Archaeology & Paleoanthropology:
How we learn about the past

1

What is Archaeology?

A body of methods designed to understand the human past through the examination and study of its material remains.

2

Who are archaeologists?

- Classical archaeologists
- Art Historians
- Ancient Historians
- Battlefield Archaeologists
- Industrial Archaeologists
- Underwater/Shipwreck Archaeologists
- Historical Archaeologists
- Anthropological Archaeologists

3

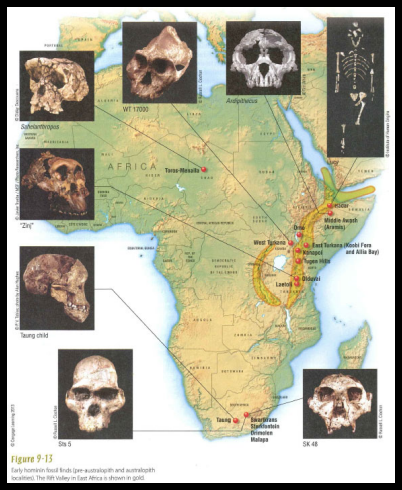
Anthropological archaeology… refers to the application of archaeological methods to the understanding of the origins and diversity of modern humans" *in all times and places*.

4

Goals of archaeology

1. Reconstruction of past events through time & space

   The “when” & “where” questions



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Goals of archaeology

2. Reconstruction of past human lifeways

   Similar to writing an ethnography about past cultural groups

   E.g., How were these pottery vessels constructed?

   What were they used for?

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Goals of archaeology

3. Explain how & why the past happened

Associated with the "New Archaeology" or "Processual Archaeology" of the 1960s-1980s

Processual archaeologists took a much more explicitly scientific approach, e.g., methods, hypotheses, comparison…

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Goals of archaeology

4. Interpreting cognitive & symbolic aspects of past societies.

Archaeologists are also interested in questions of identity, religion, politics, gender, diaspora, landscape, art, culture contact, etc.

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Goals of archaeology

5. How is archaeology relevant to the public, to descendent communities, to local communities, to taxpayers?

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How do archaeologists accomplish their goals?

1. Subjects of anthropological archaeology are societies, cultures, & people
2. What are the objects of archaeology? (material culture)
3. What is material culture?
4. How do we locate, retrieve, and study material culture?
5. How do we translate between material culture and past events and societies?

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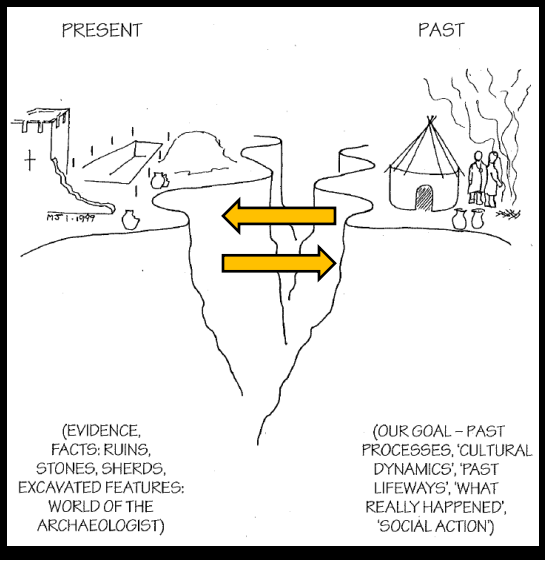
Our Problem: The gulf between (dynamic) past and (static) present



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The *scientific* archaeologist's starting point

One key assumption:

"many human activities and their by-products tend to enter the archaeological record in patterned, knowable ways that reflect the behaviors, values, and beliefs of the individuals who created them."

