Netherlands Centre for Luminescence dating

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Luminescence dating applications and research
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Netherlands Centre for Luminescence dating

The Netherlands Centre for Luminescnence dating was founded in 2003. The centre is a collaboration of the Universities of Utrecht, Amsterdam, Delft, Groningen, Utrecht, Wageningen, the Vrije Universiteit Amsterdam and TNO.

The main aims of the NCL are to make luminescence dating widely available to Netherlands research and to develop new and improved luminescence dating methods. The NCL received an equipment grant from NWO-ALW (834.03.003) to establish a dating lab at the Reactor Institute Delft of the TU Delft.

The NCL Symposium Series publishes abstracts of talks presented at the yearly NCL symposium. The NCL year report of the previous year is also published in the booklet.

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SYMPOSIUM NETHERLANDS CENTRE FOR LUMINESCENCE DATING

Date: **Friday September 23, 2005**
Theme: **Luminescence dating applications and research**
Venue: **TU Delft, Reactor Institute Delft**

PROGRAMME:

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Optical dating of individual quartz grains from young deposits

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Although optically stimulated luminescence (OSL) of individual grains is a relatively young discipline, a fairly large number of papers has already been published on the subject. The reason is that single grain (SG) techniques have a great potential for optical dating of materials from poorly-bleached deposits, in that equivalent doses (D_e) can be estimated for each grain separately by means of a sophisticated setup and a single-grain holder (Fig. 1). The most commonly used procedure for investigating individual grains is the Single Aliquot Regenerative dose protocol (SAR). This has been developed for multi-grain optical dating and proved to perform extremely well on a broad variety of sedimentary deposits. Within the SAR protocol, the test dose and the regenerative dose are conventionally chosen to be small and of the same size as the equivalent dose, respectively. However, these settings are impractical for measurements of relatively young sediments because the OSL response to small doses is dominated by noise.

Aim of this work is to optimize the existing SAR protocol for SG OSL on samples from young deposits (<300 years). The purpose is to increase the percentage of grains that can be accepted for equivalent dose analysis. The modified protocol is validated on several young well-bleached samples for which a tight independent age control is available. Critical issues like signal integration time, background subtraction and rejection criteria are discussed in detail. We show that D_e's obtained with the modified SAR protocol for SG are in good agreement with those determined with standard single aliquot methods and both agree with independent age control. We conclude that our modified protocol can be applied for optical dating of young quartz deposits. Results on an 8-year-old and on an insufficiently-bleached sample of <1 year age are also presented.

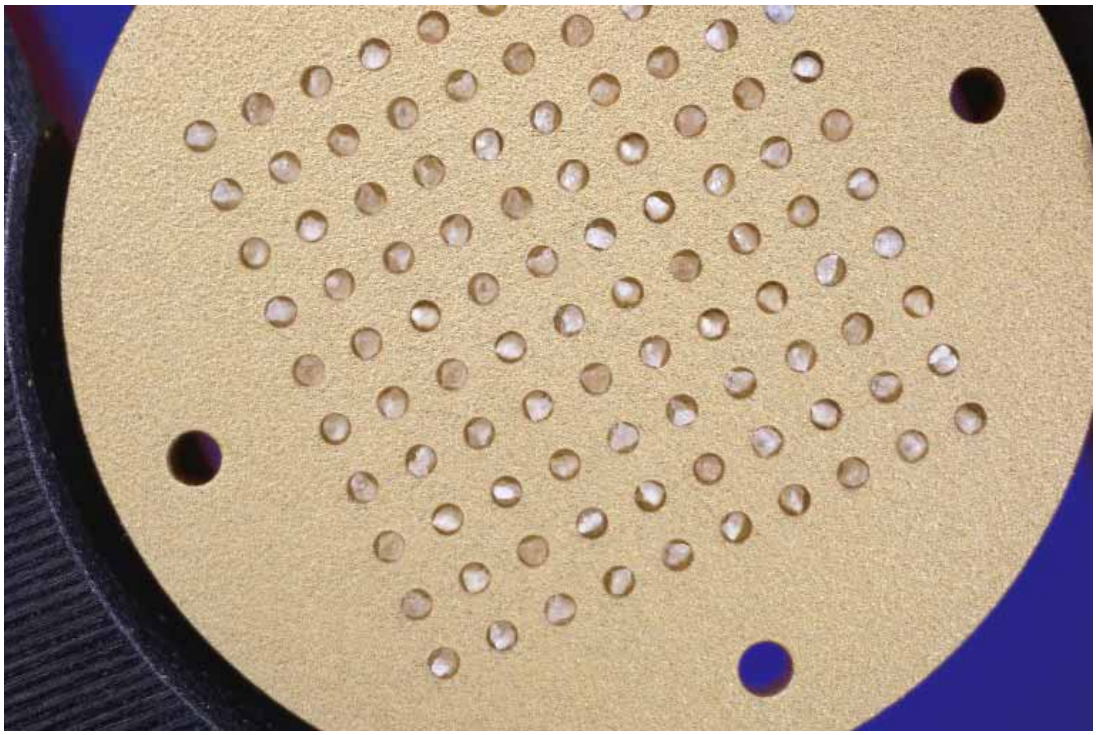

Fig. 1: *One hundred grains can be accommodated in a single-grain disk. The three large outer holes are used by the software for correct positioning.*

Multidisciplinary tracing of 120.000 years of environmental change and glacial forcing in the alluvial architecture of the Rhine-Meuse River system

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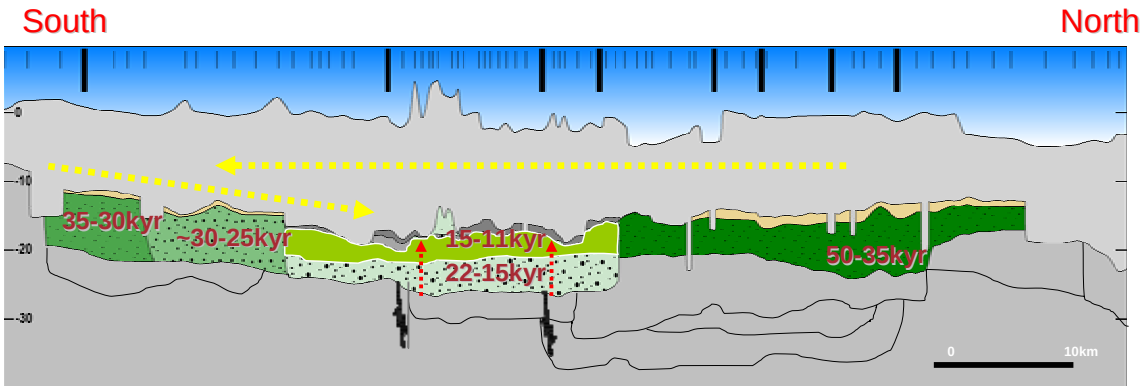
During the Late Pleistocene, over twenty meters of primarily fluvial coarse grained Rhine-Meuse sediments were deposited under slowly subsiding conditions (<0.1m/kyr) downstream of the North Sea Basin hinge line. The sequence has suffered considerably less from erosion than fluvial records in the uplifting terraced areas upstream, therefore providing a relative complete record of fluvial system change. New results are presented of multidisciplinary analyses of 12 high-resolution cores recovered from the central Netherlands and IJssel Valley regions. A large number of optical dates place the deposits in a well-constrained chronological framework.

The first indications of major environmental deterioration are indicated pollen-analytically in overbank fines in the IJssel Valley, most likely representing the MIS5e/5d transition. A severe change in sediment supply to this region occurs higher up in the profile, when deposition of (relatively) fine grained clastics and peat formation, is replaced by deposition of sands in a wide braid plain of the Rhine. The exact age of these sediments (and also correlating downstream sediments in Noord-Holland) is still unknown but might represent the cold phases of MIS5 (MIS5d/5b) or the onset of MIS4. New optical dates are being processed to answer this question.

