HIS6E01 -PRINCIPLES AND METHODS OF ARCHAEOLOGY

MODULE-4-Excavation and Dating Techniques

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Excavation

- The method of archaeological explorations that help the archaeologists to find out the material remains from the surface.
- Based on the field surveys, they will proceed with the trial pits in order to understand the potential of the site.
- Consequently, the archaeologist will start extensive excavation in that area.
- Excavation is the most systematic and scientific method to retrieve the buried object of the past societies.

- The excavations are mainly yielding the evidences of two main information on the human past societies; (1) human activities at a particular period in the past and (2) changes in those activities from period to period.
- Very broadly, we can say that contemporary activities take place horizontally in space; whereas the changes in those activities occur vertically through time.
- It means in an archaeological excavation pit the horizontal space always represent the contemporary period and the material evidences collected from the horizontal spaces belongs to a particular period.
- However, after the excavation when we observe all these horizontal evidences vertically we can see the changes occurred in different period.

Excavation of mounds

- The archaeological mounds are the locations that show significant traces of human activity, essentially where artifacts, features and eco-facts are found together.
- It is a site where the continuous human occupations occurred in the past.
- Two methods are using for the excavation of an archaeological site or mount; **vertical and horizontal digging**.

- **Vertical Excavation**
- Vertical excavation reveals the total stratigraphy of the site.
- The sediment layers cut perpendicularly and removed the soil in reverse order.
- Therefore, vertical digging discloses the entire cultural deposit of a site.
- Vertical excavation often starts from the present surface, which is known as surface humus layer, and ends at the natural layer, a sediment layer without human interaction.

- **Horizontal excavation**
- If the vertical digging exposed the cultural deposits of the past up and down, the horizontal excavation aims to expose the deposits horizontally.
- It reveals the extension of the site while presenting a stratigraphic record in the baulk left between pits.
- Mortimer Wheeler is one of the chief opponents of this excavation by using grid method

Open-Area excavation

- This type of excavation **aims to expose a large area of the archaeological site without maintaining baulk.**
- **Philip Barker** is the chief advocate of this method.
- This may **help the archaeologist to realize the total cultural deposit of a site.**

Grid excavation

- **Mortimer wheeler** has developed the grid system, which is also known as **Box-Grid System,** of excavation to **obtain information both horizontally and vertically**.
- He developed the grid system of systematic digging whereby **the field was divided into small squares.**
- **Each square clearly separated by a narrow baulk that was never excavated**.
- This method permitted an area to be excavated yet preserved a vertical cross-section that revealed the strata of the site as the trench was dug.
- Wheeler's box-grid system has been used universally in modern archaeology and although less popular in Europe it is still the most simple method to ensure a systematic approach.

Quartering

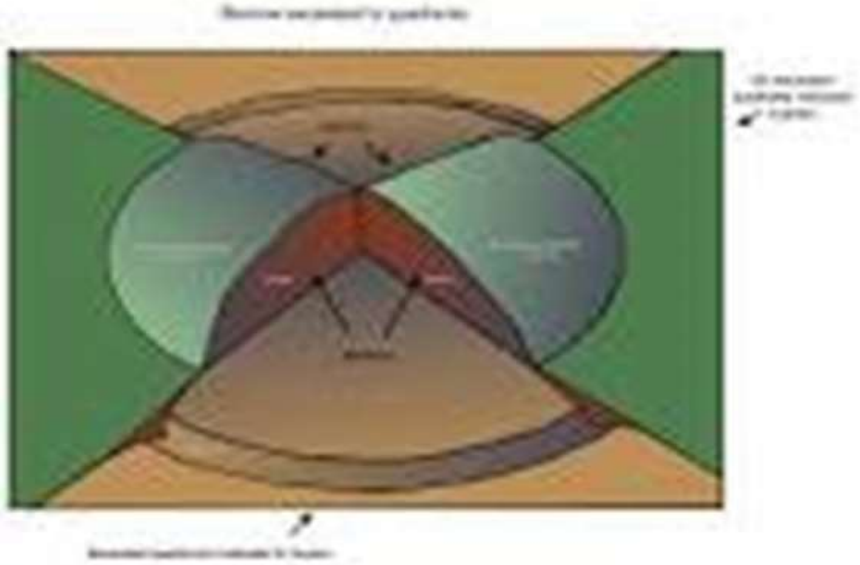
- This is an excavation technique involving **cutting archaeological sites in to four quadrants to obtain maximum vertical and horizontal information**.
- It is generally **applied to the excavation of small mounds.**

Excavation of burials (Quadrant Method)

- Burial excavation leads us to understand various aspects of the human life in the past centuries include ritual practices, believes, ancestral belief and belief on life after death.
- The skeletal remains helps to identify the racial affinities, family groups, age, sex, nutrition, palaeodemography, palaeo-diseases and other cultural information.
- Megaliths are the most important burials of Kerala and South India that have archaeological importance.

