HIS6E01-PRINCIPLES AND METHODS OF ARCHAEOLOGY
MODULE-4 DATING TECHNIQUES IN ARCHAEOLOGY

Prepared by

Priyanka.E.K

Dept of History

Little Flower College

Guruvayoor

RADIO-CARBON DATING

- Devised in USA by Willard F. Libby in 1948
- It is a radio active heavy isotope of carbon is present in the earths upper atmosphere
- C-14 atoms combine with oxygen to form carbon-dioxide & become mixed in the earths atmosphere & enter into all living organisms like plants & animals
- All living organisms absorb C-14(radio active carbon) & C-12(ordinary carbon) in a constant proportion till the moment of death, after which the radio carbon already absorbed starts decaying at a rate determined only by the half life of the isotope
- C-14 reduced to half in 5568 +30 yrs
- It is possible to determine the age of an organic sample by ascertaining the specific C-14 activity in the sample

- Amount of C-14 remaining in the dead organic matter as indicated by its radio-activity is proportional to the time that elapsed since death
- Dating of the ancient organic sample results from the measurement of its C-14 content & calculation of its age from the amount of disintegration that has occurred since death
- Dating is possible on the basis of the present day C-14 content of living matter & the known half-life of C-14
- “the laboratory procedure consists of burning the sample, reducing it to pure carbon & measuring the radio activity in a specially constructed radiation counter

- Materials suitable for this examination- wood, charcoal, charred bone, textile piece, leather, hair, skin, antler, tusk, shell, dung charred grains
- Samples should be collected in a moisture free jars or aluminum or plastic foils, labeled & kept with the necessary field data like the name of site, strata etc
- Had defects also
- Assumption that the rate of production of C-14 has been uniform through out the past is now challenged
- Possibilities of error in sampling or calibration of the counter or countering error

- In order to correct this error- the final count is expressed by the plus or minus figure appended to a C-14 date
- Recent advances made in evolving correction methods to eliminate contamination
- Number of centers in USA & UK- with laboratory facilities for C14 analysis- used by archaeologists
- In India- Tata Institute of Fundamental Research, Bombay, The Birbal Sahni Institute of Pala-Botany, Lucknow, Physical Science Laboratory Ahmadabad

- Harold Barker- “one must accept the fact that the method is not able to resolve age differences of less than several hundred years & is therefore more useful in fixing the board outlines of a chronology rather than a fine detail”
- Another writer- :the method has given the first universal means of absolute dating quite independent of archaeological methods”

THERMOLUMINESCENCE DATING

- Helpful in dating the ancient clay objects Like pottery, ceramics, bricks etc
- Clay contain crystalline constituents & also traces of radio active materials , the decay of which leads to the accumulation of energy at a constant rate with in the materials
- This accumulated energy is released as a flash of light when the clay material is heated to a very high temperature- this phenomenon is called Thermolumiescence
- Amount of light thus emitted is measured by sensitive photo electric equipment

- When pottery is made & fired, the accumulated radiation in the clay is released as thermoluminiscence
- It involves the measurement of the decay of the radio- active particles in baked clay by calculating the amount of damage to the crystal structure of the material
- If one takes a sample of pottery & measures the amount of thermoluminiscent light emitted on heating, it should be possible to relate this to the time that has elapsed since the pottery was originally fired
- certain practical difficulties in applying this method widely but attempts are being made to improve it for wider application
- Still in the experimental stage
- “once method is perfected it will give a valuable check on radio carbon dating for all periods of the past when pottery was in use”

ARCHAEO-MAGNETISM

- Developed for dating baked structure-kilns, hearths & burnt clay walls-if they remain in the original place
- Method is based on behavior of iron particles in the clay when it is in plastic state prior to its hardening during the process of finding or application of heat
- When a clay object is heated above a certain temeprature its magnetism is lost, but it is regained when it is cooled
- While regaining thus, the orientation & strength of the regained magnetism are determined by the earths magnetic field at the moment of their last cooling & hence called as archaeo or remnant magnetism
- Instrument for measuring the direction & strength of the remnant magnetism –Prof. Cook & Balsha-called magnometer