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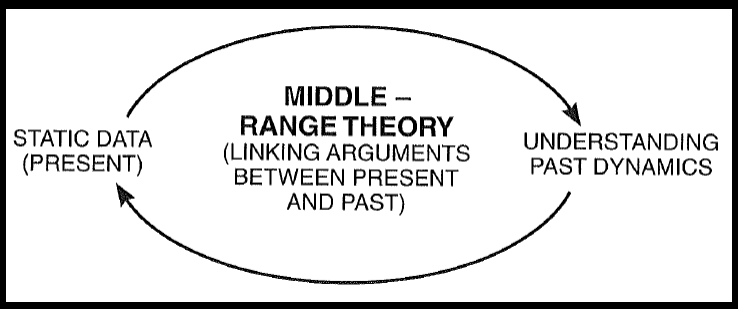
Present statics, past dynamics, & middle-range theory



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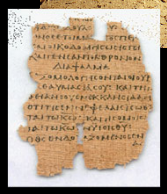
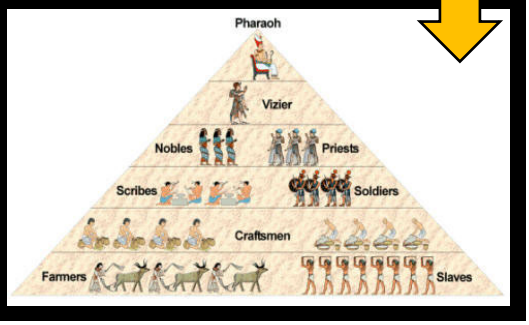
Step 1



Object: Material Culture

Step 2

Middle Range Theory



Step 3

Subject: Society & Culture

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Starting point: Static material record

Preserved Laeotoli footprints
(Tanzania, 3.7-3.5 mya)

+

“Lucy” skeleton of *Australopithecus aferensis* (Ethiopia, 3.9-3.0 mya)

15

Starting point: Static material record

Preserved Laeotoli footprints
(Tanzania, 3.7-3.5 mya)

+

“Lucy” skeleton of *Australopithecus aferensis* (Ethiopia, 3.9-3.0 mya)

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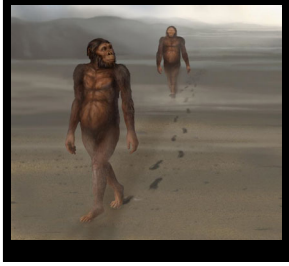

A bipedal early hominin

Result: Knowledge of dynamic behavior!

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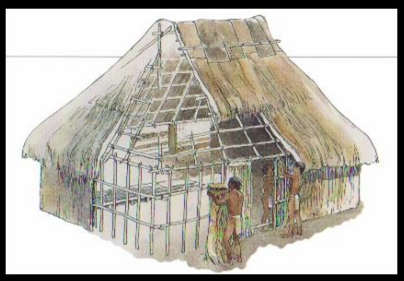
What are the objects of archaeology?

Material culture: the physical manifestation of human activities, such as tools, art, and structures



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Archaeological evidence: Types of Material Culture

- Fossils: Traces or remnants of organisms found in geological beds on the earth's surface (preserved in rock). Fossils can be mineralized bones, plant parts, impressions of soft body parts, or tracks.

fossilized Hominin skull from Dmanisi, nation-state of Georgia

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Archaeological evidence: Types of Material Culture

- Artifacts: Tangible objects or materials made or modified by hominins (humans).

Old artifacts

More recent artifacts

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Archaeological evidence: Types of Material Culture

- Ecofacts: "Natural" materials that give environmental information about an archaeological site.

mollusk shells

wood charcoal

plant pollen from cores

Sometimes ecofacts can be artifacts too.

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Archaeological evidence: Types of Material Culture

- Features: Products of human activity that cannot be removed from the ground as a single discrete entity.

pit

stone-lined well

decayed wooden post remains

earthen mounds, barrows, pyramids, ditches, roads, etc.