Optical dates indicate that a large Rhine system is present in the central Netherlands from ~80-70ka onwards, giving a maximal age for abandonment of the IJssel Valley. We relate timing of this shift to the first of two main Weichselian glacial episodes (MIS4) and related forebulge effects. MIS4 and MIS2 environmental conditions strongly controlled sediment characteristics in the central Netherlands. Coarse grained and gravely sediments indicate high supply and high transport capacities under cold climate conditions. For the latest glacial episode (Late MIS3/MIS2), optical dating resolution allows us to refine the timing of deposition. It is shown that the coarse grained sediments of the so called lower terrace, were deposited in this area during the phase that coincides with widespread permafrost degradation and Alpine glacier melt, both estimated to have occurred *after* 20ka. Furthermore it was estimated that the Late MIS3/MIS2 glacial forebulge forced the Rhine southwards, probably also explaining the reason why the Montferland route became abandoned. The two glacial MIS4 and Late MIS3/MIS2 periods are separated by a generally more temperate phase (MIS3). Sediments from this period make up an important part of the overall sediment volume in the central Netherlands and they are typically much finer grained than MIS4 and MIS2 sediments.

Bed load sediment transport and possible spatial and temporal transport delays during sudden climate transitions is investigated using the three dimensional Channel-Hillslope-Intergrated-Landscape-Development model (CHILD). Initial results by using a combined sand-gravel transport formula indicate significant lag-times in registration of upstream generated sediment fluxes (e.g. in the German Schiefergebirge) and significant differences in response time between the Rhine and the Meuse.

Glacio-isostatic related channel belt shifts and incision trends of the Rhine-Meuse system between ~50-11 kyr



Exploring the methodology for the optical dating of Chinese loess

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The Chinese Loess Plateau (CLP) represents worldwide one of the most important terrestrial archives to study the Late Quaternary climatic changes. However, establishing an absolute chronology for loess sites remains difficult. Radiocarbon dating only covers a limited (~40 ka) time span and suitable organic material is invariably scarce. Luminescence dating may provide a better alternative; loess is ideally suited for luminescence dating since the aeolian transport prior to deposition helps to ensure complete resetting of any latent luminescence signal. Until recently, multiple-aliquot thermoluminescence (TL) or infrared stimulated luminescence (IRSL) techniques applied to polymineral fine-grained material were the main methods employed. These approaches are time consuming and significantly less precise than the more recently developed single-aliquot techniques.

We investigated the suitability of two single-aliquot regenerative-dose (SAR; Murray and Wintle, 2000) protocols: a single-aliquot regenerative dose (SAR) protocol with blue-light stimulation of 63-90µm quartz grains (SAR-OSL) and a SAR protocol with infrared stimulation of polymineral 4-11µm grains (SAR-IRSL). Both techniques are discussed in terms of dose response, reproducibility (recycling ratios) and their ability to recover a laboratory beta-dose prior to any heat treatment. Additionally, we performed anomalous fading measurements in the blue emission (410 nm emission), using the protocol suggested by Auclair et al. (2003).

We first applied the quartz SAR-OSL approach to three relatively young sites from the western part of the CLP (Tuxiangdao, Zhongjiacai and Le Du). In general, the SAR procedure appears to work well at these sites as indicated by the good results in the dose recovery test (measured to given dose ratio: 0.982±0.004; n=424). The high sampling resolution allowed us to identify a marked hiatus between ~20 and 30 ka at the Tuxiangdao site, which had not been detected before. At the Zhongjiacai site, we obtained a set of ages that are stratigraphically consistent up to ~75 ka but appear to be too young compared to the age model based on particle size variations (Vandenberghe et al., 1997) (Figure 1). Because of this, we decided to study this apparent discrepancy in more detail in the second part of our study. At the well-known Luochuan site, we sampled above, in and below the the Last Interglacial (so- called "S1 soil") to provide us with a more clear pedostratigraphic age control (~70 ka and ~130 ka).

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From our results it seems that the quartz SAR-OSL method underestimates the age of deposition for samples older than ~60-70 ka. The SAR-IRSL ages appear to be more consistent with the expected ages after they have been corrected for anomalous fading, using the correction method of Huntley and Lamothe (2001). A small age underestimation is still expected due to a limitation in the correction model.

We suggest restricting the use of the quartz SAR-OSL method to loess samples not exceeding ~40-50 ka (120-150 Gy). The SAR-IRSL protocol with fading correction (g_{2days} = ~3% per decade), seems to allow dating beyond the quartz OSL range, possibly over the entire last interglacial-glacial cycle.

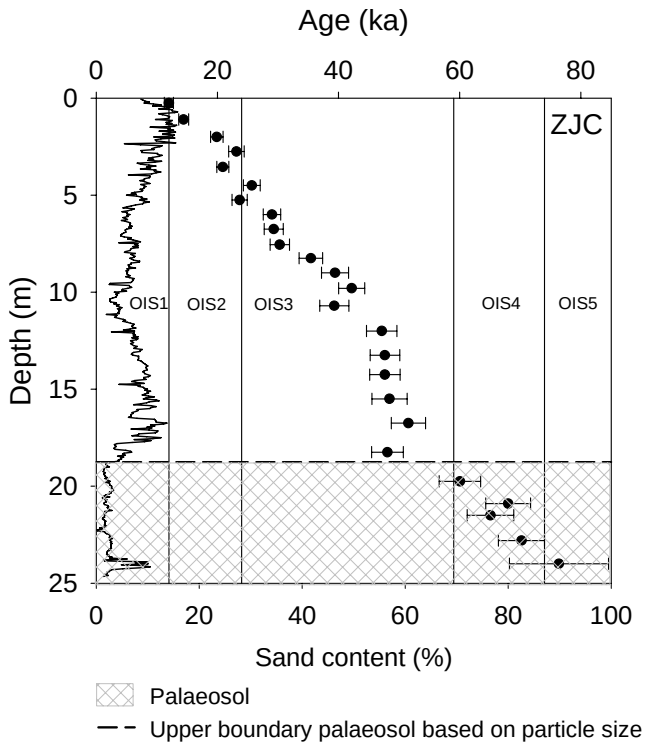

Fig. 1: *SAR-OSL ages and sand content (>63 µm) versus depth for the Zhongjiacai (ZJC) site. The palaeosol is expected to be the S1 soil (Last Interglacial soil) of the CLP. The vertical lines represent the OIS stage boundaries and are given as a reference.*

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IRSL dating of aeolian activity phases in South-West Sweden during the Holocene

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Introduction

This study has tried to reconstruct the coastal dune development in Haverdal nature reserve in the province of Halland, South-West Sweden during the Holocene. Several studies have shown optical dating is a good dating method for aeolian sediment. Several dune and beach ridges have been dated with infrared stimulated luminescence. Feldspars were the best possibility because the quartz grains had no fast component signal. During the study we defined the following research questions: 1) What were the aeolian activity phases in Haverdal during the Holocene? 2) Are these dune formation phases compatible with aeolian influx phases from a nearby peat core? 3) Are these aeolian activity phases local or regional events?

Results and interpretation

Sample behaviour

The feldspars reacted well to dose recovery and dose response tests. The tests for the preheat-plateau show the D_e to be independent of preheat temperature below 180 °C. Recuperation and recycling showed good results. The samples experienced a strong fading of the feldspar signal, approximately 9 percent per decade. The equivalent dose was corrected for anomalous fading. One young sample shows a slight dependency on the stimulation temperature.