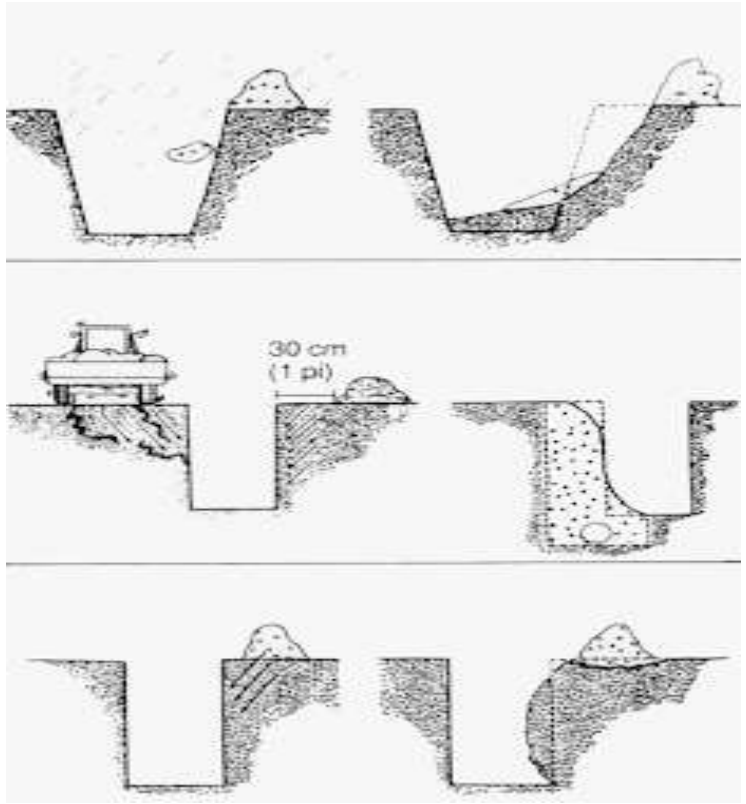
- There are different types of megalithic burials like Umbrella stone, Cap stone, cist, dolmen, rock-cut sepulchers, stone circle, urns, sarcophagus etc.
- Quadrant method of is **normally used for the burial excavation**.
- Quadrant method **involves dividing the mound or burial into four segments and each quadrant removed very systematically**.
- After removing the soil of one quadrant, the archaeologist tries to understand the actual position of the burial and then proceed with the removal of remaining three quadrants. Even depth must be maintained in the entire quadrant.

- For instance, if one tries to excavate an urn burial he/she has to remove the four quadrants until the capstone is identified and then proceed with removal of one or two quadrant simultaneously.
- Once the burial is exposed the entire burial goods have to be documented in situ(on site).
- The documentation includes, drawing or illustration, photographs, mapping etc.
- The samples, especially bones or fossils, charcoal, pottery etc have to be scientifically collected.
- After the completion all documentation the burial goods will send to the museum



Trench excavation

- Trench is used to **refer to small or sample excavation as opposed to open area excavation.**
- Even a large area excavation is only a sample of archaeological landscape and so is really a large trench.
- Trial trenches or trial pits or sondages are also the sampling excavation of the sites.
- They are often small square trenches (1m x 1m) in order to recognize the archaeological potentials of the site.


30 cm
(1 pi)

Sieving

- Sieving is the most important part of excavations.
- This method, **also known as screening or sifting, used to recover quantifiable data from excavations.**
- The cultural materials meticulously recover through sieving and record its context properly.
- Prior to the New Archaeology of the 1960s, sieving was not widely practiced and usually was restricted to the use of coarse mesh sieves for the recovery of small artifacts such as coins and beads.
- However, presently the archaeologists collect and document all artifacts, whether it is small or big, from the archaeological sites.

Stripping

- Stripping is **not often advisable in archaeological excavation.**
- **It involves the removal of top soil accumulations.**
- It is often carried out after a series of excavations that had taken place in various parts of the site.
- The **removal, as efficiently as possible, of all above the surface those considered archaeologically not significant**.
- For instance, in an urban context, this may involves removing the remains of recently demolished concrete building.
- This method is employed in contract archaeological work when the time factor is short.

Stratigraphy and Law of superposition

- Stratigraphy is the **analysis and interpretation of depositional layers or strata in excavated area.**
- In archaeology, stratigraphy **involves a careful consideration of the characteristics of individual soil layers in order to understand how these layers relate to one another**.
- As we learned in the previous chapter, there are geological strata and archaeological strata.

- The relation between the top most humus layer and natural layer in archaeological site explains the continuity or rupture, and changes occurred in the site during the past.
- **Edward Harris strongly advocates that archaeological stratigraphy differ from geological stratigraphy**.
- There are **certain basic laws and notions that are followed in identifying the archaeological stratigraphy**.
- They are **Law of Superimposition, Original Horizontality, Original Continuity and Stratigraphical Succession**.