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Archaeological evidence: Types of Material Culture

- Sites: Locations of past human activity, determined through associated fossils, artifacts, ecofacts, and features.

the Stonehenge landscape

small hunting camp, a “campfire”

current & future site of Philadelphia…

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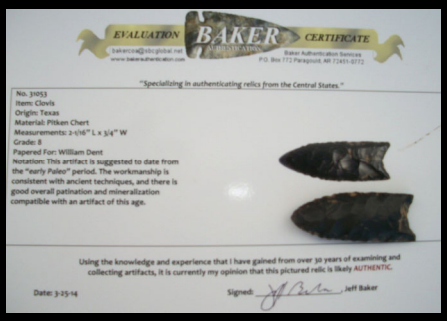
Archaeological evidence

- Context: the spatial and temporal associations of fossils, artifacts, ecofacts, and features in an archaeological site

Clovis projectile point *in situ*



Clovis projectile point on Ebay

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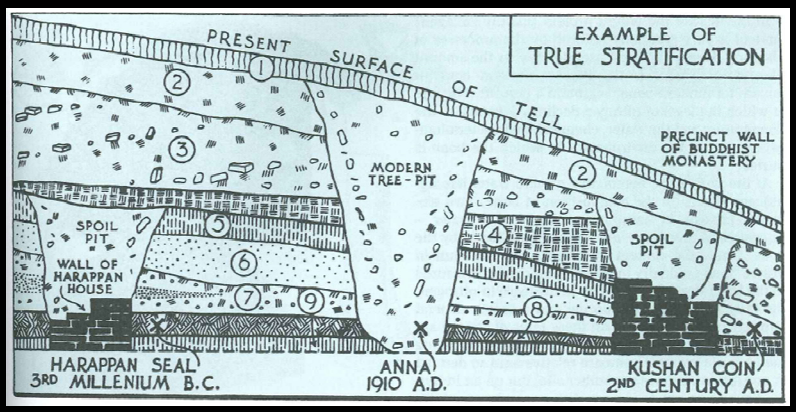
Archaeological evidence

- Stratigraphy: study of the sequential layering of deposits



Mortimer Wheeler's excavations into mound/tell in Pakistan

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Archaeological evidence: Relative Dating

- Principle of Superposition: principle from geology that states that lower layers were deposited before upper layers – i.e., bottom layers are older than top layers
- Relative Dating: ability to establish the relative order of events, but does not scale the amount of time that separates them
- Cross-Dating: relative dating method that estimates the age of artifacts/features/strata based on their similarities with comparable materials from dated contexts elsewhere

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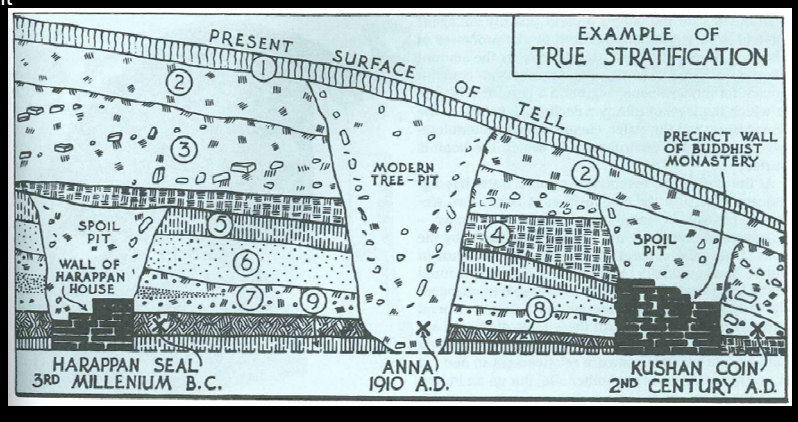
Archaeological evidence: Relative Dating

Present



Past

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Archaeological evidence: Relative Dating