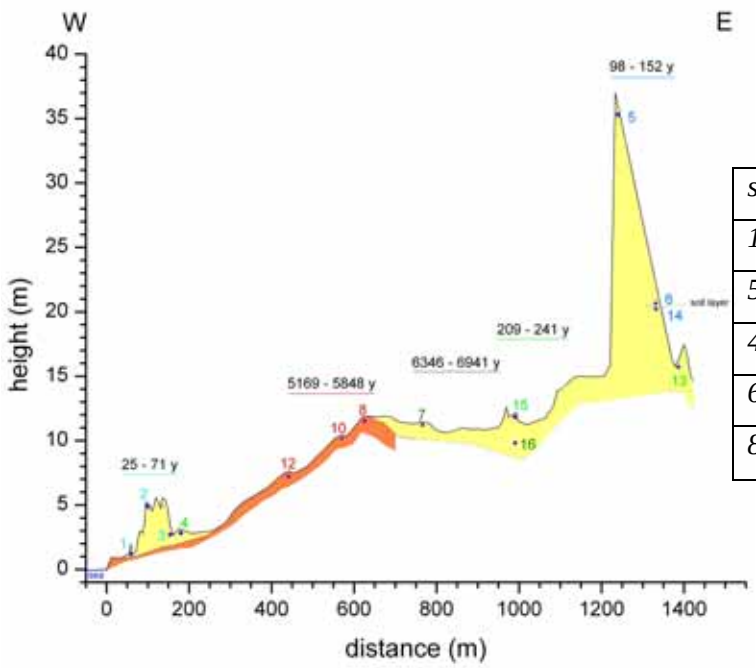
Reconstruction of the development of the coastal dune area

Haverdal dune area is built up from aeolian sediments, which overlie marine sediments (fig. 1). In some places the marine sediments resurface. Three former beach ridges (samples 8, 10 and 12), consisting of very badly sorted coarse material were recognisable in the landscape. The ages of the three samples are very close together. This suggests a period of rapid sea level fall.

Samples 7 and 16 are grouped into the oldest aeolian phase. The age range is very large. The second aeolian phase consists of samples 4, 13, 14 and 15. This aeolian phase corresponds with the Little Ice Age. Samples 17, 6 and 5 are probably induced by anthropological influence. Finally, samples 1,2 and 3 are part of the current beach ridge system.

There are large uncertainties about the exact ages of the older samples. Because we could only use feldspars and the anomalous fading was very large in these particular samples, the age ranges have become so broad that there is no point in comparing them to other known aeolian activity phases. In this way it cannot be ascertained whether these aeolian phases are a

local phenomenon or a regional phenomenon. Only the aeolian activity phase which corresponds with the Little Ice Age has been found in various places in North-West Europe.



samples	*Age group (y old)*
1,2,3	*25-71*
5,6,14, 17	*98-152*
4,13,15	*209-241*
6,17	*6346-6941*
8,10,12	*5169-5848*

Fig.: *Aeolian and marine sediments with locations IRSL samples in a perpendicular transect to the coastline.*

Conclusions

Optical dating can be a suitable dating method for aeolian samples in this area. The young samples show that the IRSL signal is reset to zero quite well. Recuperation and recycling tests show good results. The equivalent dose shows a slight dependence on the stimulation temperature. However, the feldspar grains experience a strong fading of the IRSL signal, approximately 9 percent per decade. As a result of the fading correction the age ranges are very large. Because of this an exact comparison with other indicators is difficult.

In Haverdal three aeolian activity phases can be distinguished. The youngest aeolian deposit is the current beach ridge system. The most common aeolian phase , which can be found in different places in Haverdal, corresponds with the Little Ice Age. The oldest aeolian phase has such a large age range that this precludes comparing it accurately with other known aeolian phases.

Optical dating of very young estuarine sediments

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Previous evaluation of sediment budgets and recent sedimentation rates in the Danish part of the Wadden Sea has relied mainly on ^{210}Pb dating. This method is strongly dependent on the supply rate of ^{210}Pb excess (over its parent ^{226}Ra) and grain-size effects. Unfortunately, the activity concentration of excess ^{210}Pb is below detection level in most sandy sediments and, as a result, earlier estimates of sediment budgets based on this method have only been concerned with the fine-grained fraction (e.g. Pejrup et al. 1997).

This study therefore tests the application of OSL dating to young estuarine sediments (<1000 years) to investigate i) the bleaching condition of the quartz grains in the sediment before deposition, ii) whether this method can complement and support ^{210}Pb dating, and finally iii) if the method also is applicable to the great variety of sediment types in an estuary (i.e. muddy, silty, sandy tidal flats and salt-marsh sediments).

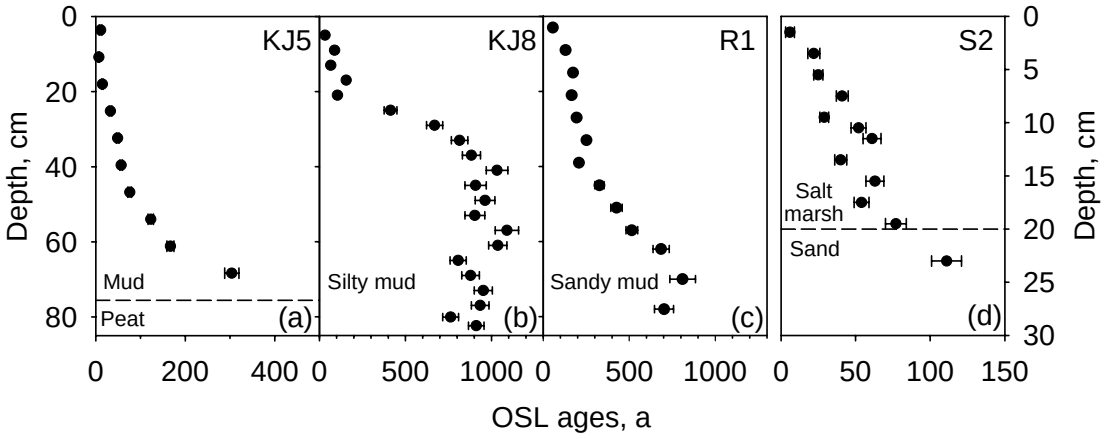

Fig. 1: *The variation of optical ages with depth in the KJ5-, KJ8-, R1- and S2-core.*

Inter-comparisons of ^{210}Pb and optical dating are presented from 4 sediment cores. The consistency between optical ages and ^{210}Pb ages is shown to be satisfactory on a time-scale down to only a few years. We therefore conclude that OSL provides reliable and reproducible results in cores from sub-, inter- and supra-tidal sediments, ranging from only a few years up to ~1000 years old, confirming its value in the estimation of estuarine accretion rates. With OSL it is, for the first time, possible to date sediment cores from silty and sandy tidal flats, providing a new approach to the problem of evaluation of stability and calculation of sediment budgets for estuaries and coastal lagoons.

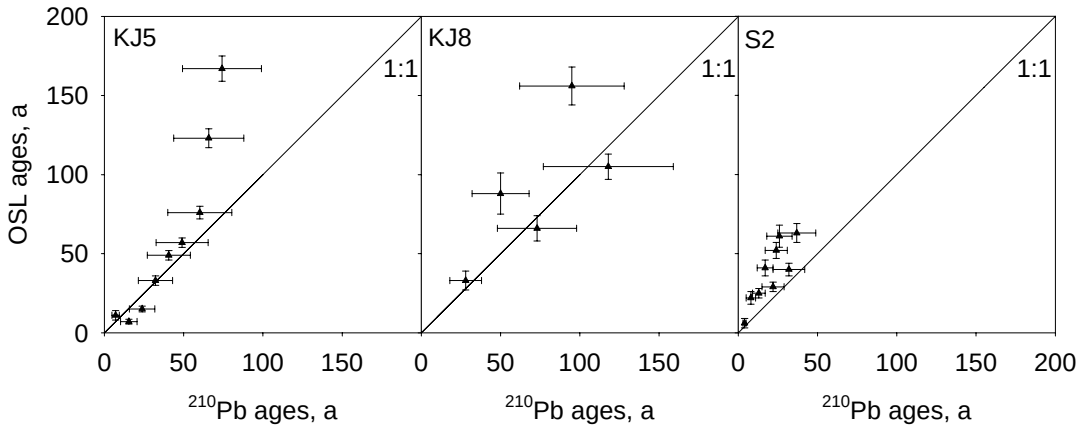

Fig. 2: *Comparison of optical ages and ^{210}Pb ages in the KJ5-, KJ8- and S2-core.*

