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OSL dating in palaeoenvironmental reconstructions. A discussion from a user's perspective

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Abstract. Four studies with series of OSL dated aeolian sediments are outlined and used for a discussion of the reliability of this dating method in palaeoenvironmental reconstructions. The OSL ages form series controlled by interfingering radiocarbon ages, historical records or relative position of the samples. A locality dated by a thermoluminescence method is also included. The examples range from subrecent to more than 200 kyr. It is suggested that in most cases the precision and accuracy of the OSL method are insufficient for the establishment of detailed, late Quaternary stratigraphies and associated palaeoenvironmental reconstructions. It is suggested to start a discussion on the potentials and limitations of luminescence dating.

Key words: OSL dating, chronology, stratigraphy, palaeoenvironmental reconstruction, Quaternary.

INTRODUCTION

Understanding our natural environment requires the knowledge of the past developments that have taken place through time, including the rate and intensity of these changes. Endogenic and exogenic processes continuously influence the development of land surfaces. The impact of major climatic changes has been especially great during the last few million years, so that the present natural conditions differ from those of the past in many areas and can be expected to change also in the future.

In order to come forward with qualified reconstructions and understandings of past developments, studies of landforms, sediments, floras, and faunas, as well as their changes in space and time, are in need of a reliable chronological framework that can provide information on the timing and rate of the changes.

At a specific locality it is usually possible to give a relative time sequence of the sedimentary profile and thus a brief outline of the succession of changes through time, but once an investigation is broadened to include a larger geographical area, the reconstruction becomes more complex and it has turned out that it can be difficult to undertake reliable stratigraphic correlations even over short distances. This is because open and cored profiles are points in the landscapes and owing to the possibility of erosional events and facies changes, a reliable chronological relationship between the profiles cannot always be ascertained.

It follows that reliable and accurate dating methods become of key importance in the time correlations for palaeo-developmental reconstructions. Otherwise there is a danger that correlations are drawn between similar situations and deposits from different times, because they look alike or represent similar conditions rather than, instead, the reconstructions outline contemporaneous, yet different parts of the mosaic of local developments within an area as they also occur today in relation to local topography, hydrology, regolith, and other natural parameters that influence the spatial environmental diversity.

Where organic material is present in a locality, Earth scientists normally prefer to use the well-established radiocarbon method including the accelerator mass spectrometry (AMS) dating to obtain ages if they are estimated to be younger than ca 50 000 yr BP. The radiocarbon method is based on the decay of ^{14}C upon the death of carbon-containing organisms, and reliable ages require the presence of uncontaminated, in situ, organic accumulations. However, many sedimentological sequences show variations of textures and structures that indicate environmental changes, but are devoid of organic matter. Such sequences kindle the curiosity to find out what the sedimentary changes indicate and when they took place. The luminescence method is often applied to such deposits.

The advantage of the luminescence method is that it can be applied to minerogenic sand- and silt-sized particles of quartz and most feldspars. This is because mineral particles that are exposed to sunlight during transport and deposition can be emptied of their stored energy and bleached, owing to the exposure to light. Once the particles are buried, they start to store and accumulate new energy from the surrounding background radiation again. The amount of new, accumulated energy is time-dependent and, put in a simplified way, the amount of the stored energy can be used to determine the time when the sample was last buried (e.g. Duller 2004).

Different luminescence dating methods are used (e.g. Singhvi et al. 2001). Traditionally the thermoluminescence (TL) method has been applied (Aitken 1985), but in recent years variants of the optically stimulated luminescence (OSL) method have taken over (Wintle 2006). In this paper, therefore, the focus is on OSL results. Unfortunately, even though the OSL dating is widely used, it still has some uncertainties (Singhvi et al. 2001; Duller 2004).

This paper raises some critical questions about the reliability of the OSL method and the ways in which the results are applied, and provides several examples. It is to be stressed that the outline below is presented by a user who is not specialized in the luminescence dating techniques, but who has to rely on the information given together with the dating results in publications that use the age results. It is therefore possible that some aspects of the methods are not sufficiently considered from a technical point of view. In spite of this, the paper intends to stimulate a discussion on the use of the method in palaeoclimatic and palaeoenvironmental reconstructions.

UNCERTAINTIES OF OSL AGES

The fact that sand particles must have been exposed to (sun)light in order to be emptied of their stored energy before they are buried and new energy can build up means that aeolian sand and loess are generally better suited for OSL dating than particles, which have undergone other means of transport. It is sometimes stated that exposure to sunlight during aeolian transport through the air is almost always sufficient to empty the OSL signal completely (e.g. Kolstrup et al. 2007), but there are exceptions and some of the sand particles in wind-transported sediments may have been incompletely bleached and can therefore give too old ages (Olley et al. 2004). Samples collected from deposits laid down by other means of transport have, on the other hand, more often been insufficiently bleached and are therefore less likely to provide reliable ages. For example, surficial glaciofluvial sediments have proved to be unreliable in many cases (e.g. Raukas 2004).