- Biostratigraphy (faunal correlation): relative dating method based on known evolutionary changes that occurred in particular groups of animals, or the presence or absence of particular species. Technique used to date geologic strata where fossils are recovered.
  - E.g., employed at Olduvai and other African sites, using known morphological changes for fossil pigs, elephants, antelopes, rodents, carnivores.
  - Requires that these other fossil species have been dated using chronometric methods (e.g., potassium-argon dating) locally or in a nearby region

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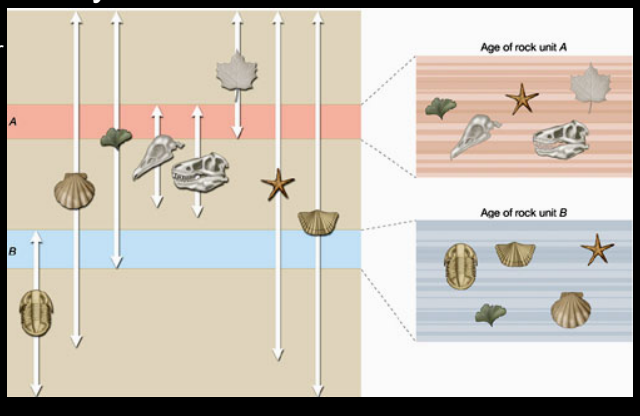
Archaeological evidence: Relative Dating

- Index Fossils: fossil remains of known age, used to estimate the age of the geological stratum in which they are found.

younger



older

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Archaeological evidence: Absolute Dating

- Chronometric (Absolute) Dating: determination of an estimated absolute age of a fossil/artifact/ecofact on a specific time-scale, as in years before present (B.P.) or according to a fixed calendrical system (B.C.-A.D.)

Years "BP" in radiocarbon dating = the # of years an organism died counting back from AD 1950

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Archaeological evidence: Absolute Dating

- Methods use natural processes as 'clocks'.
- Mostly based on measuring a form of radiation (e.g., radiometric dating)
  - Measure radioactive decay OR
  - Measure accumulation of radiation
- Result: an age estimate that can be converted to actual calendar years

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Chronometric Dating Techniques

LJ&K 2013

Table 8-1 Summary of Dating Methods Described in This Chapter

Method	Basis	Limitations	Comments
Relative dating methods establish the relative order of events			
Stratigraphy	Principle of superpositioning of strata	Most robust relative dating method	Geological strata and archaeological strata are created by different processes and must be interpreted separately
Biostratigraphy	Estimates of consistent modifications in evolving lineages of animals; presence/absence of species	Requires very well-documented sequences and somewhere must be correlated with chronometric results (e.g., with K/Ar)	Best estimates in East Africa using pigs, monkeys, antelopes, and rodents; has been important dating method in South Africa
Cross-dating	Shared similarities of material remains found in an undated context with remains from a context of known age	Weak when used by itself; best applied in conjunction with other dating methods	Widely applied in archaeological research, the logic of cross-dating is similar to that of biostratigraphy
Seriation	Orders artifacts from different sites or contexts into series based on presence/absence or frequencies of shared attributes	There's no way to know which end of a seriated sequence of artifacts is the oldest unless it is determined by stratigraphic or chronometric methods	Gradually being replaced in archaeological research by a quantitative method called correspondence analysis, which achieves the same end
Chronometric methods give absolute measures of age, often scaled in calendar years			
Potassium-argon (K/Ar)	Regular radioactive decay of potassium isotope	Can be used only on sediments that have been superheated (usually volcanic deposits)	Used to date materials in the 1- to 5-million-year range, especially in East Africa
Argon-argon ($^{40}Ar/^{39}Ar$)	Works similar to potassium-argon technique	Same as above	Often used to check the validity and reliability of potassium-argon results
Fission-track dating	Regular fission of uranium atoms, leaving microscopic tracks	Usually derived from volcanic deposits; estimates generally less accurate than for K/Ar	Very important corroboratory method in East Africa
Paleomagnetism	Regular shifts in earth's geomagnetic pole; evidence preserved in magnetically charged sediments	Requires precise excavation techniques; both major and minor reversals occur and can easily confuse interpretation	Important corroboratory method in East and South Africa
Radiocarbon dating	Measures the $^{14}C/^{12}C$ ratio in samples of organic materials	Applications limited to roughly the past 50,000 years	Most widely used chronometric dating method
Thermoluminescence (TL)	Measures the accumulated radiation dose since the last heating or sunlight exposure of an object	Yields the estimated age of the *last* heating event	Widely used for dating ceramics, hearths, and other artifacts and features that were subjected to extremes of heat
Electron spin resonance (ESR)	Measurement (counting) of accumulated trapped electrons	Age estimates can be biased by tooth enamel uptake of uranium; best applied in conjunction with other dating methods	Widely applied in paleoanthropology to date fossil tooth enamel
Uranium series dating	Radioactive decay of short-lived uranium isotopes	Can yield high-precision age estimates; main limitation is the potential range of datable materials	Used to date limestone formations (e.g., stalagmites) and ancient ostrich eggshells
Dendrochronology	Tree-ring dating	Direct archaeological applications limited to temperate regions for which a master chart exists for tree species that were used by humans in the past	Although very important for archaeological dating in some parts of the world (e.g., the American Southwest), its greatest general application is to calibrate radiocarbon age estimates, which greatly enhances their accuracy and precision