- The **Law of Superposition is of first importance in the interpretation of the stratification**.
- It **assumes that the strata and features are found in a position similar to that of their original deposition**.
- **“In a series of layers and interfacial features, as originally created, the upper units of stratification are younger and the lower are older, for each must have been deposited on, or created by the removal of, a pre-existing mass of archaeological stratification”.**

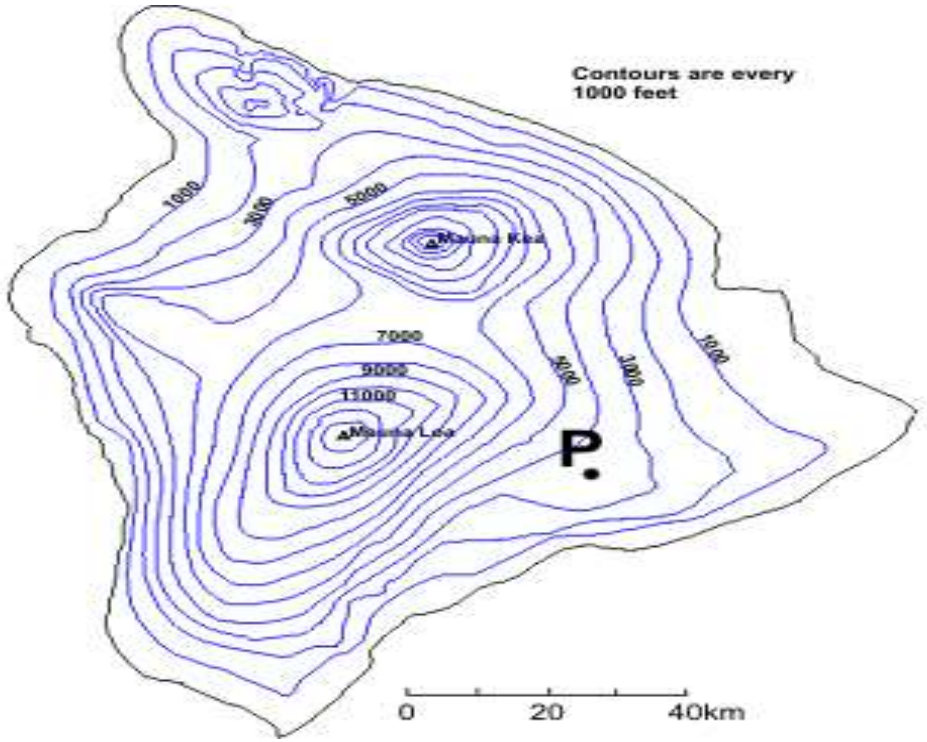
- The Law of Superposition is a **statement about the depositional order between any two strata.**
- Since it **only relates to any two units of stratification, it can make no declaration about the detailed position of strata in the stratigraphic sequence of a site.**
- The law is **simply a statement about the physical relationships of superimposed deposits, i.e. one lies on top of or underneath another, and is therefore later or earlier.**
- By recording super positional relationships, the archaeologist amasses a body of data, which **will be of assistance in determining the stratigraphic sequence of the site.**

Mapping of sites

- Map is one of the important tools in archaeological exploration and excavation.
- It includes **topographic map, site map, aerial map, contour map** etc.
- **Topographic map depicts the topographical data in combination with representation of archaeological features.**
- **Topographic map helps an archaeologist to observe the landforms through which he/she may able to locate an archaeological mound before and during the exploration and excavation.**
- The **contour map represents the elevation or undulation of the landscape**.
- The Satellite maps, Google earth maps etc are also widely using nowadays to locate and document the archaeological site.

TOPOGRAPHIC MAP

CONTOUR MAP


Contours are every
1000 feet
1000
3000
5000
7000
9000
11000
13000
1000
300
100
P.
0
20
40km

Excavation reports

- Excavation report is the **final product of the excavation**.
- It is generally **divided into many parts representing the evidence in a meaningful way and placed in logical sequence.**
- The **first part deals with the discovery of the site, proper identification of the site, previous researches including salvage operations, exploration and excavations, stratigraphical record of the site, and a detailed description of the site**.

- The **second part contains a detailed report of trenches (excavated pits) with description of archaeological layers, material remains and an analysis of the trench supervisor.**
- It **mentions the location of the trench and its relation to other trenches if any in the same site, topographical features of the site, the measurement of the trench (eg. 4m x4m), and GPS position of the trench and the ownership of the land where the trench is laid out.**
- The report contains the report of all trenches laid out in the site. (For instance, seven trenches were laid out at Pattanam in 2007.Then in the second part of the report of Pattanam Excavation 2007, a detailed report of seven trenches will be included).

- The **third part contains a detailed catalogue of artifacts.**
- It includes the list of artifacts and eco-facts collected from the site.
- The numbers of features if any noticed in the site may also recorded in this part.
- This may be placed as appendixes to the report as well.
- The **last part of the report carries the result of the samples collected during the time of excavation from various experts**.
- It includes the result of carbon dating, thermoluminescence, dendrochronology or such other dating if any.
- The **last part also gives a comprehensive conclusion of the excavation.**

Interpretation of archaeological data

- Excavated sites represent the cultural sequence of a region from ancient to present.
- Therefore, the **interpretation of an archaeological data is crucial part in any excavation project.**
- The interpretation archaeologist actually **gives meaning to the site.**
- The archaeological interpretation of a site is **based on the site stratigraphy, cultural materials include artifacts, features, and eco-facts, result of the expert reports, previous research etc.**
- **various theories include, cultural context, cultural evolution, ethno archaeology, New archaeology, post processual archaeology, cognitive archaeology etc. are also using for the interpretation of archaeological data**.