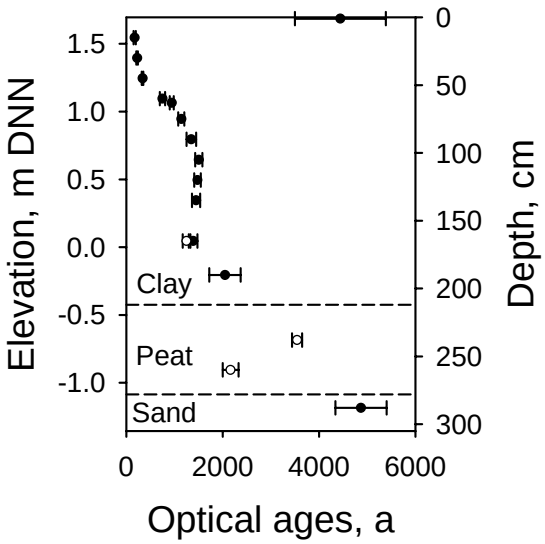

Fig. 3: *The variation of optical ages with depth in the Ho Havn clay-silt sequence (filled circles) and three independent radiocarbon ages (open circles).*

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Validation of luminescence and carbon dating, implicated on horizons of polycyclic sandy soils (SE Netherlands).

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Introduction

Mankind has intensively influenced geomorphology and soils in the Dutch coversand district. The soil of lots of arable land rose due to application of sod manure. Cambic podzols of the former forests turned over in carbic podzols under heath lands and on due to intensive sod digging the vegetation was destroyed and reactivated aeolian processes created from the coversand morphology a drift sand landscape.

Dating of the fimic horizons of anthrosols and driftsand deposits approved to be complicated. The inaccuracy of radiocarbon dates, pollen diagrams and archaeological finds has been described in literature. Luminescence dating could create new trustable evidence of age based on the mineral fraction.

Dating of fimic horizons.

Dating of the fimic horizon of the soil profile Valenakker
(OSL dating in ky AD, NCL-Delft; ^{14}C dating in ky BP, CIO-Groningen)

Depth (cm)	OSL	^{14}C humines	^{14}C humin acids
20	0,23		
40	0,37		
60	0,44	1,43	1,34

Dating of the fimic horizon of the soil profile Dijkerakker
(OSL dating in ky AD, Wales; ^{14}C dating in ky BP, CIO-Groningen)

Depth (cm)	OSL	^{14}C humines	^{14}C humin acids
40	0,39		
80	1,02	1,7	1,15

Comparison of OSL and radiocarbon dating of samples of fimic horizons, points to systematic overestimating of the age by radiocarbon dating. The explication seems to be clear:

- The soil organic matter in fimic horizons is a mixture of decomposed manure of cattle and organic matter from sods from different sites in the surroundings with different inherited ages. The differences in radiocarbon age of the various organic fractions illustrate the complexity of soil organic matter.
- Sods contain quartz grains. As long as the grains are part of the annually plowed soil, bleaching takes place. After burying, the accumulation of luminescence signal starts in the grains. OSL dates points to moment of burying of the quartz grains.

Dating of humic horizons of polycyclic soil sequences

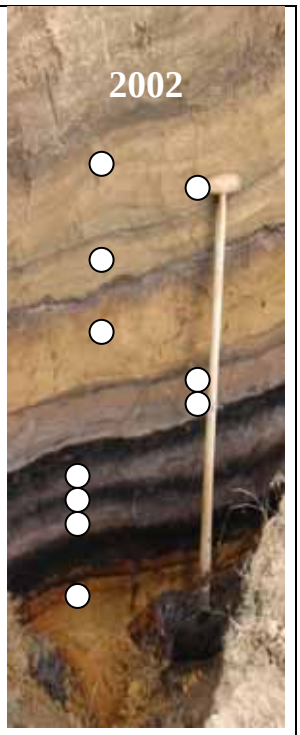
In polycyclic soil sequences OSL dates provide information about time, available for sedimentation and soil development. In 1984 the humic horizons were sampled for fractionated radiocarbon dating.

The radiocarbon 'ages' of the humic acids are en general younger than humines. The explication is that humines will accumulate during active soil development in comparison with humic acids. Exception is the 2AE horizon. Maybe 'older' humines of eroded soil horizons accumulated with sand grains in the sediment. Also the parent materials were sampled for TL dating. The results fitted with the radiocarbon dates. The ages of the 2C1 and 2C2 horizons seemed to be 'reversed'. The low feldspar concentrations of the sediment disenabled precisely TL dating.

In 2002 the parent materials were sampled again but now for OSL dating of the quartz fraction. The profile pit was close to the former site, but the sequence of the horizons of the paleopodzols was less evident. In comparison with the TL age, the OSL dates of the driftsand deposits (1C and 2C) fit better. Resedimentation processes on short distances probably influence the OSL dates of the 3C. This explains too 'old ages' for the 3C, but the indication of OSL dating is always better defined than the interpretation complicated soil organic matter. Additional pyms analysis of the carbon fractions point to another complication.

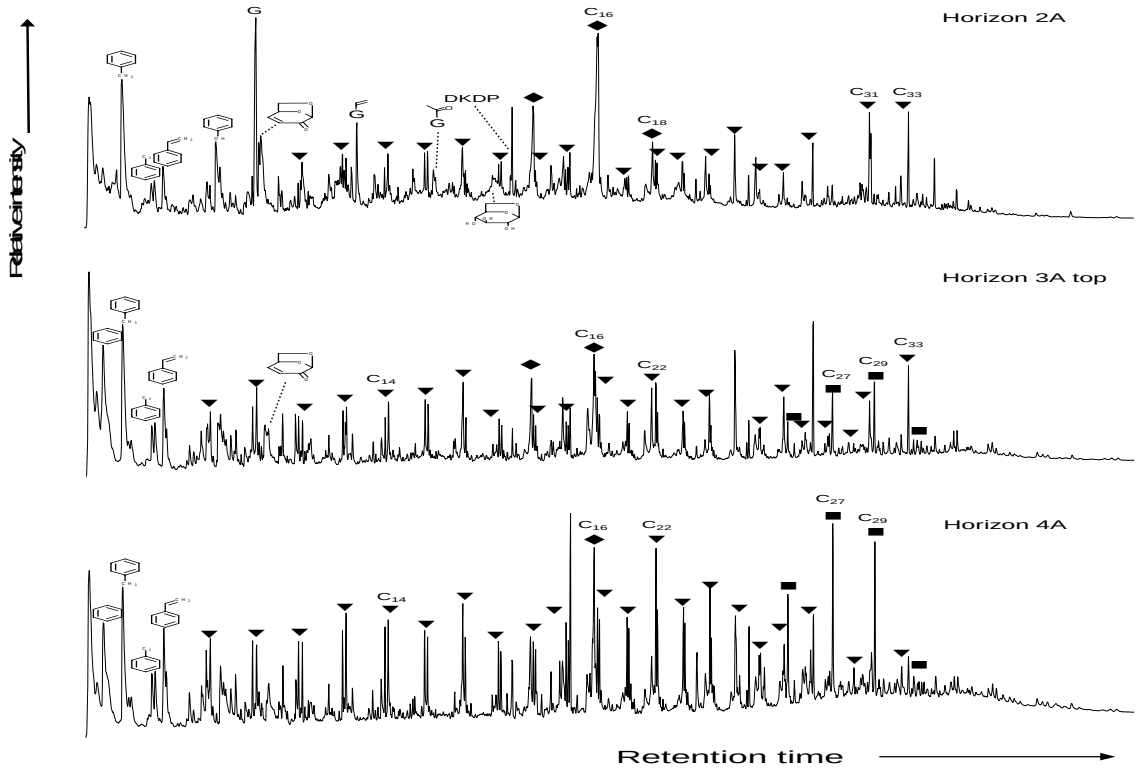
Dating of organic and mineral horizons of profile Defensiedijk
(TL dating in ky AD, Wales; OSL dating in ky AD, RU-Gent;
^{14}C dating in ky BP, CIO-Groningen)