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Two commonly used chronometric dating techniques

Method	Basis	Limitations	Comments
Potassium-argon (K/Ar)	Regular radioactive decay of potassium isotope	Can be used only on sediments that have been superheated (usually volcanic deposits)	Used to date materials in the 1- to 5- million-year range, especially in East Africa
Radiocarbon dating	Measures the 14C/12C ratio in samples of organic materials	Applications limited to roughly the past 50,000 years	Most widely used chronometric dating method

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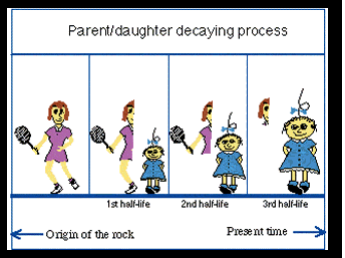
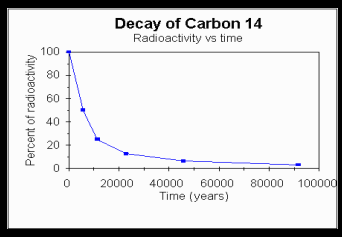
Isotopic (radiometric) methods

- 1896: radioactivity discovered
- Radioactive 'parent' isotopes decay into 'daughter' isotopes
- Average rate of decay is constant and predictable
- Expressed as half-life: time for half the original to decay
- Compare amounts of original & decay isotopes, consider half-life, & estimate how long decay has been occurring





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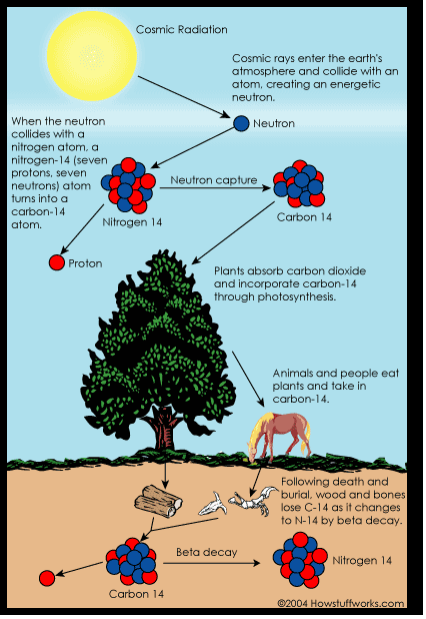
Carbon 14 Radiocarbon dating