Preservation and conservation of archaeological sites and materials

- Any buried artifact would have reached a chemical and physical equilibrium with its environment.
- It remains relatively stable in that environment.
- After burial in the earth, they have to adapt a new environment through certain modification to establish equilibrium with its microenvironment.
- The artifacts will again have to adapt to the new environment when it is excavated.
- This process causes the breakdown of the object either physically or chemically or biologically or combination of all these factors.
- **Archaeologist must follow certain procedures for the care of archaeological materials; Cleaning, Repair and Stabilization**.

- **Cleaning means the careful removal of dirt to facilitate examination, recording and conservation of the artifacts**.
- **Repair means securing the original position of the objects.**
- **Stabilization means to strengthen the specimens in all means to reduce or arrest its further deterioration**.
- There are **different methods applying for the conservation of organic and inorganic materials.**
- **Organic materials like bone, wood, leather, ivory are best kept under the conditions in which they are found.**
- If the microenvironment is dry, wet, or humid, the object must be kept in the same microenvironment.
- **Various chemical applications are practicing for the preservation of inorganic materials like potteries, stone, metals etc**.

Archaeological museums

- **An archaeological museum is an institution that preserves a collection of artifacts and other objects of artistic, cultural, historical, or scientific importance.**
- The **goal of museum is to serving the material remains to the researchers also make available to public to get an idea about their cultural heritage.**
- The earliest necessity to house objects of antiquarian remains dates back to late **1796 AD when the Asiatic Society of Bengal felt the need to house the enormous collection of archaeological, ethnological, geological, zoological pursuits.**
- However, the **first museum by them was started in 1814**.
- The nucleus of this Asiatic Society Museum later provided to the **Indian Museum, Calcutta.**

- In Archaeological Survey of India also, due to the various explorative investigations that was initiated since the times of its **first Director General, Alexander Cunningham, vast quantity of antiquarian remains were collected.**
- The **creation of site museums had to wait until the arrival of Sir John Marshall, who initiated the founding of the local museums like Sarnath (1904), Agra (1906), Ajmer (1908), Delhi Fort (1909), Bijapur (1912), Nalanda (1917) and Sanchi (1919).**
- **National Museum Delhi, Salar Jung Museum Hyderabad, Madras Museum, Trissur Sakthan Museum, Pazhassi Raja museum Kozhikkode, Ambalavayal museum Waynad etc have a good collection of archaeological materials.**

Dating Methods- Absolute and relative dating techniques

- Archaeologists have **used many methods to find out the date of artifacts collected from the archaeological sites.**
- They are mainly **classified into three;**
- 1. **Relative Dating Methods** that **identify the order in which sites or artifacts were used in a sequence from earliest to latest.** It include **historical dating, typology, sequence dating series, geological timescales, varve, pollen analysis, stratigraphy, Geochronology etc**

- 2. **Absolute Dating (Chronometric)** that **try to establish an extract or approximate calendar date for a site or artifacts.** It includes **Radio-carbon dating, Potassium- argon method, Uranium series method, Thermoluminescence, Electron spin resource (ESR), Dendrochronolgy etc**
- Along with these two broad categories there is another technique named **derivative dating method** that includes **Fluorine test, Uranium test, Nitrogen test, Amino acid test, Obsidian hydration dating, Archaeomagnetic dating, Cation-ratio dating (CR) etc.**

Dendrochronology

- **A.E Douglass** has developed this method in the **first half of 20th century**.
- This is the **most accurate chronometric dating method**.
- It is an approach **based on counting the annual growth rings observable in the cross-sections of cut trees.**
- Every year trees produce a visible ring of new wood under their bark.
- Early in the annual growing season trees produce thin walled ‘early wood cells.
- Towards the end of the year thick walled ‘late wood’ cells are produced. This cycle produces a visible ‘ring’ in the wood each year.

- The **rings are wider in good weather conditions** than in poor ones and can provide a record of local climate variation.
- Trees in the same area will have similar ring patterns, which mean wood from different periods can be matched in overlapping sequences.
- These are tied to historical dates by modern trees.
- _Scientists have prepared a sort of calendar based on tree ring samples for the last three thousand years.
- By comparing a sample with these calendars or charts, the archaeologist can estimate the age of that sample.


1980
1970
1960
1950

Radio Carbon Dating

- This is one of the **most important methods of dating organic materials collected from the archaeological sites, which contain some carbon in them**.
- **Willard F. Libby discovered this method in 1946**.
- This method is **more reliable one for the dating of the pre-historic material remains**.**-bone & charcol**

- **All living things absorb several types of carbon isotope from the atmosphere in similar ratios until death.**
- **About one percentage of these carbons is an unstable isotope known as C14 (Carbon 14), which decays at a known rate.**

- **By comparing the weight of remaining C14 with amounts of other carbon isotope in organic sample it is possible to work out how much C14 has decayed.**
- **These indicate how long it has been since decay began (and the creature and plant was alive).**

- **This method is based on the presence of radio-active carbon of atomic weight 14 in organic matter.**
- **Cosmic radiation produces in the upper atmosphere of the earth Neutron particles, some of which hit the atoms of ordinary Nitrogen.**
- **This is captured by the nucleus of the nitrogen atom, which gives off a proton and thus changing to Carbon14**