Horizon	TL	OSL	^{14}C hum	^{14}C hac
1C	0,2	0,08 0,10 0,09		
2AE			3,23	0,41
2C1	0,8	0,35		
2C2	0,4	0,56 0,65 1,20		
3Ah-top			1,35	1,36
3Ah-bottom			1,90	1,67
3E				
3Bh			1,90	1,70
3BC	3,1	5,0 ? 4,5 ?		
4Ah-top			4,11	3,61
4Ah-bottom			4,43	3,96
4Bh			3,35	3,70
4Bs	7,7	7,7		
4C	9,6	8,9		



Pyrolysis-gas chromatography/mass spectrometry and thermally assisted hydrolysis and methylation (THM)

The pyrolysates of the HA shows pyrolysis products of lignin (guaiacol, 4-vinylguaiacol, 4-acetylguaiacol), polysaccharides (2-furaldehyde, 5-methyl-2-furaldehyde, levoglucosenenone, levoglucosan), phenols and diketodipyrrole. In addition, series of *n*-alkenes/*n*-alkanes (C_{10}-C_{33}) were observed. The relative abundance of this series decreases after C_{22}. The humin fraction is dominated by these alkenes/alkanes (C_{10}-C_{33}) series. A predominant C_{31} and C_{33} alkanes were found, most likely are these from the wax layer of *Calluna*. Also a series of 2-methylketones (C_{23}-C_{33}), with an odd over even predominance were identified. A few pyrolysis products derived from polysaccharides and lignin were found, but only in very low abundance. Together, HA contains still some plant derived compounds, such as lignin and polysaccharides, but the humin fraction is mainly composed of aliphatic material. These homologous series of *n*-alkene/*n*-alkane doublets have been attributed to the non-hydrolyzable aliphatic biopolymers cutan and suberan. C_{31} and C_{33} alkanes are characteristic additional wax alkanes of *Calluna*, suggesting that both leaves and stems/roots contributed to the Hu fraction. The combination of 2-methylketones and an alkene/alkane pattern is typical of *Calluna* bark/roots, pointing to suberan THM of humin (data not shown) also revealed the ω-hydroxyalkanoic acids with chain lengths of C_{12} and C_{14}, and dehydroabietic acid. These compounds are typical of pine, the first of cutin and the latter as a typical resin constituent



Gas chromatograms of the pyrolysates of the HA of horizons 2A, 3A (top) and 4A. Legend: G = guaiacol; DKDP = diketodipyrrole; ▼: *n*-alkene and *n*-alkane (pair); ■: 2-methylketone; ◆: alkanoic acid; C_n indicates chain length.

The pyrolsyates of the HA fractions 2A, 3A and 4A horizons are shown below. The composition of 2A is already given above. As can be seen from the massa spectra, both 3A and 4A are dominated by the *n*-alkene/*n*-alkane series, and the 2-methylketone series. With

depth, the latter series increases in abundance with respect to the alkene/alkane series. Pyrolysis products of lignin and polysaccharides were virtually absent from these two horizons. Only aromatic products benzene, toluene, dimethylbenzenes and styrene were abundant in the pyrolsyates of the HA fractions, while in the humin fraction they were hardly present (data not shown). The great similarity between the pyrolysates of 3At and 4A horizons suggests that with time (from 1365 years BP up to 4000 years BP) (Van Mourik et al., 1995), the aliphatic compounds, most likely derived from suberan of *Calluna*, are selectively preserved. Also free lipids, such as the C_{31} and C_{33} alkanes, decrease in concentration with depth suggesting that these compounds are also subject to degradation.

The pyrolsyates of the B-horizons are dominated by the alkene/alkane series, suggesting that with time, the illuviation horizons are dominated by compounds that are supposed to be insoluble. Typical compounds that would expected to be water-soluble and candidates to be precipitated in B horizons, such as lignin-derived phenols, were not identified. Most likely, these compounds were degraded, and only the aliphatic compounds survived (partly) this degradation. Also, the contribution of root-derived material may have been more important than illuviation. The HA fractions, and particularly the humin fractions (data not shown), provide strong indications of *Calluna* remnants, mainly in the form of roots. Such aliphatic patterns have been observed earlier in fossil podzols B horizons in Belgium and were considered as a possible origin of aliphatic constituents in soils in which even ester-bound moieties such as those derived from suberin can survive (bio)chemical degradation .

Conclusions

- In studies of polycyclic soil sequences and fimic horizons the combination of luminescence dating of minerals and radiocarbon dating of SOM are important tools for the reconstruction of the genesis.
- The interpretation of radiocarbon dates of organic fractions requires more knowledge about the sources and decomposition processes of SOM. Pyms is an important technique to provide this knowledge. Surprising was the observation of (young) root derived SOM in the Ah and Bh horizons of the oldest paleopodzol.
- The interpretation of OSL dates requires accurate knowledge of sedimentary processes; especially in situations where bleaching of grains could not take place or where sedimentary patterns were disturbed by secondary soil formation.

Reconstruction of the former IJ estuary using radiocarbon and optical dating
(OSL onderzoek in het PWN duingebied bij Castricum)

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In de periode tussen februari 2001 en maart 2002 heeft het Provinciaal Waterleidingbedrijf Noord-Holland (PWN) een deel van de oude en overbodig geworden waterwinsystemen (pompstations en secundairs) verwijderd uit het duingebied bij Castricum. Bij het opruimen van de gebouwen zijn op 8 locaties diepe ontsluitingen gegraven in het duingebied tot ca. 6-7 m –NAP (ca. 1-2 m –NAP). Het betrof de ontsluitingen Pompstation (Po), Waterverdeelstation (WRK), en de secumdairs 3, 5, G, D, E, en L (zie figuur 1). De ontsluitingen waren zowel om archeologische als om geologische redenen interessant. In het duinprofiel komen oude bodems voor uit de IJzertijd tot en met de Vroege Middeleeuwen en in deze horizonten komen archeologische resten voor. De ontsluitingen vormde een unieke gelegenheid om de archeologische sporen, zoals ploegkrassen, in een putwand te onderzoeken. Geologisch waren de putten belangwekkend omdat zij precies over het mondingsgebied van het voormalige Oer-IJ estuarium lagen (getijde systeem dat actief was tussen 5000 en 2000 voor heden in het gebied tussen Castricum en Amsterdam). Omdat de putdiepten tot 1 à 2 m –NAP reikten, kon de verlandingsgeschiedenis van het Oer-IJ in het duingebied van PWN in de profielwanden bestudeerd worden. Om ook de dieper liggende lagen van de Oer-IJ mondingafzettingen te kunnen onderzoeken (met name dateren) zijn aanvullend bij de onderzoekslocaties 8 steekboringen tot 35 m diep gezet door TNO.