- ^{14}C decays to ^{14}N, while ^{12}C stays stable
- Measure ratio ^{14}C to ^{12}C
- Half-life is ~5,730 years
- Up to 50,000 yrs BP
- Only useful to date Neandertals, early modern humans, and recent archaeological materials



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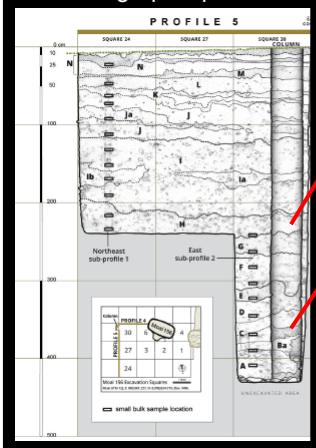
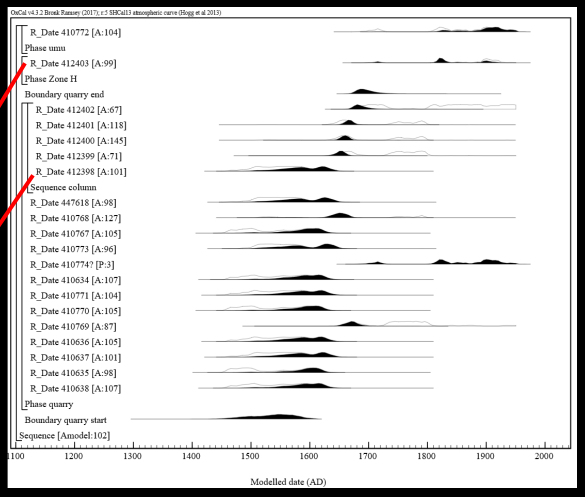
Carbon 14 Radiocarbon dating

Stratigraphic profile





Dating burnt tree branch twigs & sweet potato fragments

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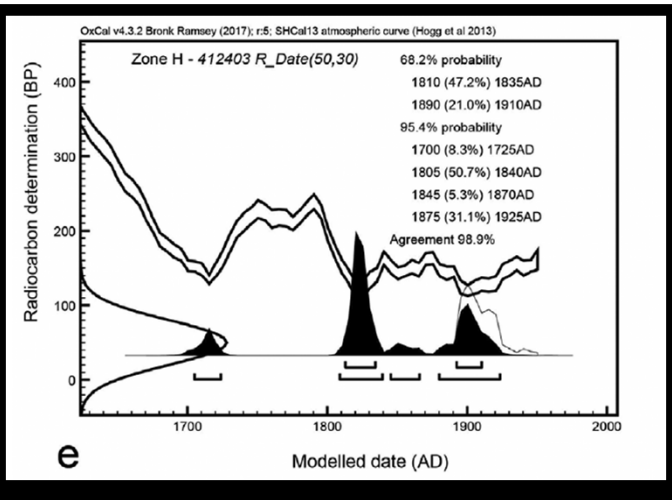
(Variables: C13/C12 = -26.2 o/oo : lab. mult = 1)

Laboratory number **Beta-412403**

Conventional radiocarbon age **50 ± 30 BP**



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Archaeological Evidence: How do we locate & then study it?

Archaeological survey: A systematic search of the landscape for artifacts and sites on the ground

- Aerial photography
- Satellite & Google Earth
- Geophysical (Remote Sensing)
- Field-walking & Sub-surface probing

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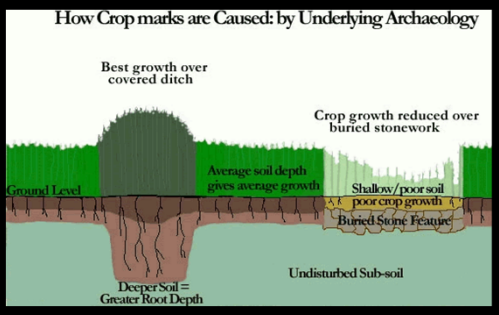
Surveying