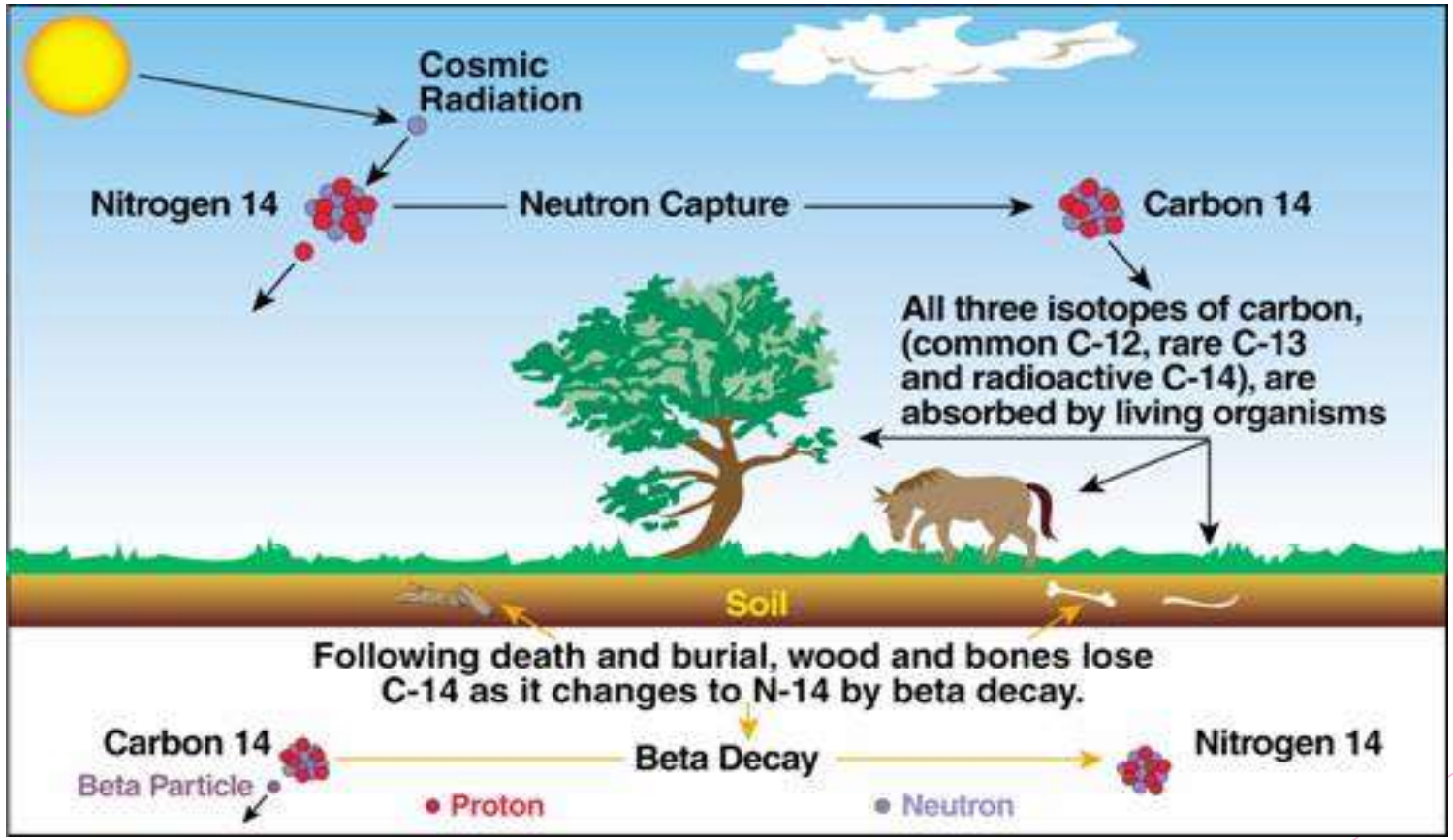
- This Carbon-14 in turn is radio-active and by losing an electron reverts to nitrogen.
- This creation of new carbon atoms and then reverting to nitrogen has achieved a state of equilibrium in the long duration of the earth’s existence.

- C-14 along with the carbondioxide enter the living organisms in the process of photosynthesis, and all the radiocarbon atoms that disintegrate in living things are replaced by the C-14 entering the food chain.

- Thus the process of radio carbon present in the living organism is same as in the atmosphere.
- It is further assumed that all living animals derive body material from the plant kingdom, and also exhibit the same proportion of C-14 material.

- Therefore as soon as the organism dies no further radiocarbon is added. At that time the radioactive disintegration takes over in an uncompensated manner.
- The C-14 has a half-life of about 5730 years, i.e. only half the C-14 will remain after the half-life period. In the disintegration process the Carbon-14 returns to nitrogen emitting a beta particle in the process.

- The quantity of the C-14 remaining is measured by counting the beta radiation emitted per minute per gram of material.
- Modern C-14 emits about 15 counts per minute per gram, whereas Carbon-14 which is 5700 years old, emits about 7.5 counts per minute per gram.


