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# RADIOCARBON DATING OF SOILS AND ENVIRONMENTAL RESEARCH

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The evolution of mankind took place during the Quaternary. Large oscillations of temperature forced pre-human and human beings to adapt to changing environmental conditions. There are close connections between environmental and the human being. Since ~10,000 B.P. human beings made themselves more independent by agriculture and stock farming.

Dating of soils, especially buried soils, is of geoscientific interest. It shows the influence of the human activity. Investigations, carried out in a brown coal open cast, provided insights into the Holocene. Radiocarbon dates and archaeological finds date the soil layers. The conclusions for environmental research should be : deforesting to gain new agricultural land leads to the destructions and coverage of already existing soils.

**Key Words : Soils; Radiocarbon Dating; Environment**

## INTRODUCTION

THERE are hardly two disciplines that appear more different from each other than archaeology and environmental research. Environmental research involves climate, weather, humidity, temperature, radiation, the magnetic field, soil, water, flora, fauna and pollution. Archaeology is the science of the development of mankind from the early beginnings up to the middle ages. The development of mankind from the animal state took place during the last period of the history of the earth, the Quaternary. Looking at the temperature curve from Tertiary to Quaternary one can see large oscillations of temperature at the end of the Tertiary and during the whole of Quaternary. The pre-human beings, along with other animals, were forced to adapt to the changing environmental conditions. Had the pre-human being and the early man not adapted they would never have survived.

Dnring the Quaternary a large area of the earth's surface was several times covered by ice. Between the glaciations the climate was more pleasant than in recent times, the temperature was higher. New kinds of animals and plants developed.

## INTERRELATIONSHIP BETWEEN ENVIRONMENT AND ARCHAEOLOGY

The course of the early history of mankind shows close connections between environment and the human being. Big changes of the relations between mankind

and the environment took place during the Holocene. Since *c.* 10,000 B.P. human beings made themselves more independent of nature by beginning agriculture and stockfarming. The early hunter of the Palaeolithic and mesolithic also used fire for hunting. A piece of forest was set on fire, the animals which tried to flee the fire were caught. While the closer environment was damaged, the landscape in general was not seriously affected. The slash and burn method used by neolithic tribes to gain cultivable land had a much larger influence on their environment. Large forests were transformed into arable land. This type of agriculture exhausts the soil very quickly, often in only two or three years, so that new arable land is needed. Thus, large stretches of land changed their envirnment. Today we know this is still happening in Burma, Vietnam, Borneo, Africa and Brazil.

But in what way does archaeology support environmental research ? It can show us possibilities for future development of the soil. The soil surface in riverside valley meadows was buried under the exhausted soil of upper arable land, so that thick layers of sand and loam, sometimes 2 to 5m deep, covered the former surface.

## Radiocarbon Dating of Soils

Dating of soils, especially of buried soils, is of general geoscientific interest because their formation depends upon climate, vegetation, environment and topography. An important influence is also the human activity.

There is general agreement[1] that radiocarbon dating of alkaline extracts of soils only yields apparent mean residence times.[2,3]

These are lower than the corresponding true ages which start with the beginning of humus formation. The best results have been obtained from the residue remaining after successive hydrolysis with 6 N HCL.[1,4] This residue may consist mainly of biologically inert humus. It should be remembered that "soil dating" is a questionable attempt to date only a small part of the total humic matter of a soil horizon and to interpret the result as representative of the whole sample.

The discrepancy between radiocarbon soil dates and true ages results from the complexity of soil genesis which is a continuous process of accumulation and decomposition of organic substances. Penetration of rootlets, bioturbation, activity of animals and other "biomass" (worms, bacteria) and percolation of soluble humic substances cause rejuvenation. The admixture of allochthonous plant residues may cause apparent ageing. As a result, the organic matter of soil is a mixture of an unknown number of compounds of unknown chemical composition, concentration and age.[3] Investigations, carried out in a brown coal open cast located in Central Germany, provided us with interesting insights into the Holocene riverside meadows. As much as 3m of loam was interspersed by a maximum of 3 buried soils. These buried soils contain archaeological finds

which date the soil layers. The soil covering loam is water proof and there is no danger of penetration of the soil itself by foreign humic acids.

This fact makes it possible to carry out radiocarbon dating of the buried soil layers in this special case. The archaeologic finds were located in the buried soil which divided a loamy layer into two parts. The sherda are not from only one period. The decoration elements show late to the latest Bronze Age styles; some sherds also belong to the early Iron Age. Thus it can be assumed that buried soil was the surface during the late Bronze Age and the early Iron Age.

A sample was taken from this buried and archaeologically dated soil. In a Soxhlet-apparatus the soil sample was treated with a hot 6 per cent hydrochloric solution for 8 hours, to remove calcareous impurities. After washing with distilled water a solution of 1 per cent sodium hydroxide was added. The dissolved humic acids were reprecipitated with conc. hydrochloric acid. Due to the small amount of carbon, less than 1 per cent, this procedure was not adequate. Also insufficient was an experiment to extract the humic acids with 5 per cent ammonium hydroxide solution in a Soxhlet.

This organic matter was bound very strongly to the inorganic minerals of the soil and only a very small amount could be extracted. Thus we assume that the humic acids were unable to move into other horizons and the organic matter of the investigated soil was autocthonous. The whole sample material was now put into our combustion line. In a stream of pure oxygen the organic component was oxidised to carbondioxide. The carbondioxide was synthesised to methane with the help of ruthenium catalyst and hydrogen. After purification methane was measured in our radicarbon measurment counters and the radiocarbon age estimated. For the upper buried soil (sample 05 from profile IV a) a radiocarbon age of 2940 $\pm$ 80 B.P. was measured. Considering that a soil age is always only an average age, it agrees very well with the archaeological dating. Sample 03 was dating in the same way, the radicarbon age was 5100 $\pm$ 60 years B.P. The covering loam of the three buried soils is connected to the three stages of Agricultural cultivation.

| Period | Sample No. | $^{14}C$ age B.P |
|---|---|---|
| Middle Age | 05/04 | 2940 $\pm$ 80, 3340 $\pm$ 60 |
| Bronze Age | 03 | 5100 $\pm$ 60 |
| Neolithic Age | 02 | 5680 $\pm$ 60 |

## Conclusion

This study shows large influence of expanding agriculture on the environment during the Neolithic period, the Bronze Age and the Middle Age. Erosion was widespread and the soil surface was buried with layers of loam that was few meters thick.

Our conclusion for environmental research and today should be : deforesting to gain new agriculture land leads to destruction and coverage of already existing soils. This underlines the demand for environmental preservation.

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