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OSL versus 14C dating of sandy pedosediments as paleo-ecological archives in cultural landscapes

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Late glacial aeolian coversand dominates the surface geology of an extensive area in Northwest Europe. During prehistoric and early historic time, forest grazing, wood cutting and shifting cultivation gradually transformed natural forest into heath land. Subsequently the use of the heath for the production of organic manure during the period of plaggen agriculture (from early Middle Ages to the invention of chemical fertilizers around 1900 AD) resulted in the comeback of active sand drifting. Locally the coversand landscape transformed into a driftsand landscape with characteristic new landforms and soils. Important parts of soil archives in these cultural landscapes are fimic covers, records of a long period of agricultural history and polycyclic driftsand deposits, records of alternating instable and stable phases in landscape development.

Based on pollen analysis of fimic covers and buried humic soil horizons in polycyclic driftsand sequences, a lot of paleoecological information is available to reconstruct the development of soils and landforms in cultural landscapes, but we need a correct chronological framework to correlate information of various sources and sites. Traditionally 14C dating was applied on humic horizons of buried soils and a 14C based chronological framework was designed to estimate the accumulation rate of fimic covers and to date stable and instable periods in polycyclic driftsand profiles.

However, 14C dates of extracted SOM (soil organic matter) are not always reliable. Firstly, in studies of fimic antrosols arose disagreement between paleoecological and historical interpretators of the evolution of these antrosols. The results of soil micromorphology and 14C dating, applied on separated SOM fractions (humine, humic acids and fulvic acids) showed that SOM, present in fimic horizons, consists of a complex mix of compounds of different ages and sources.

Secondly, 14C dates of buried humic soil horizons are not always reliable. In thin sections, the soil matrix of humic horizons of buried podzols seems to be undisturbed. But the results of pyrolysis / mass spectrometry point to change in chemical composition of SOM after burying, resulting in ‘rejuvenation’. Also another question, related to polycyclic driftsand deposits cannot be answered. Every cycle reflects a period of landscape instability (deposition) and landscape stability (soil development) but based on a 14C chronological framework it is impossible to separate time for active deposition and for soil formation.

Recently, the technique of OSL dating was introduced in geoscience. OSL dating is excellent for aeolian sandy deposits with a high percentage of quartz grains. OSL age is defined as the time after the last bleaching by solar radiation of mineral grains. Or in other words, the start of a stable period without sand drifting.

The results of OSL dating, applied on quartz grains, extracted from fimic horizons, show a time lag between the 14C dates of SOM and the OSL age of mineral grains. The paleoecological information (pollen grains are part of SOM) is not consequently correlated with the age of the mineral skeleton of the fimic horizon. An older soil organic matrix seems to be suspended in the voids of a younger mineral soil skeleton.

OSL dating, applied on quartz grains, extracted from drift sand deposits, provide a chronological correct framework to separate periods with active sand drifting and periods with soil development.

The introduction of an OSL based chronological framework improves knowledge of the development of soils and landforms in cultural landscapes. Paleoecological information, derived from element as fimic covers and polycyclic driftsand sequences, can be correlated.