Cosmic Radiation
Nitrogen 14
Neutron Capture
Carbon 14
All three isotopes of carbon, (common C-12, rare C-13 and radioactive C-14), are absorbed by living organisms
Soil
Following death and burial, wood and bones lose C-14 as it changes to N-14 by beta decay.
Carbon 14
Beta Particle
Beta Decay
Nitrogen 14
Proton
Neutron

Luminescence dating

- **Farrington Daniels** has developed a method known as Thermoluminiscence measurements **for dating the ancient pottery in 1953.**
- This method is **useful to all terracotta materials like pottery, tiles, bricks and all other terracotta objects**.
- Thermoluminescence is the **release in the form of light of stored energy from a substance when it is heated.**

- **All ceramic material contains certain amounts of radioactive impurities (uranium, thorium, potassium).**
- **Radioactive decay in the quartz crystal found in clay leads to a buildup of electric charge at a known rate.**
- **The electrical charge is released as light when the crystals are heated.**
- **When the ceramic is heated the radioactive energy present in the clay until then is lost, and fresh energy acquired gradually depending on the time of its existence.**

- The thermoluminescence observed is a **measure of the total dose of radiation to which the ceramic has been exposed since the last previous heating, i.e. in the kiln.**
- **For calculating dates, the sample is heated up to 500'C and thermoluminiscence observed as a flame is measured with very sensitive instruments.**
- The **glow emitted is directly proportional to the radiation it received multiplied by the years**.
- However, it is **significantly less accurate than C-14 dating and can give false readings due to radiation from the soil or if the initial firing at low temperature**.
- It is **useful for older periods and instances where there are no organic remains such as dating pre-historic times**.

Electro spin resonance dating

- This method is **useful to date the bone and calcite material remains discovered from the archaeological site.**
- It has developed by **Ikeya and Miki in 1980**.
- Electro spin Resonance (ESR) **measures radiation- induced defects or the density of trapped electrons in bone and calcite remains**.
- The **tooth enamel particularly with the thick enamel layers is the best material for ESR studies**.
- **On counting on the amount of electrons trapped in the bone, the date is determined**.

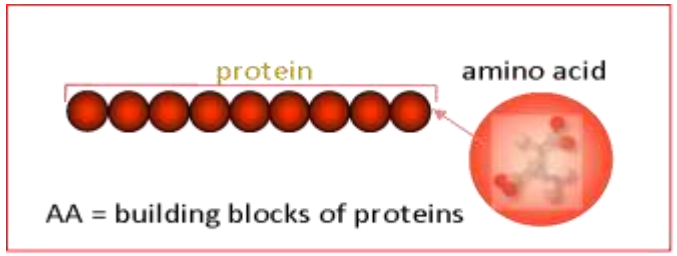
Fission track

- **Fleischer, Price and Walker** has jointly developed this method.
- It **is known that many minerals and natural glasses (obsidian, tektites) contain very small quantities of uranium**.
- **Through time, the uranium undergoes a slow spontaneous process of decay**.
- The natural splitting (fission) of Uranium-238 atoms present in obsidian (volcanic lava) and other glassy volcanic minerals, leaves traces called fission tracks.

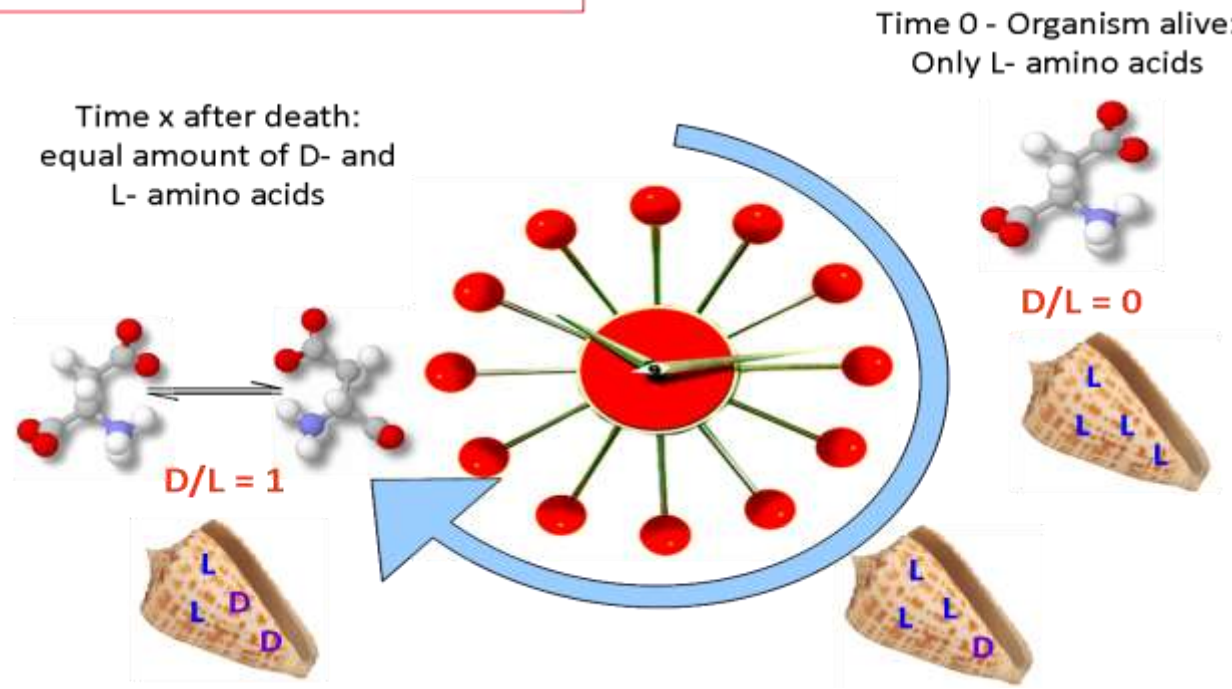
- **This method of dating depends upon the measurements of detectable damage called tracks in the structure of glasses caused by the fission.**
- **These tracks disappear when the glass is heated above a critical temperature and fresh tracks formed in course of time.**
- The **fresh tracks are counted to date the sample**.
- This method is **suitable for dating objects which have undergone heating process some 100,000-1,000,000 years ago**.