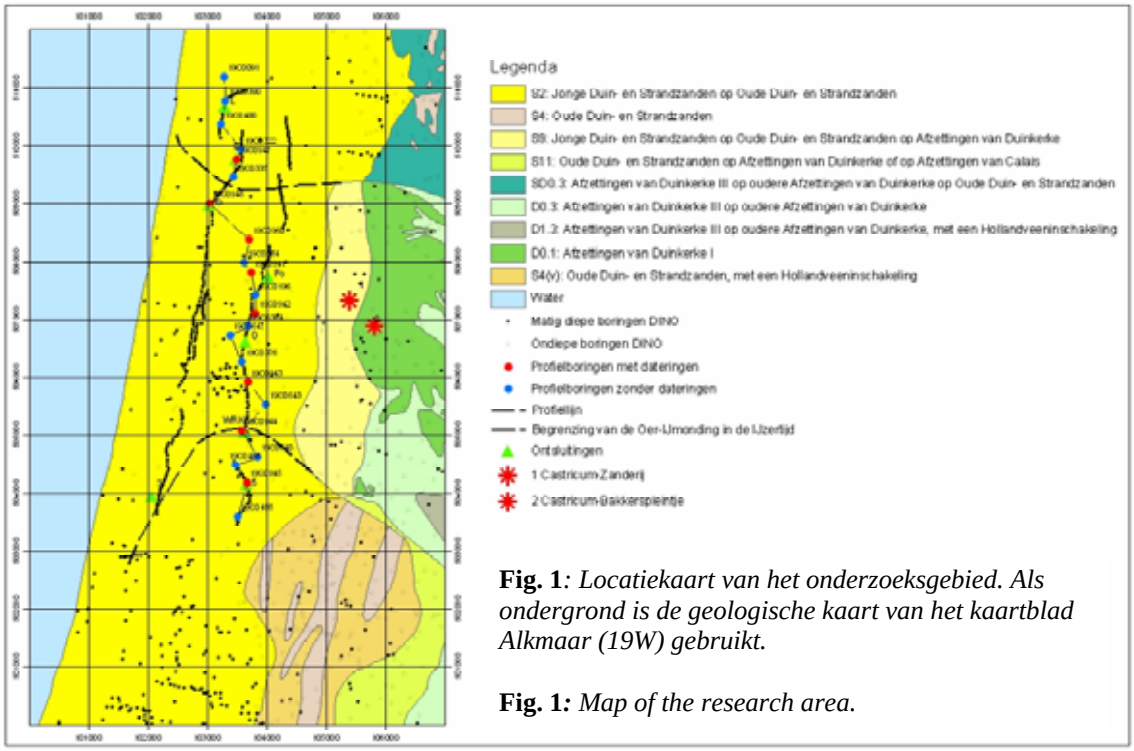

Fig. 1*: Locatiekaart van het onderzoeksgebied. Als ondergrond is de geologische kaart van het kaartblad Alkmaar (19W) gebruikt.*

Fig. 1: *Map of the research area.*

Door de lithologische lagen op de onderzoekslocaties te dateren kon de verlandingsgeschiedenis van de Oer-IJ monding van de laatste 5000 jaar in beeld worden gebracht. Gedateerd zijn de schone duinzanden (OSL), de organische lagen in het duinprofiel

(^{14}C) en de mariene schelpen (meest juviniele Spisula's) uit de strand- en diepe liggende mondingsafzettingen (zie voorbeeld WRK gebouw / boring 19C944). Doordat verschillende dateringstechnieken zijn gebruikt (OSL, ^{14}C-methode en archeologische dateringen) konden de dateringsresultaten - in de stratigrafische sequentie - met elkaar vergeleken worden en konden de resultaten van de OSL bepalingen geijkt worden met deze andere dateringstechnieken

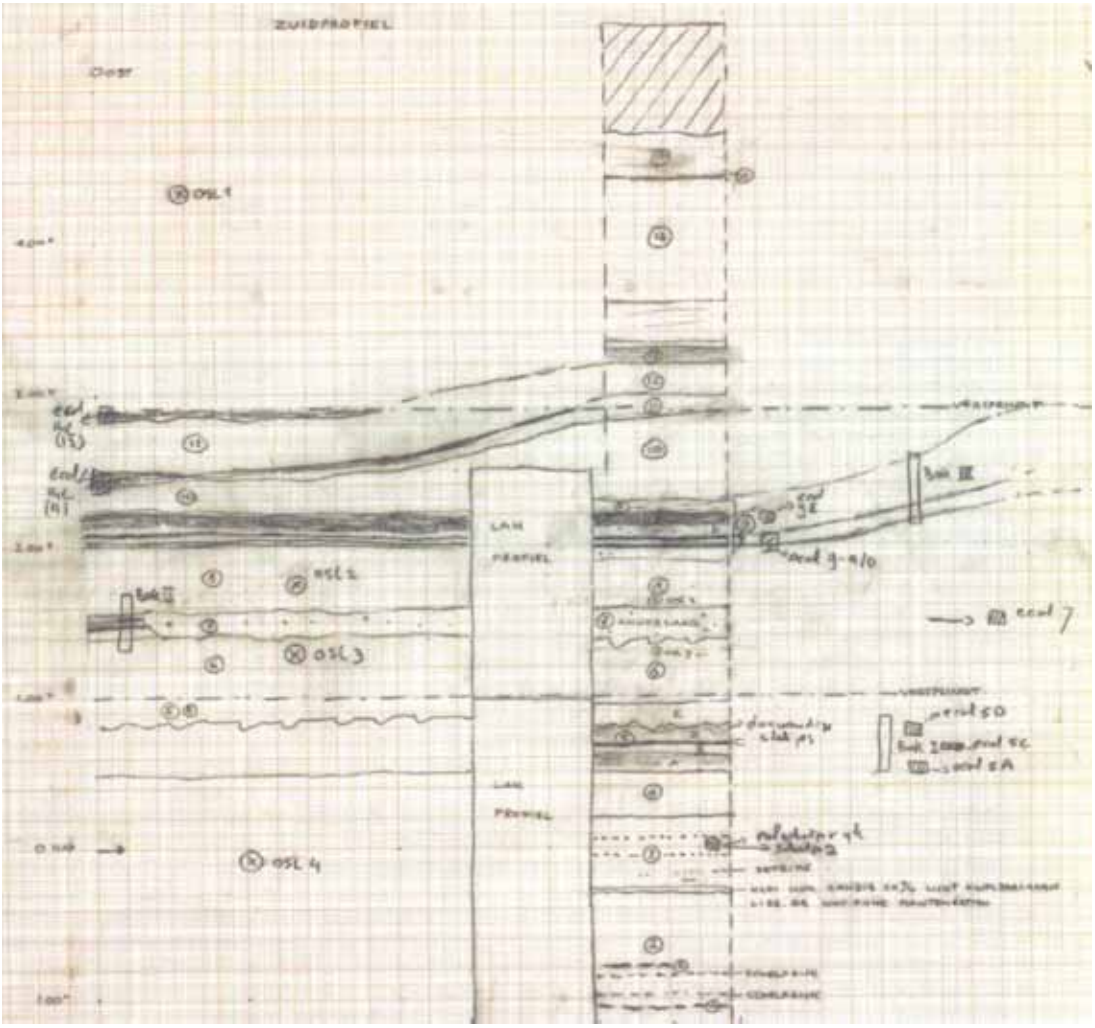

Fig. 2: *Veldtekening van de opgenomen zuidelijke profielwand van het WRK gebouw. In totaal zijn van de duinzanden 4 OSL monsters genomen (aangegeven links op de tekening). Drie daarvan zijn daadwerkelijk gedateerd, de resultaten staan in tabel 1.*

Fig. 2*: Field drawing of the southern wall of the WRK building excavation. Four OSL samples were taken (indicated on the left). Three samples were dated: results are presented in table 1.*

De belangrijkste conclusies van het onderzoek waren:

