Glossary of technical terms

Time periods

Quaternary. A period beginning 2.6 million years ago that includes the Pleistocene and Holocene epochs. The beginning of the Quaternary saw global cooling, glaciation of both poles and the appearance of the genus Homo.

Pleistocene. Beginning about 2.6 million years ago, the Pleistocene was a time marked by the periodic growth and decline of high-latitude ice sheets and glaciers.

Late Pleistocene. The late Pleistocene is made up of the last complete glacial–interglacial cycle, beginning about 126 ka with the onset of the last interglacial.

LGM. The last glacial maximum (26.5–19 ka). Formally defined as the latest period when global glaciers reached their maximum extent. The LGM was the driest of all glacial: forests shrank, deserts and ice sheets expanded, and sea levels fell to their lowest recorded levels, 135 m below modern sea level.

Holocene. The Holocene began at 11.7 ka with the resumption of rapid global warming after the last glacial episode. Although this was a comparatively stable period, it was not uniform and can be divided into three distinct phases: the early Holocene (11.7–8.0 ka), when vegetation and geomorphic systems were still adjusting to rapid postglacial changes in temperature, sea levels and rainfall; the mid-Holocene (8.0–4.0 ka); and the late Holocene (from 4.0 ka), which saw the onset of a drier, more variable climate dominated by the El Niño–Southern Oscillation (ENSO).
MIS

Marine isotope stages. The cornerstone of the Quaternary climate sequence is the deep-sea oxygen isotope record from marine foraminifera, which define a series of marine isotope stages (also called oxygen isotope stages). By convention, cold, dry glacial stages are given even numbers, and warm interglacial stages have odd numbers. In Australian drylands, these climatic oscillations are mainly reflected in cyclical fluctuations in available moisture: interglacials reactivated lakes and rivers across the interior; the colder drier glacial periods are marked by active dunefields and windblown dust.

MIS5

The last interglacial is marine isotope stage 5 (or, more precisely, substage 5.5). This represents the last significant imprint of widespread river and lake activity in the arid zone.

DATING METHODS

$^{14}$C

Radiocarbon dating is the major means of dating archaeological sites and organic materials in Australia’s deserts. Mainly applied to charcoal, wood, shell and some minerals such as carbonates, the technique relies on the decay of $^{14}$C – a common radiisotope of carbon – to provide a ‘clock’ that counts down.

ABOX $^{14}$C

Radiocarbon dating paired with a pretreatment process (acid–base oxidation) designed to remove otherwise intractable contaminants in charcoal. The technique is used with stepwise combustion at progressively higher temperatures to selectively remove the outer layers of a sample and separately date the resulting CO$_2$.

AMS $^{14}$C

High-precision radiocarbon dating using an accelerator mass spectrometer to directly measure the $^{14}$C content of a sample (standard radiocarbon dating relies on radioactive emissions as an indirect measure of $^{14}$C content). AMS $^{14}$C is widely used where only small samples (as low as 1–2 mg) are available or where the necessity of extensive pretreatment reduces sample size.

TL and OSL

Luminescence methods are widely used to date sediments in the arid zone. Mainly applied to quartz sediments, the technique measures the charge accumulated in mineral grains after burial (or when sunlight is otherwise excluded). The ‘clock’ is zeroed
by exposure to light and counts up after burial. Thermoluminescence (TL) uses heat to release the accumulated charge (emitted as photons), whereas optically stimulated luminescence (OSL) uses a laser. OSL is the technique of choice for high-precision work, for single-grain dating or for samples where mixed-aged sediments are suspected or where bleaching (i.e., zeroing) may have been incomplete (as in some fluvial or cave sediments).

**ESR**
Electron spin resonance is an alternative approach to measuring the dosage of nuclear radiation received by an archaeological sample. ESR is mainly used to date tooth enamel and speleothems, materials that are unsuitable for luminescence techniques. For these materials, ‘time-zero’ is formation of the crystals in these materials: hydroxyapatite in tooth enamel; calcite in speleothems.

**Cation-ratio dating**
A technique formerly used for dating mineral varnishes on rock surfaces but now shown to be unreliable. The method assumes that the leaching of mobile elements (Ca and K) in these varnishes is time-dependent.

**AAR**
Amino acid racemisation. In eggshell and marine shell, the progressive alteration of amino acids is a function of time and temperature. Provided one of these can be controlled, AAR can provide either an indication of age or a record of palaeotemperature. In Australia’s deserts, AAR dating has been applied to eggshell from emu and *Genyornis*, often calibrated against $^{14}$C dating of the eggshell, or TL/OSL ages on associated sediments.

**U/Th and U-series**
One branch of uranium-series dating looks at the radioactive decay chain $^{238}\text{U} \rightarrow ^{234}\text{U} \rightarrow ^{230}\text{Th}$. U/Th dating specifically looks at the build-up of thorium-$^{230}$ in a sample, assuming that the original sample was free of detrital thorium and there has been no subsequent uptake or leaching of uranium. In the arid zone, this dating method has been applied to tooth enamel or calcite in speleothems (cave flowstone and stalagmites) and less often to bone, carbonates or rock varnish.

**TIMS U/Th**
The use of thermal ionisation mass spectrometry (TIMS) has broadened the archaeological application of U/Th dating by allowing very small samples to be measured.
TIMESCALES

BP Radiocarbon ages are given as years ‘before present’. By international convention, this is ‘years before 1950 AD’, the point at which burning of fossil fuels diluted the concentration of radiocarbon in the atmosphere.

cal. BP A calibrated radiocarbon age. Even in the deep past, fluxes in atmospheric $^{14}\text{C}$ have distorted the radiocarbon timescale, so that radiocarbon years are not calendar ages. Calibration programs such as OxCal, CALIB or CALPAL are used to convert radiocarbon ages (years BP) to sidereal years (years cal. BP or ka).

ka Throughout this book, calendar or sidereal ages are quoted as ‘ka’ in the sense of ‘thousands of years ago’.

OTHER

C$_3$ and C$_4$ plants Different photosynthetic pathways in plants result in minor fractionation of carbon isotopes, giving them different isotopic signatures. C$_4$ grasses are more resistant to water stress and are characteristic of hot climates or summer rainfall regions. C$_3$ plants are mainly shrubs or temperate zone grasses.

Summed probability plots Summed probability plots of radiocarbon ages provide a more sophisticated picture of archaeological trends than do simple frequency plots. Because radioactive decay is a random process, there are statistical counting uncertainties associated with each radiocarbon date. This is reflected in the way radiocarbon ages are reported: as mean age ± 1 standard deviation. For calibrated ages, the irregularity of the calibration curve introduces other uncertainties: a single radiocarbon date might have multiple age intercepts on the calibration curve. In effect, each calibrated radiocarbon age has a spread of probabilities. For a series of ages, summed probability plots combine these probabilities into a single plot. Ready access to radiocarbon calibration programs has made these plots the mainstay of time-series analysis of archaeological trends.

ENSO The El Niño–Southern Oscillation (ENSO) is a major driver of interannual and decadal climatic variability on both sides of the Pacific. Differences in sea surface
temperature (SST) determine the strength of airflow across the tropical South Pacific, contributing to droughts and floods in Australia. This pattern of atmospheric thermal circulation is inherently unstable, and extremes tend to recur on a 3- to 8-year cycle.