Aerial photography



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Surveying

Field-walking: the search for artifacts that have been plowed up to the surface

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Surveying

Subsurface probing (shovel-test probes): the search for artifacts that are beneath the ground surface

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Magnetometry

Ground-Penetrating Radar

Surveying

Geophysical (Remote Sensing): Suite of techniques used to detect buried archaeological features by measuring variability within soil conditions and composition, both horizontally and vertically

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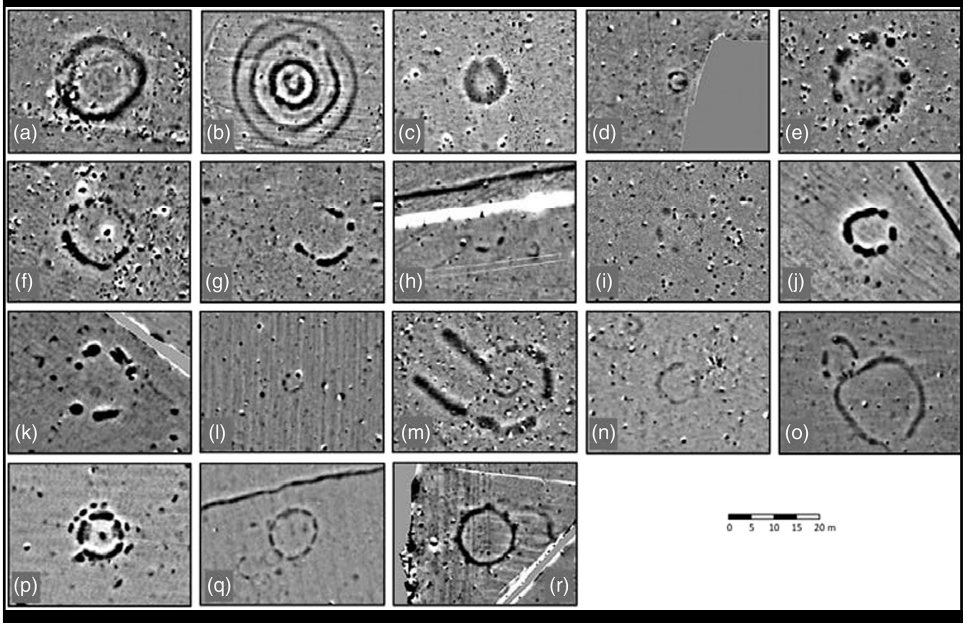
Magnetometry results from the recent "Stonehenge Hidden Landscapes Project"



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Archaeological Evidence: How do we locate & then study it?

Excavation: digging to expose and record buried materials within sites

- Excavation at different scales:
  - Small test pits
  - Deep vertical excavations (to reveal deeply stratified deposits/layers)
  - Broad-scale horizontal excavations (to reveal horizontal spatial patterns)
- Excavation is inherently destructive (you can't put it back after you dig!!)

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Excavation

Vertical exposures: studying the stratigraphy of sites

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Archaeologists “control” their excavations to record the context (location) of artifacts, features, etc.

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Excavation

Horizontal exposures: Uncovering an entire building, a village, or large expanses of a site

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screening through wire mesh

water flotation to recover small organic materials, e.g., seeds and plant remains

Excavation

Artifact, Ecofact, and samples recovery

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Archaeological Evidence: How do we locate & then study it?

Laboratory analyses: The examination of recovered artifacts, ecofacts, and fossils in the lab

- Many kinds of analyses, e.g.:
  - Ceramics, lithics/stone, etc.
  - Zooarchaeological (animal bones), ethnobotanical (plant remains)
  - Geo-archaeological (soil science & stratigraphy)
  - Geo-chemical (residues, proteins, starches, alkaloids, etc.)
  - Bio-archaeology & human osteology
  - Forensics
  - Chronometric (absolute dating)
  - Spatial (GIS – Geographic Information Systems)
  - Etc.

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