RADIOCARBON MEASUREMENTS:
COMPREHENSIVE INDEX, 1950-1965

Introduction

Use of the Index

All radiocarbon dates published by the measuring laboratories between 1950 and 1965 have been scrutinized by the laboratories, and have been changed or declared invalid when necessary. They are here republished in index form. Laboratories' lists are entered as units, arranged in alphabetical order according to each laboratory's code designation, not necessarily to its name. Dates and other measurements are listed by laboratory number. The originally published date or other value is entered in Column 3, corrections if any are in Column 4, the observed deviation from the standard C^{14} assay is given, as $\delta\ C^{14}$, in Column 5, and the accepted date is converted to the A.D./B.C. system and entered in Column 6. Bibliographic references, coded for entry in Column 2, will be found at the end of this Introduction.

Notes, applied throughout the Index, are as follows:
s   solid-carbon measurement; the most untrustworthy of these have been rejected (note d);
a   adjustment of standard from provisional standard to oxalic-acid standard supplied by U. S. National Bureau of Standards (abbreviated: NBS oxalic acid);
b   adjustment for isotopic fractionation in the substance assayed;
c   mistakes in laboratory procedure, computation, or printing;
d   original date considered by laboratory to be unreliable.

Some laboratories have amplified their explanations of changes by extending this list; these explanations, and numbered footnotes dealing with other matters, are found at the end of each laboratory's list.

Where no corrected entry appears in Column 4, no correction is thought necessary.

All dates, by agreement at several Radiocarbon Conferences, are computed in terms of the Libby half-life of C^{14}, 5570 ± 30 yr. A better figure, using the newer half-life, 5730 ± 40 yr, can be obtained by multiplying the published date by 1.03. All users are warned, however, that the agreed-upon convention is to be modified only with full and careful explanation; a "corrected" date, cited as if it were the published date, is subject to further, erroneous "correction" by unwary users, and chaos will result. As all radiocarbon measurements, corrected and uncorrected, are equally arbitrary as estimates of age, the responsible laboratories prefer to retain the convention.

All dates are published in "(C^{14}) years before present," where "present" means A.D. 1950.

Geochemical measurements

Where the quantity of the isotope, C^{14}, in a substance is of intrinsic interest apart from the age of some accompanying or including object, the measurement is geochemical. Such measurements are made for a great variety of purposes, and are therefore published in various ways. The figure that contains the fewest assumptions is the observed deviation, $\partial\ C^{14}$, from the NBS oxalic-acid standard (i.e. from 95% of the C^{14} activity of the NBS standard, which proved

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to be "super-modern" owing to incorporation of some artificial C^{14} from weapons testing; the effect of the convention is to make the standard equivalent to age-corrected 19th-century wood, grown before dilution of the atmosphere by carbon dioxide from fossil fuels). Sometimes this figure is expressed in percent (%), sometimes in per mil (‰); scrupulous editorial care has been exercised to make the units clear in this Index. "Percent of modern" is identical conceptually *but not arithmetically*. Of derived figures, the one most commonly used is Δ, in the computation of which the measurement is first corrected for isotopic fractionation, normal fractionation of C^{14} being taken as twice the observed fractionation of the stable isotope, C^{13}; a mass-spectrometric measurement of C^{13} is therefore needed, and few laboratories find this necessary for routine dating. Where the fractionation is important, as it is in many geochemical problems, Δ normalizes all carbonaceous substances, carbonates as well as organic, to the same assumed value, and expresses, ordinarily in per mil, the deviation of the C^{14} assay from that value. In the original definition of Δ (ref. 16), it was understood that the C^{14} assay (∂C^{14}) was also corrected for known age, as would be practical and necessary for tree-ring measurements but for few others. Subsequently, this age correction has been lost sight of, by editors as well as authors, mainly because it is not often practical, and the more logical usage followed nowadays is to enter ∂C^{14} as the *observed* deviation, regardless of age if known. Values of Δ (and of a similar but numerically different figure, ΔC^{14}), have been republished in this Index as they were in the original publication; if the laboratory (despite editorial pleas) has not supplied the observed ∂C^{14} for Column 5, reference to the original publications may be necessary to make certain that values of Δ are all alike.

Carbonate dates

Dates based on carbonates rather than on terrestrial organic carbon are not necessarily suspect, and many laboratories publish them routinely, but they can be differently affected by isotopic fractionation and by other processes related to the ultimate source of the isotope. Fractionation alone makes a small difference, at most 5% or 400 yr, and as sea-surface carbonate, utilized by molluscs in forming shell, is generally depleted in C^{14} below the assumed equilibrium value, the effect of using a shell for a date is usually smaller; several laboratories consider it to be entirely negligible. The modern practice appears to be to report carbonate dates by reference to the NBS standard, just as if they were organic, but often with mental reservations that can be made explicit only if the oceanographic situation of the submitted sample is either well known or certainly anomalous. Much more serious, usually, are problems arising from use of carbonates from inland waters or from ground water, but these are commonly spotted as geochemical problems and reported as such. No change in any date has been made for any such reason, unless by the laboratory, where note (b) is the appropriate designation; but for a few early lists, where the standard was not NBS oxalic acid, and where a "modern, living shell from the same locality" may or may not have been used as reference standard, the editors have thought it best to asterisk carbonate dates that may not have been corrected for isotopic anomalies.

General notes

All reasonable care has been exercised by the editors to attain accuracy and consistency of treatment, to call attention of the laboratories to apparent inconsistencies and a host of other small problems, and to check against the

original lists when doubts arose. Ultimately, however, the editors found it impossible to take personal responsibility for every date, and this responsibility rests, as it always has rested, on the laboratories. Their cooperation has been exemplary, despite the numerous changes of personnel, organizational structure, and laboratory practice that have occurred since 1950. That all concerned will have avoided all mistakes is too much to expect, and we trust that users of the Index will forgive the mistakes they find, and call them to the editors' attention when they find them.

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Published Reference Code

1   Deevey et al., 1954, Natl. Acad. Sci. Proc., v. 40, p. 285-288.
2   Yale I, 1953, Science, v. 118, p. 1-6.
3   Yale II, 1955, Science, v. 122, p. 954-960.
4   Yale III, 1957, Science, v. 126, p. 908-919.
5   Yale IV, 1959, Radiocarbon Suppl., v. 1   p. 144-172.
6   Yale V, 1960, Radiocarbon Suppl., v. 2, p. 49-61.
7   Yale VI, 1961, Radiocarbon, v. 3, p. 126-140.
8   Yale VII, 1962, Radiocarbon, v. 4, p. 250-262.
9   Lamont I, 1951, Science, v. 114, p. 565-568.
10 Lamont II, 1952, Science, v. 116, p. 490-414.
11 Lamont III, 1956, Science, v. 124, p. 154-165.
12 Lamont IV, 1957, Science, v. 126, p. 1324-1334.
13 Lamont V, 1959, Radiocarbon Suppl., v. 1, p. 1-28.
14 Lamont VI, 1959, Radiocarbon Suppl., v. 1, p. 111-132.
15 Lamont VII, 1961, Radiocarbon, v. 3, p. 141-175.
16 Lamont VIII, 1961, Radiocarbon, v. 3, p. 176-204.
17 USGS I, 1954, Science, v. 120, p. 467-473.
18 USGS II, 1955, Science, v. 121, p. 481-488.
19 USGS III, 1956, Science, v. 123, p. 442-448.
20 USGS IV, 1958, Science, v. 127, p. 1476-1487.
21 USGS V, 1960, Radiocarbon Suppl., v. 2, p. 129-185.
22 USGS VI, 1961, Radiocarbon, v. 3, p. 86-97.
23 Michigan I, 1956, Science, v. 124, p. 664-672.
24 Michigan II, 1958, Science, v. 127, p. 1098-1105.
25 Michigan III, 1958, Science, v. 128, p. 1117-1123.
26 Michigan IV, 1959, Radiocarbon Suppl., v. 1, p. 173-198.
27 Michigan V, 1960, Radiocarbon Suppl., v. 2, p. 31-48.
28 Michigan VI, 1961, Radiocarbon, v. 3, p. 105-125.
29 Michigan VII, 1962, Radiocarbon, v. 4, p. 183-203.
30 Heidelberg I, 1957, Science, v. 126, p. 194-199.
31 Copenhagen I, 1953, Science, v. 118, p. 6-9.
32 Iversen, 1953, Science, v. 118, p. 9-11.
33 Copenhagen II, 1956, Science, v. 124, p. 879-881.
34 Vinogradov, A. P., 1962, p. 86-88 *in* "Radioisotopes in the physical sciences and industry, Internat. Atom. Energy Agency, Vienna, 1962.