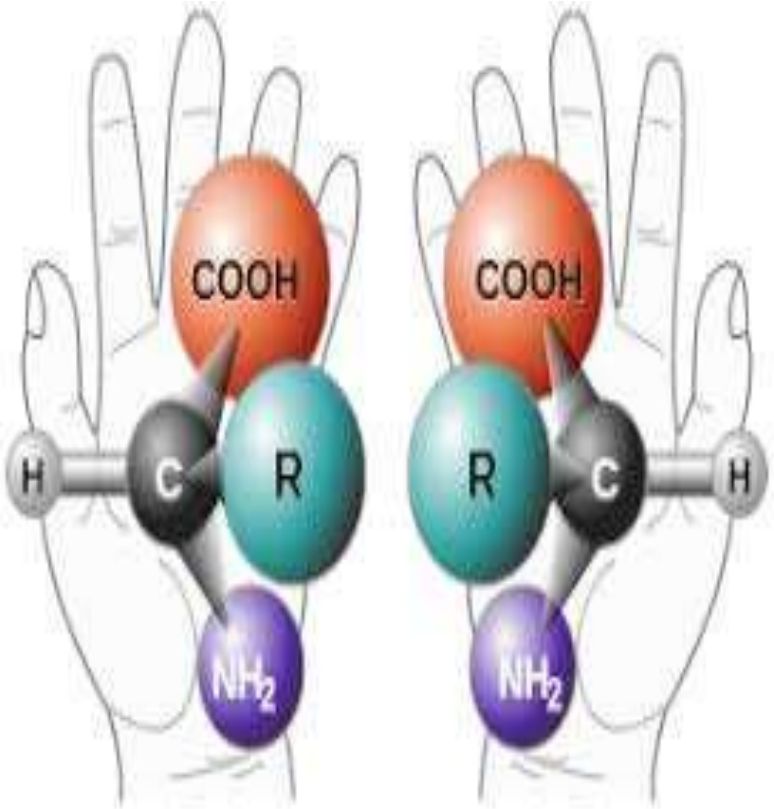
Amino acid racemization

- Amino acid method **is useful to find out the age of bone.**
- **Jeffrey L. Bada** has developed this method.
- This method **depends on cumulative changes in amino acids in bone after the creature has died.**
- Among the above 20 kinds amino acid present in the modern bone, only 1 kind of amino acid (Aspartic acid) exist in two mirror-image forms.
- **As long as the organism is alive, the amino acid molecules are in left-handed form (or L-isomer form) but at death, they began to change to distinct right handed form (D-isomers). This process of change called Recemization.**
- If one knows the recemization rate, one could be able to calculate the date of the bone.



AMINO ACID RACEMISATION DATING (AAR)




COOH
H
C
R
NH2
COOH
R
C
H
NH2

Obsidian (glass) hydration

- **Irving Friedman and Robert Smith**, two geologists, began looking into **obsidian's potential as a time marker in 1948** and **introduced the obsidian hydration dating method to the archaeological community in 1960.**
- Obsidian hydration dating is a **geochemical method of determining age in either absolute or relative terms of an artifact made of obsidian.**
- **Obsidian is a volcanic glass that was used by prehistoric people as a raw material in the manufacture of stone tools such as projectile points, knives, or other cutting tools through knapping, or breaking off pieces in a controlled manner**.

- The **surface of many geological materials undergoes chemical changes through time**.
- These weathering reactions create a visibly distinct surface layer or patina.
- When **obsidian artifacts are buried, they start absorbing water and form a layer called hydration layer.**
- The **thickness of the layer depends on how long the article has been buried; the surrounding temperature condition, long term change in the soil humidity and the petrographic nature of the sample**.
- The sample is **dated by measuring the thickness of the hydration layer**.

Fluorine dating method

- Fluoride (or fluorine) dating is a **relative dating method that can be used to date archaeological bone.**
- As a relative dating method, it can **determine the relative age of specimens, but cannot provide a calendrical date unless the fluoride chronology is calibrated with an absolute dating method.**
- Bones are primarily composed of the mineral calcium hydroxy apatite. When exposed to water that contains fluoride, a fluoride ion (F-) can replace a hydroxyl ion (OH-) in the bone mineral.
- The resulting fluorapatite is more stable than the original form, thus the fluoride content of a bone will increase over time if it is exposed to a solution containing fluoride ions.
- Fluoride ions are present in trace amounts in most soils and ground waters.
- Over time, buried bones pick up fluoride ions from soil moisture or exposure to groundwater.
- Older specimens have higher fluoride contents than younger ones when burial conditions are identical.
- The requirement of identical burial conditions means that fluoride dating works best when it is applied within a single site with little variation in soil chemistry.

