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RADIOCARBON DATING APPLIED TO THE STUDY OF THE TURNOVER OF SOIL ORGANIC MATTER

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This paper is not an exhaustive review of radiocarbon dating applied to soil organic matter studies. Its aim is to illustrate the usefulness of dating for a comprehensive knowledge of the evolution of organic matter in various soils.

Radiocarbon activities of soil organic matter can be interpreted in terms of mean ages (or mean residence times) only if one hypothesis on the age distribution is accepted. The ^{14}C involved by nuclear tests must be taken into account. The relationship between then mean age (1/b) and the radiocarbon activity is shown in fig. IV, in the case of compartments with an age density distribution of the type $q(t) = b \exp(-bt)$.

From three known characteristics of the compartment « soil organic matter », i.e. the total amount of organic carbon (Q), its radiocarbon activity and the flux of organic carbon entering the compartment (annual inputs = qo), it is shown that the decomposition rate of organic matter is very high at the beginning of decomposition and then decreases with time. This can be expressed by an age density distribution of the type $q(t) = qo\,(1 + t/a)^{-n}$. In this way, mean age and turnover time (mean transit time) were calculated for two meadow soils : mean ages were 1650 and 450 years, whereas respective turnover times were 32 and 50 years.

The vertical increase of apparent ^{14}C ages in a Hapludalf can be explained by the juxtaposition (fig. 5) of pool of stable organic matter (4800 years old) and a pool of young organic matter (75 years).

With examples taken from samplings in podzols and andosols, it can be shown that interactions with minerals cause variations of apparent ^{14}C ages. So, in a podzolic soil sequence, the cofloculation of amorphous alumina and fulvic acids around skeleton grains leads to the progressive induration of the B_h horizon and a subsequent depletion of the organic matter turnover rate : high apparent ages in indurated B_h (alios) suggest a fossilization of the organic matter.

In a (B) horizon of an andosol, the organic matter associated with glomerular halloysites was found to be the oldest organic fraction. This can be explained by the fact that its inclusion in the pores of halloysites prevents its degradation by soil microorganisms.

The ability of chemical extractions to separate young organic matter from old organic matter is also discussed.

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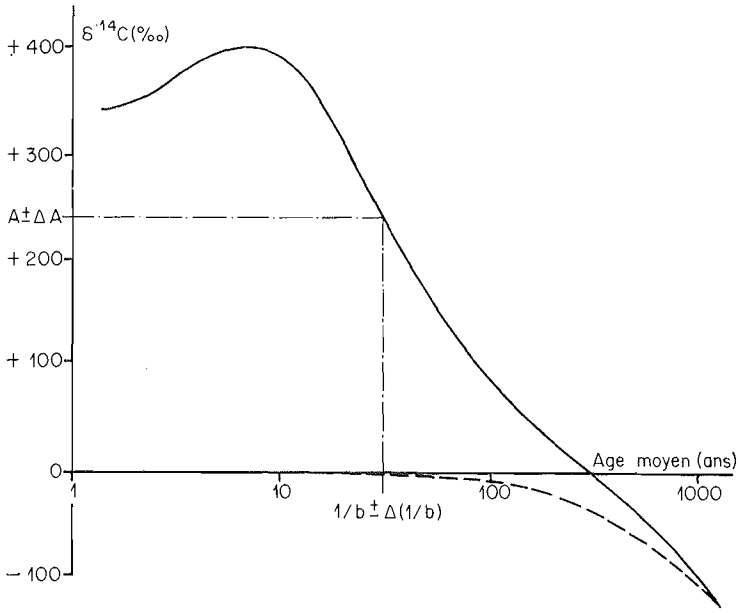

Figure 4 : Relationship between ^{14}C concentration and mean age of « well mixed » compartments (calculated for 1980, in the northern hemisphere). The dotted line represents relationship before nuclear tests.

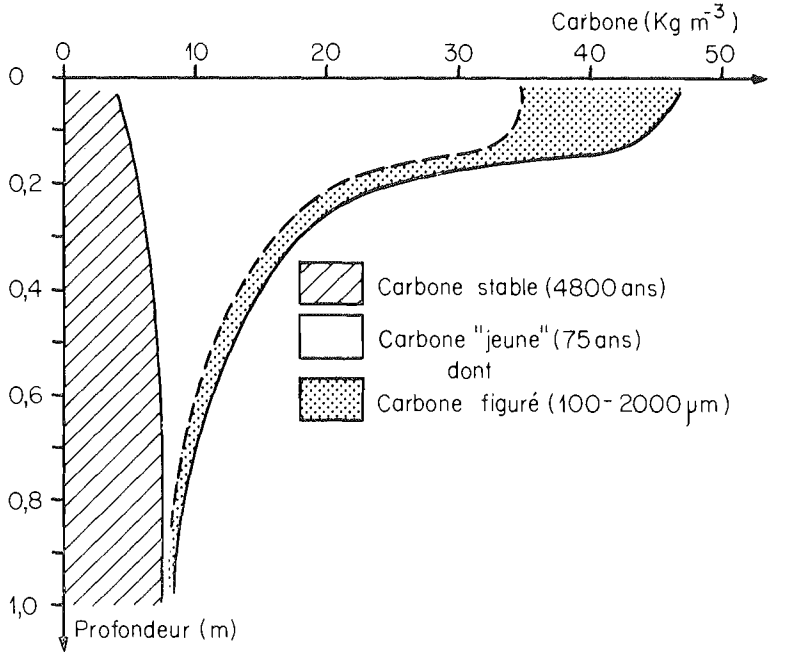

Figure 5 : The concentration profiles of stable organic matter and young organic matter in soil (hapludalf)