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Q5(a)

Chronometric dating

UPSC Civil Services Mains 2024 · Anthropology GS 1 · 10 marks · Principles of Prehistoric Archaeology. Chronology

(a) Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods.

Core demand of the question

- Define chronometric dating and distinguish it from relative dating
- Name the principal chronometric methods used in prehistoric anthropology
- State the material, approximate range and limitation of each
- Show why context and cross-checking remain necessary

Revision summary

Chronometric dating gives an age in years; relative dating only orders remains.

Radiocarbon dates organic material to about 50,000 years and requires calibration.

K-Ar/Ar-Ar dates volcanic layers associated with early hominins.

TL dates last heating; OSL dates last light exposure.

U-series and ESR extend the cave and tooth record.

Every date belongs to a sample and event and must fit association and stratigraphy.

Introduction

Chronometric dating assigns an age in calendar years, with an error range, to an archaeological event or deposit. Unlike relative dating, which only orders layers or artefacts, it uses a measurable physical clock. No method dates "the site" in the abstract: it dates a particular sample and event.

Body

Principal clocks

- **Radiocarbon (Willard Libby):** decay of carbon-14 dates once-living charcoal, bone collagen or seed, normally to about 50,000 years. Calibration against tree rings is essential; contamination and reservoir effects can mislead.
- **Potassium-argon and argon-argon:** decay of potassium-40 dates volcanic minerals from roughly 100,000 years into geological time. Tuffs bracketing Olduvai and East African hominins are classic applications; the dated eruption is not automatically the fossil's death.
- **Uranium-series:** radioactive disequilibrium dates carbonates, corals, cave speleothems and sometimes teeth, broadly from thousands to several hundred thousand years. Open-system uranium movement is the chief danger.
- **Luminescence:** thermoluminescence dates the last heating of pottery or burnt flint; optically stimulated luminescence dates the last sunlight exposure of quartz or feldspar sediment.

Incomplete zeroing produces old ages.

- **Electron-spin resonance:** trapped electrons in tooth enamel or carbonate can reach into the Middle Pleistocene, but dose-rate reconstruction is demanding.
- **Dendrochronology**, pioneered by **A. E. Douglass**, gives annual precision where preserved wood and a regional master sequence exist.

Indian prehistory often combines radiocarbon for Neolithic charcoal, as at Mehrgarh-related contexts, with luminescence for older alluvial Palaeolithic deposits. A secure date also requires association, stratigraphy and preferably a second clock.

Flow diagram

Sample and event -> Choose clock
Choose clock -> C-14: organic death-14: organic death
Choose clock -> K-Ar: volcanic eruption-Ar: volcanic eruption
Choose clock -> TL or OSL: heat or light reset
Choose clock -> U-series or ESR-series or ESR
C-14: organic death -> Calibrate and cross-check
K-Ar: volcanic eruption -> Calibrate and cross-check
TL or OSL: heat or light reset -> Calibrate and cross-check
U-series or ESR -> Calibrate and cross-check

Conclusion

Chronometric dating transformed prehistory from a sequence into a timescale. Its anthropological value lies in matching the clock to the sample and behavioural event, then testing the result against stratigraphy rather than treating a laboratory number as self-validating.

Facts & figures

Willard Libby

Developed radiocarbon dating; carbon-14 dates the death of once-living material, not stone tools directly.

Olduvai tuffs

Volcanic horizons dated by potassium-argon methods helped place East African hominins and industries on an absolute timescale.

OSL event

Optically stimulated luminescence estimates when mineral grains were last exposed to sunlight before burial.

Error term

A chronometric result is an estimate with uncertainty and calibration assumptions, not an exact historical birthday.

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