- De OSL dateringen passen goed binnen het chrono-stratigrafisch raamwerk van ^{14}C- en archeologische dateringen
- Net als bij de ^{14}C methode is de foutenrange met de OSL techniek (1 - sigma) groot (100 – 300 jaar, voor wat betreft de onderzochte periode). Exacte absolute dateringen, zoals met dendrologisch onderzoek, kunnen met de OSL techniek niet verkregen worden. De OSL techniek is wel zeer bruikbaar om de vorming van zandige afzettingen te dateren op het niveau van de archeologische perioden (bijvoorbeeld Vroege- , Midden- en Late-IJzertijd).
- Het litho- en chronostratigrafisch onderzoek wijst uit dat de Oer-IJ mondinafzettingen gevormd zijn binnen (= relict van) het grote mariene getijde bekken van het Vecht/IJsseldal dat zich bevind in de ondergrond van centraal Noord-Holland.
- De dateringen van de PWN onderzoekslocaties geven een goed inzicht in de opvullingsgeschiedenis van de Oer-IJ monding. Rond het jaar 0 is de Oer-IJ monding totaal verland. Deze constatering wordt ook bevestigd door het archeologisch onderzoek in de regio. Vanaf het jaar 0 (Romeinse Tijd) wordt op grote schaal gewoond en gewerkt op de (voormalige) getijde afzettingen van het Oer-IJ. Een rechtstreekse (Romeinse) scheepsverbinding (o.a. castellum Flevum, bij Velsen) naar de Noordzee is daarom zeer onwaarschijnlijk. Een verbinding tussen Oer-IJ achterland en de Noordzee was er wel, maar deze liep via het IJ naar de Flevomeren en de Waddenzee.

Tabel 1: *Voorbeeld van dateringsonderzoek bij één van de locaties (WRK) in het PWN duingebied (zie ook Fig. 1).*
Table 1: *Example of dating research at location WRK of the PWN dune area (see Fig. 1)*

Monster nr.	Lab. Code	Diepte NAP	Datering	Foutmarge	Richtgetal
WRK / OSL-1	NCL 303004	+ 4.35 m	1275 ± 44 AD	1-S: 1231-1319 AD	1275 AD
WRK / ^{14}C-O9	UtC 11896	+ 2.85 m	1046 ± 39 BP	2-S: 890 -1040 AD	1000 AD
WRK / ^{14}C-O8	UtC 11897	+ 2.40 m	1226 ± 36 BP	2-S: 680-900 AD	850 AD
WRK / ^{14}C-O6	UtC 11898	+ 2.10 m	1454 ± 35 BP	2-S: 540-660 AD	610 AD
WRK / OSL-2	NCL 303005	+ 1.70 m	146 ± 128 AD	1-S: 18-274 AD	146 AD
WRK / ^{14}C-O2	UtC 11899	+ 0.70 m	2243 ± 43 BP	2-S: 400-200 BC	275 BC
WRK / ^{14}C-S2	UtC 11895	0 m	3458 ± 36 BP*	2-S: 1880-1680 BC	--
WRK / OSL-4	NCL 303006	- 0.10 m	250 ± 146 BC	1-S: 396-104 BC	300 BC
B 944 / ^{14}C-S1	UtC 12014	- 0. 77 m	3089 ± 35 BP*	2-S: 1440-1260 BC	--
WRK / ^{14}C-S1	UtC 11894	- 1.30 m	2658 ± 38 BP*	2-S: 900-790 BC	800 BC
B 944 / ^{14}C-S2	UtC 12015	- 2.82 m	2614 ± 40 BP*	2-S: 900-550 BC	800 BC
B 944 / ^{14}C-S3	UtC 12016	- 5.40 m	2944 ± 35 BP*	2-S: 1270-1010 BC	1150 BC
B 944 / ^{14}C-S4	UtC 12017	-10.87 m	3194 ± 37 BP*	2-S: 1530-1390 BC	1450 BC
B 944 / ^{14}C-S5	UtC 12018	- 14.87 m	4424 ± 38 BP*	2-S: 3380-2910 BC	3050 BC
B 944 / ^{14}C-S6	UtC 12019	- 15.35 m	4687 ± 39 BP*	2-S: 3350-3030 BC	3250 BC
B 944 / ^{14}C-S7	UtC 12020	- 15.87 m	4698 ± 36 BP*	2-S: 3630-3360	3500 BC

*: AMS datering mariene schelp, gecorrigeerd met 402 jaar reservoir ouderdom

Fig. 3: *Foto van de geoarcheologische opname van het WRK gebouw (vergelijk de profieltekening van Fig. 2).*

Fig. 3: *Photo of the excavation of the WRK building (see drawing of Fig. 2).*

Optical dating of fluvial deposits in and around a Roman barge

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Fluvial systems are one of the most important geomorphic agents shaping the landscape. Both fluvial style and behaviour are influenced by external forcing such as climate, sea-level and land use. As a consequence fluvial deposits form an important archive of environmental change. One of the difficulties in interpreting this archive is that chronological information on fluvial deposits is difficult to obtain. Radiocarbon dating, the most used geochronological method for the Holocene, is often not applicable as organic material is sparse. Moreover, if organic material is present, it is likely reworked and therefore not necessarily of the same age as the deposits in which they are incorporated.

Optical dating is an alternative method by which the burial age of sediments can be directly determined. The method uses the optically stimulated luminescence (OSL) signal of quartz or feldspar grains. The method is best suitable for aeolian deposits, where light exposure to grains is sufficient to completely reset the OSL signal prior to deposition. If light exposure is too limited in intensity or duration to completely reset the luminescence signal, the burial age of a sample will be overestimated.

Previous research has shown that optical ages may overestimate the burial ages for fluvial deposits, but that offsets are usually less than a few hundred years for large fluvial systems (see e.g. Wallinga, 2002). Most previous work uses contemporary fluvial deposits to investigate offsets (e.g. Stokes *et al*., 2001). Such studies assume that there is no dependency between remnant luminescence signal and preservation potential. Moreover, it is arguable whether the results on modern samples are directly applicable to the dating of palaeosediments as many of the present fluvial systems are no longer in their natural states due to locks and other water works.

In this study we explore the validity of optical dating for Holocence fluvial channel deposits by applying the method to deposits with extremely tight independent age control. We dated six samples from fluvial channel deposits in and around a beautifully preserved Roman barge which sank between 180 and 200 AD. Single-aliquot equivalent dose distributions were slightly skewed. This indicates that the majority of grains was well bleached but that incomplete resetting of the OSL signal in some grains prior to deposition and burial caused

Fig. 1: *sampling for optical dating of fluvial deposits at the Roman Barge.*

overestimation of the equivalent dose for some aliquots. We investigated methods to identify and remove aliquots which were affected by poor bleaching from the distribution. After discarding poorly-bleached aliquots we obtain optical ages on the six samples that are in excellent agreement with the independent age control (Fig. 2). Further measurements on individual quartz grains from two samples corroborated that the vast majority of grains had their signal completely reset at deposition (Fig. 3). However, for reasons that are not understood the single-grain optical dating results underestimate the burial age.