Uranium dating and Uranium series dating

- Uranium dating is a radiometric dating method. It is useful to date ancient rocks.
- Uranium series dating is a radiometric dating technique commonly used to determine the age of calcium carbonate materials such as speleothem or coral.
- These methods are based on the radioactive decay of isotopes of uranium.
- The process whereby a radioactive isotope of uranium 238U+ decays into 235U+ is calculated.
- The date is determined based on the amount of 235U+ that had accumulated through radioactive decay.

Nitrogen dating

- This derivative dating method is **useful to date bone remains from the archaeological sites.**
- Bone basically consist of calcium phosphate, fat and bone protein or collagen.
- **On death, fats gradually disappear. The collagen survives much longer though it decays at a uniform rate**.
- These can be measured by a nitrogen assay.
- The rate of decay depends on physical, chemical and other factors of the soil. Therefore, it is not universal.
- However, bone of different dates in a single deposit can be distinguished based on nitrogen content.

Varve Analysis

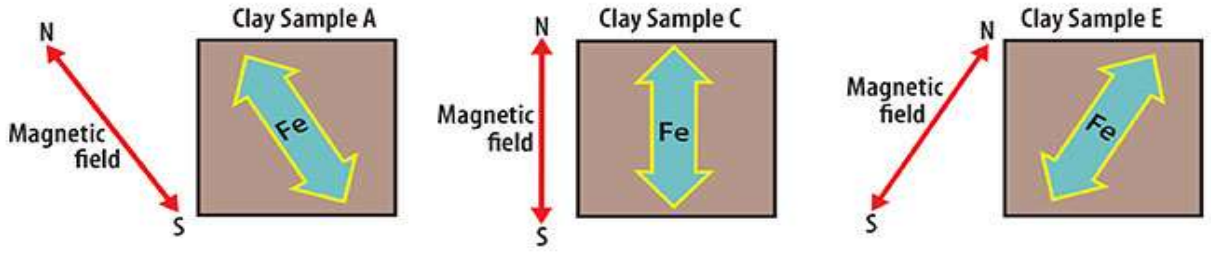
- **De Geer and Antevs** are developed the Varve dating method.
- The **annual deposit of sediment in the lake bed in called varves, which can be counted**.
- They **note a regular alteration between the coarser silts deposited by glacial melt water in the summer, and fine clays deposited as suspended particles settled during the winter months when the lake was covered with ice.**
- The recurring pattern of coarse and fine sediments could be read as a yearly record of glacial discharge.
- Geologist established a dated sequence of varve by moving back in time from recent layer of known age.
- The thickness of the varve pairs varies from year to year, depending upon the amount of glacial melting.
- This also serves as a sequential landmark. Some of the ancient shorelines were established through this system.
- Considerable deposits of varves were found in Scandinavia, representing thousands of years, stretching from the present back to the begging of the retreat of the glacial ice sheets in Scandinavia some 13,000 years ago.

Seriation

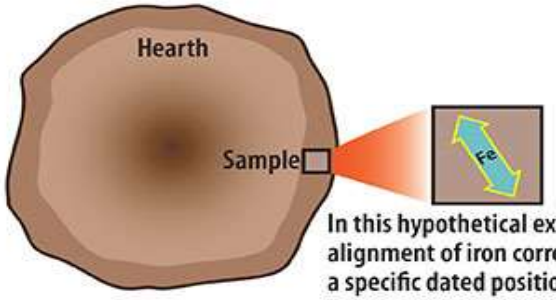
- This is a **method of determining the age of the artifacts based on style type and technique.**
- It is broadly **divided in to two categories; Stylistic seriation and Frequency seriation.**
- The **first one refers to a technique through which artifacts and attributes are ordered according to similarity in style**.
- For example **dish on stand, S-shaped jar and perforated jar are some of the diagnostic styles available in Harappan style**.
- This will **help the archaeologist to determine the cultural phases**.
- The **second one is more strictly oriented to chronological ordering of the artifacts and assessing the origin, popularity and disuse of the artifacts**.
- The **length of time and degree of popularity would be assessed in the given archaeological context**.
- For example, **Painted Gray Ware, Northern Black Polished Ware, Black and Red Ware are noticed in a particular time range only**.

Archaeo-magnetic dating

- This method is **based on the fact that the earth's magnetic field varies through time**.
- It is **based on the constant change, both in direction and intensity, of the earth's magnetic field.**
- The **location of magnetic north pole changes its position both horizontally as well as vertically**.
- The **direction of that magnetic field at a particular time is recorded in any baked clay structure like oven, kiln, hearth etc that has been heated to a temperature of 650° to 700° C.**
- **At that temperature, the iron particles in the clay permanently take up the earth's magnetic direction and intensity at the time firing.**
- This **helps to date the newly discovered fired clay samples directly by using the archaeomagnetic data**.



An archaeomagnetic sample collected from the clay lining of an ancient hearth is compared with the archaeomagnectic reference curve to determine the date of the last hot fire in the hearth.



In this hypothetical example, the alignment of iron corresponds to a specific dated position on the reference curve: