ-51, 230 ± 60 (A.D. 1720) and NZ-52, 830 ± 50 (A.D. 1120), corrected dates, (New Zealand I-V).

ANU-47. Ahuriri rockshelter, Ahuriri Gorge **625 ± 65**
A.D. 1325

Charcoal from undisturbed fireplace 6 in. below surface, ($44^{\circ} 32'$ S Lat, $170^{\circ} 12'$ E Long). Coll. 1958 by W. R. Ambrose; subm. by Anthropology. Benzene dilution, 2-day count.

ANU-48. Gooseneck Bend rockshelter, Waitaki Gorge **850 ± 150**
A.D. 1100

Charcoal and charred twigs from lowest cultural deposit, 6 in. below surface, associated with flake tools, ($44^{\circ} 29'$ S Lat, $170^{\circ} 12'$ E Long). By evidence of superimposition drawings made here over period of time.

Coll. 1959 by W. R. Ambrose; subm. by Anthropology. Benzene dilution, 1.5-day count.

695 ± 135

ANU-49. Junction Point rockshelter, Ahuriri River **A.D. 1255**

Charcoal 6 in. from surface in lowest deposit, (44° 33' S Lat, 170° 14' E Long), associated with flake tools and necklace section of fossil *Dentalium*, considered early type in New Zealand. Coll. 1962 by W. R. Ambrose; subm. by Anthropology. Benzene dilution, 2-day count. *General Comment* (W.R.A.): dates early penetration to inland areas of South Island; may be compared with those of inland moa-hunting site of Hawksburn, Central Otago (Lockerbie, 1959, p. 85-87), dated 14th to 16th century, (NZ-59 to 62, New Zealand I-V). Thin occupation at shelters suggests equally early art.

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