- Help the scientist to search the true magnetic north & discover n what century & almost in which year true magnetic north was pointing exactly in that direction
- They can arrive at the near date for the object
- Dates obtained by archaeo-maganetic methods are very encouraging & agree with the known dates of the objects tested
- Tested objects from Roman sites in England & the dates obtained tally well with known dates

POTASSIUM- ARGON DATING

- Resembles closely C14 method
- Earth crust contains potassium of which isotope K-40 decays to argon 40 at a known rate , its half life being 1300 million yrs
- Date of a sample determined by m-40 meausring both potassium
- Volcanic ash & basslt which have come out of eruption serve as a good samples - early Plseistocene period in he Olduvai George
- Useful for dating materials 23 to 26 million yrs old

FLOURINE DATING

- Fluorine present in the ground water is gradually absorbed by buried bones or teeth
- It replaces the hydroxyl(oxygen & hydrogen) content
- Greater the fluorine content of a bone, greater is its antiquity
- But the rate at which this absorption happens, depends on the fluorine in circulation, climate & similar factors & therefore this method may not be useful in comparing the bones of different areas of hydrological conditions
- It gives us relative age of bones of different geological ages

- Combination with uranium content test & radiocarbon test proved of great value notably in detecting the fake claim of the Piltdown man(unknown early human”) & also confirming the Acheulian age(tool of lower paleolithic) of the Swanscombe skull(England)

URANIUM DATING

- Present in ground water & is absorbed by mineral matter of bones & teeth
- Uranium content of bones –measured & relative age of bones determined- by method of radio metric assay- exposing a simple Geiger counter & counting the radiations per minute
- Helps us to distinguish b/w fossil bones & recently introduce bones in old gravels of sand

PHOSPHATE ANALYSIS

- Decay of animal & organic matter leaves a residue of phosphates
- Chemical analysis reveal their presence
- Used in study of cave deposits-to show human or animal occupation, settlement sites & burials
- Chemical analysis of ancient metallic objects give information about technological devpt of ancient civilizations
- Methods used in metal casting & fabrication can often be reduced through chemical analysis & metallographic examination of the object

- Physical methods of chemical analysis such as optical emission spectrometry, x-ray fluorsecence analysis, neutron activation analysis etc developed & yielded valuable data

NITROGEN / COLLAGEN DATING

- Bones consist of calcium phosphate, fat & bone protein or Collagen
- On death fats disappear gradually- collagen survives much longer-it decays at a uniform rate
- This can be measured by a nitrogen assay-rate of decay depends on physical, chemical & other factors – cannot be universal-but bones of different dates in single deposit can be distinguished on the basis of nitrogen content
- Useful for relative dating of bones of several ages
- Very valuable as a means of cross- checking the results of uranium & fluorine analysis of bones believed to be of the pleistocene age on open sites

DENDROCHRONOLOGY

- Tree-ring counting or dendrochronology
- Developed by A.E.Douglas-1929
- All trees form rings each year but they vary in thickness according to the climatic condition -permit comparison & correlation of ring patterns found on cut surfaces of recent & ancient trees
- Douglas showed how the variations could be used to date archaeological material
- Showed how in one restricted area in USA having the same climatic condition, he could build up a scale of ring pattern of timbers from the present back to pre-Colombian period

- Growth of rings demarcated in trees growing in areas which have regular seasonal climatic changes
- Wet springs & summers produce thick rings – dry winter produce thinner rings
- It has difficulties in Europe where seasonal variations are not so clear
- Another difficulty-in some trees the same rings vary in thickness in different parts of their circumference
- Extensively used in USA, England, Scandinavia
- Attempts made to co-relate the tree rings over long distances to link the climatic sequences of America, Europe & other continents
- Tree rings serve as indicators of oscillations
- Has been successfully adopted for dating pre-historic settlements in South West USA