Radiocarbon Dating: Measurement, Calibration and Archaeological Meaning

A reproducible guide to samples, probability, context and chronological models

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Direct answer. A radiocarbon result is a laboratory estimate of the time since organic material stopped exchanging carbon with its environment. The conventional radiocarbon age is reported in years BP, where 'present' is 1950, with a measurement uncertainty. Because atmospheric carbon-14 varied, that result must be calibrated with an appropriate curve such as IntCal20, SHCal20 or Marine20. Calibration produces a probability distribution that can contain several separated calendar ranges. Archaeological meaning then depends on association: short-lived seed in a sealed hearth may closely date an event, while old timber, residual charcoal, intrusive roots, mixed sediment, shell with an uncertain reservoir correction or contaminated bone may not. Reliable chronology uses documented pretreatment, quality indicators, multiple well-chosen samples, stratigraphy and transparent statistical models.

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1 Measurement model

Radiocarbon dating estimates time since a sampled carbon fraction ceased exchange. Conventional ages use BP relative to 1950 and include analytical uncertainty, but do not automatically incorporate archaeological association error.

2 Calibration

Atmospheric variation makes radiocarbon and calendar time non-linear. IntCal20, SHCal20 and Marine20 encode different reservoirs. Calibration yields probability densities, often multimodal, whose ranges and curve version must be reported.

3 Material selection and pretreatment

Short-lived, taxonomically identified samples closely associated with an event are preferred. Chemical protocols isolate relevant carbon in charcoal, cellulose, collagen and carbonate; yields, blanks and quality diagnostics support evaluation.

4 Formation processes

Inbuilt age, reuse and residuality can produce older results; roots, burrows and later disturbance can produce younger ones. Stratigraphic integrity and the organism-deposition-event relationship determine archaeological relevance.

5 Reservoirs and mixed sources

Marine and freshwater carbon can carry offsets. Marine20 requires appropriate regional adjustment, while mixed diets or environments may need mixing models. Uncertain corrections should broaden inference rather than be hidden.

6 Sampling design

Multiple targeted samples across secure contexts are stronger than an isolated determination. Replication, short-lived pairs and explicit research questions expose outliers and quantify phase duration.

7 Bayesian chronological models

Bayesian models combine calibrated likelihoods with justified stratigraphic order and phase structure. Posterior precision depends on prior assumptions; model code, agreement indices, outlier treatment and sensitivity tests must be published.

8 Reporting and reproducibility

Laboratory identifiers, context records, raw conventional ages, curve, software, corrections, calibrated distributions and model inputs enable reanalysis. A midpoint without probability and metadata is inadequate.

9 Limits of historical inference

Radiocarbon dates organic samples. Moving from one sample to a feature, phase, site or civilisation requires progressively more contextual and independent evidence. Language, ethnicity and political identity are not measured by carbon isotopes.

10 Evidence assessment

Strong	Radiocarbon measurements require calibration because environmental carbon-14 varied through time.
Strong	Context and sample-event association are necessary to translate a sample age into archaeological chronology.
Strong	Short-lived identified material and multiple targeted samples usually reduce major interpretive risks.
Strong	Marine samples require marine calibration and may require a regional reservoir correction.
Probable	A transparent Bayesian model can materially improve phase and boundary estimates when its prior constraints are valid.
Contested	Exact treatment of local reservoir offsets, mixed-source samples and ambiguous outliers in particular datasets.
Unsupported	The claim that a single radiocarbon result directly dates a civilisation, language, ethnicity or political event without contextual linkage.

11 Conclusion

Radiocarbon dating is powerful because it converts a measurable isotope ratio into a probabilistic chronology. Its limits are equally precise: it dates sampled carbon, and every step from sample to historical claim must be demonstrated. Good practice joins appropriate material, pretreatment, calibration, context, replication and transparent models, while reporting uncertainty as evidence rather than an inconvenience.

References

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This paper is an evidence review for public scholarship.

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