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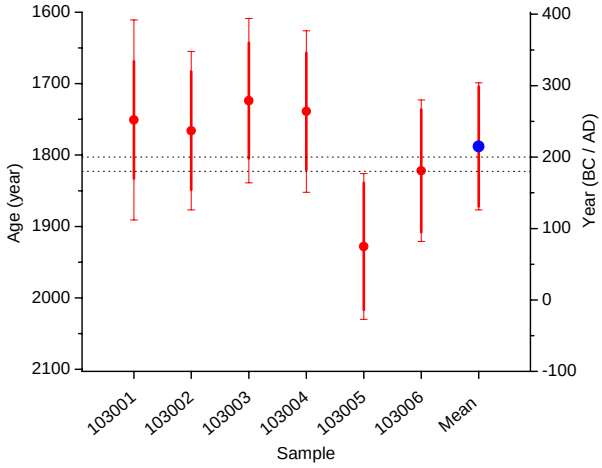

Fig. 2: *Optical dating results (red) agree perfectly with the independent age control (dotted lines) provided by the Roman barge.*

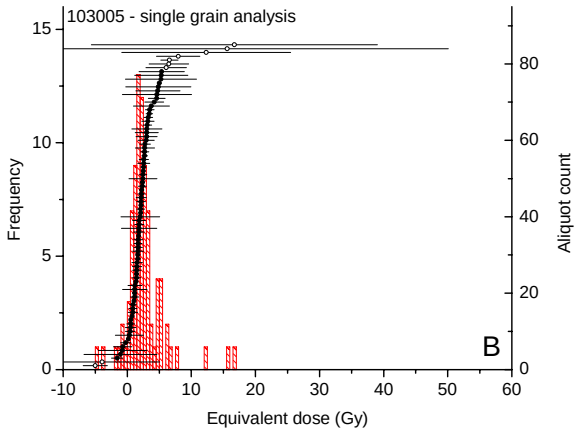

Fig. 3: *Equivalent doses obtained on individual quartz grains from sample 103005. The shape of the distribution indicates that the majority of grains is sufficiently bleached. The spread in data is quite large, likely due to the small OSL signals of single grains of quartz.*

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Realisatie luminescentiedateringsfaciliteiten Delft

Het NCL luminescentiedateringslaboratorium bij het IRI in Delft is geheel operationeel. Calibratie van de beta bronnen gebruikt voor dosis bepaling, en de gamma-spectrometer gebruikt voor dose-rate bepaling is gecontroleerd met het Nordic Laboratory for Luminescence dating. Vergelijkingen waren positief, op de bepaling van kalium na. Een dubbelcheck met K_2SO_4 bevestigde onze calibratie, de problemen bleken bij het Nordic laboratory te liggen en zijn nu opgelost.

Apparatuur - Het overgrote deel van de apparatuur voor het Delftse lab is geleverd. Er is nog ongeveer 64 k€ beschikbaar voor additionele aankopen in 2005. Geplande aankopen zijn een PM buis voor luminescentie detectie in het infrarood, een microscoop, een monster-splitter, een oven en een GPS. Daarnaast zal personeel voor het opstarten van een dateringsdatabase uit dit potje betaald worden. Geïnventariseerd wordt of de dateringscapaciteit aanleiding geeft een additionele TL/OSL reader aan te schaffen uit het apparatuurbudget en opgebouwde reserve van het NCL.

Ondersteuning - Candice Johns heeft een 0.7 fte aanstelling, waarvan 0.5 fte gefinancierd uit middelen van het NCL. Per 1 april 2004 is deze taak opgehoogd naar 0.8 fte, waarvan 0.6 fte gefinancierd uit middelen van het NCL. Vanaf 1 november 2004 is Femke Davids voor 6 maanden aangenomen als student assistent voor 0.4 fte. Zij zal Candice assisteren met het bewerken van monsters voor luminescentiedatering.

Opdrachten

In 2003 en 2004 zijn in totaal 170 monsters voor datering ingediend bij het NCL, daarnaast zijn 46 monsters binnengebracht voor eigen onderzoek en onderzoek van gaststudenten. In tabel 1 staat een uitsplitsing van opdrachten per partner en project en de status van het project. Ook staat in de tabel hoeveel dateringen de partner nog tegoed heeft van het quotum.

Van de 216 monsters zijn metingen aan 117 monsters afgerond. Voor 55 van deze monsters zijn alle metingen uitbesteed aan het Nordic Laboratory for Luminescence dating (NLL) in Denemarken, en voor 36 monsters is de dose rate bepaling uitbesteed aan het NLL. Op dit moment worden metingen aan 73 monsters gedaan, terwijl 26 monsters in de wacht staan. Hiernaast hebben partners nog 43 dateringen tegoed uit de quota voor 2003 en 2004.

De capaciteit van het NCL bedraagt ongeveer 100 monsters per jaar. De geschatte tijd tussen indiening en afronding van de metingen is 10 tot 12 maanden. Bij indiening van een grote hoeveelheid monsters ineens zal deze periode langer zijn.

Onderzoeksactiviteiten Delft

Jakob Wallinga werkt aan onderzoek op oude monsters om methoden voor datering van oude afzettingen (> 100.000 jaar) te verbeteren. Vergelijking van resultaten op kwarts en veldspaat duidt erop dat veldspaat de ouderdom onderschat ten gevolge van anomalous fading, het verlies van signaal. Correcties hiervoor worden bemoeilijkt doordat de snelheid van fading afhankelijk is van de dosis waaraan het materiaal blootgestaan heeft en het dosistempo. De informatie uit experimenten wordt nu verwerkt in enkele publicaties. Naast dit methodologisch onderzoek is Jakob bezig met uitwerken van resultaten van dateringsonderzoek aan Rijn-Maas afzettingen om inzicht in de respons van dit riviersysteem

op zeespiegel, klimaat en vergletschering te vergroten. Dit onderzoek wordt voortgezet in samenwerking met Freek Busschers (VU).

Mirko Ballarini ontwikkelt verbeterde methoden voor datering van individuele korrels van jonge afzettingen. Zijn resultaten zijn / worden in een aantal publicaties verwerkt en hij hoopt in 2005 te promoveren.

Adrie Bos onderzoekt een nieuwe methode voor calibratie van de betabronnen in the OSL readers.

Femke Davids is een gast student van de Universiteit Utrecht. Zij dateert de monsters die ze afgelopen zomer in Zuid-Zweden heeft genomen.

Onderzoeksactiviteiten in Groningen

Het onderzoek naar luminescentieprocessen in zircoon is voortgezet in samenwerking met buitenlandse gastonderzoekers. Een deel van de resultaten is inmiddels gepubliceerd (Turkin *et al.*, 2005).

Het promotieonderzoek van Harriet van Es bevindt zich in de afrondingsfase. Harriet heeft een nieuwe baan en heeft in 2004 een kindje gekregen. De verwachting is dat zij in 2005 zal promoveren.

NCL Symposium

Op 11 mei 2004 werd het NCL symposium 'Geological applications of luminescence dating' gehouden. Het was een geslaagd symposium met zeer goede en verzorgde presentaties van Jeroen Schokker (UU/TNO-NITG), Jan van Mourik (UvA), Leo Tebbens (UU/BAAC bv), Mirjam Vriend (VU) en Candice Johns (TUD). Ruim twintig deelnemers bezichtigden na afloop de NCL faciliteiten en kletsen na bij een gezellige borrel.

Homepage NCL

De NCL website is uitgebreid met informatie van de meeste stuurgroepleden. NCL highlights 2004 en publicaties zijn aangevuld. Up-to-date houden van persoonlijke informatie is afhankelijk van input van stuurgroepleden. Informatie over Gronings onderzoek is nog niet beschikbaar.

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List of registered participants NCL symposium 2005

Name	Affiliation
Peter Attema	RUG - GIA
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Adrie Bos	TU Delft
Hans Brouwer	TU Delft
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Freek Busschers	VU / TNO
Jan-Pieter Buylaert	Ghent
Kim Cohen	UU
Femke Davids	UU / NCL
Gilles Erkens	UU
Rik Feiken	RUG - GIA
Gunther Ghysels	Ghent
Tim van der Hagen	TU Delft
Sytze van Heteren	TNO
Nadinja Hettinga	UU
Wim Hoek	UU
Candice Johns	NCL - TUDelft
Ward Koster	UU
Martijn van Leusen	RUG - GIA
Robert van Lil	ADC
Rik Linssen	TU Delft
Anni Madsen	Copenhagen
Jan van Mourik	UvA
Jos van Oijen	Leiden
Jan Oude Nijhuis	Losser
Maarten Prins	VU
Christiaan Rieffe	Gem. Den Haag
Madeleine Schilder	UvA
Jeroen Schokker	TNO
Deon Slagter	UU
Rieks van der Straaten	Emst
Arnaud Temme	WUR
Dimitri Vandenberghe	Ghent
Peter Vos	TNO
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Mirjam Wijnand	RUL
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