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Q5(c)

Fission track dating method and its applications.

UPSC Civil Services Mains 2025 · 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

- State the principle of **fission-track dating**
- Name the materials and the time range in cautious terms
- Give archaeological and geological applications useful to anthropology
- Note one limitation

Revision summary

Fission-track dating counts damage trails from uranium-238 fission in minerals or glass.

Price, Walker and Fleischer developed the method.

Zircon, apatite and volcanic glass are the usual materials.

Applications include dating tephra at hominin sites, heated stone, and Himalayan or Siwalik thermal history.

Heat can anneal tracks and reset the clock, so dates need stratigraphic and other radiometric checks.

Different minerals do not share one single year-range.

Introduction

Fission-track dating is a radiometric clock that counts damage trails left when uranium-238 atoms split inside a mineral or glass. **P. B. Price, R. M. Walker** and **R. L. Fleischer** developed the method. For anthropology it is a way to date volcanic layers and heated materials that sit with fossils or tools.

Body**How the clock works**

Uranium-238 occasionally undergoes spontaneous fission. Each fission leaves a tiny track in the crystal. The sample is polished and etched so the tracks can be counted under a microscope. The uranium content is measured, often by inducing extra tracks in a reactor. Age is then a function of track density and uranium concentration.

Useful materials include **zircon, apatite** and volcanic glass (obsidian or tephra). The method works over a wide geological span, from relatively young volcanic glasses to much older crustal minerals. The range depends on the mineral and on whether tracks have been reset by heat.

Heat can reset as well as date. Heating can anneal old tracks and restart the clock, which is why the method also records thermal history, not only "the age of the rock".

Applications

- **Hominin and Palaeolithic sites:** Volcanic ash and tuff above or below fossils can be dated, alongside potassium-argon and argon-argon where those apply. East African rift volcanics are a standard setting.
- **Obsidian and burnt flint:** Provenance and last-heating events can be approached where tracks and chemistry allow.
- **Siwaliks and mountain belts:** Fission-track work on **apatite and zircon** is widely used in Himalayan cooling and uplift histories. That geological clock matters when we place Siwalik apes such as *Sivapithecus* in a landscape that was itself rising.
- **Thermochronology:** Even when the "age" is not an occupation date, the thermal path of a basin or a tool-stone source is anthropological context.

Limitation

Tracks fade if the mineral is heated above a closure temperature. Mixed ages and partial annealing need specialist interpretation. Fission-track dates should be cross-checked with stratigraphy and, where possible, with another radiometric method.

Flow diagram

Uranium-238 fission -> Tracks in mineral

Tracks in mineral -> Age from density plus Uranium-238 fission content

Age from density plus U content -> Volcanic layers with fossils

Age from density plus U content -> Himalayan cooling / Siwaliks

Conclusion

Fission tracks count uranium fission damage in zircon, apatite or volcanic glass. Anthropology uses them for volcanic layers, heated stone and landscape history. Heat can reset the clock, so the date is never a slogan.

Facts & figures

Fission-track dating

A radiometric method based on counting etched tracks from spontaneous fission of uranium-238 in a mineral or glass.

Fleischer, Price and Walker

The scientists most closely associated with developing fission-track dating as a usable geochronological method.

Apatite and zircon

Common minerals for fission-track work. They also record cooling history because tracks anneal above a closure temperature.

Tephra dating

Volcanic ash layers associated with fossils or tools can be dated by fission tracks when suitable glass or mineral grains are present.

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