In addition to insufficient bleaching, other factors, such as the radionuclide concentration and the water content of the sediment through the time after burial, can influence the dose rates and thus the age outcome of a sediment. For every 1% increase in water content by weight (water/dry sediment) the age increases by about 1% (Kolstrup et al. 2007). In the case of the samples that are collected from open (now dry) profiles, it is often necessary to estimate the natural lifetime water content of the sediment, and therefore the corresponding ages can become uncertain.

The presence of peat layers can also influence the age of interfingering sand, although to a lesser extent (see also the discussion in Kolstrup et al. 2007). Finally, it has been noted that in some samples only a low percentage of all quartz particles (down to 1–2%) account for the total OSL signal (e.g. Duller 2004) and that different particles can have different signal intensities.

It can still not be excluded that there are other uncertainties apart from the mentioned ones, which have not yet been recognized and/or quantified. These include, for example, the question of how far energy can be trapped by surface coatings, iron oxides for example, or whether the source area/isotope contents of the percolating water through time plays a role, or to what extent the presence of fine-grained particles or the lifetime content of heavy minerals in the sediments should be considered. As to the latter, OSL dating is not readily performed in areas with volcanic deposits.

Two principal methods are used to assess the reliability of OSL age results:

(A) The results are tested against ages obtained by means of an established dating method, such as the radiocarbon method within the same locality, preferably within the same profile, so that there is a clear litho- and chronostratigraphic link between the samples. Obviously, in the case of the radiocarbon method, the deposits should be within the ca 50 000 yr BP age range. In order to provide a reliable comparison, the test localities should contain alternating sediment units that are suitable for the OSL method and the radiocarbon method, respectively. The results from such a locality can be assessed both relatively and numerically. The examples from Sig and Orten below (Kolstrup et al. 2007) belong within this category.

(B) The second method is based on relative dating and can be subdivided into two subcases:

  a) determination of luminescence ages from minerogenic depositional sequences with homogeneous, undisturbed accumulations, i.e., with deposits becoming increasingly younger upwards, such as in the example of Nussloch (Lang et al. 2003) below. In such sequences the results can be mutually compared;

  b) determination of ages from accumulations in which sedimentary structures indicate events that can be relatively dated. An example is post-sedimentary aeolian fill of sand wedges, which extend down into older host sediments, such as the examples of Tjæreborg (Kolstrup 2004) and Wilczyce (unpublished) below. In such cases the age of the fill can be compared with the age of the host sediments.

In both subcases of B the validation of the luminescence age results can be done with regard to older and younger, but numerical values of the ages cannot be ascertained.

One further possibility that might be mentioned is to relate ages to proxy data in addition to mutual comparison of the results from paired luminescence ages. Such an approach has been applied in two Danish areas with young dunes (Clemmensen & Murray 2006).

EXAMPLES

In spite of the numerous luminescence ages obtained so far, a perusal of the literature shows that most studies have made use of only a single or a few datings for their chronology and that the testing possibilities of (A) and (B) above have only been applied to a few localities, several of which (see Fig. 1) are outlined below.

Sig and Orten

The ^{14}C AMS ages and OSL ages of two up to 2-m deep sedimentary sequences near Sig and Orten in western Jutland, Denmark (X in Fig. 1) are compared. These localities are considered in detail in Kolstrup et al. (2007), together with the description of the dating technique and discussion of the application of the methods. Therefore, only a general overview is given here.

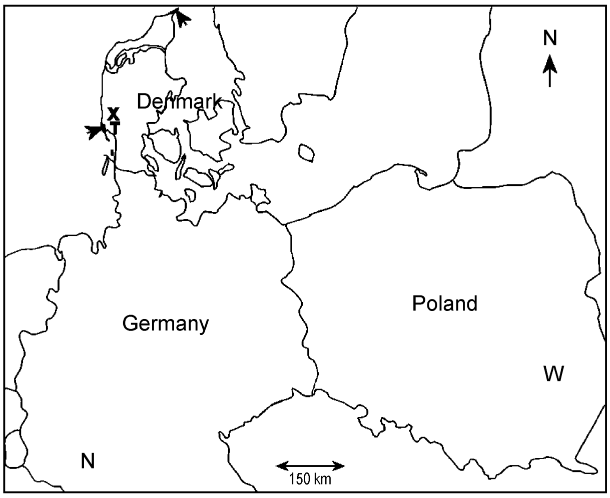

Fig. 1. The localities Sig and Orten lie close to each other and are indicated jointly by an X, the location of Tjæreborg is shown by a T. All these localities are in western Jutland, Denmark. The young coastal dune area at Vejers is indicated by an arrow towards the west coast of Jutland and that at Skagen is shown by an arrow at the northern tip of the peninsula. Nussloch in Germany is indicated by N and Wilczyce in Poland by W.

The OSL datings are performed according to the single aliquot regeneration dose procedure on quartz from the two profiles, which contain layers of quartz-rich aeolian sand or silty sand alternating with organic deposits. Part of the profile from Sig, which has a better defined layering than the Orten profile, is shown in Fig. 2. The open profiles from which the sediments

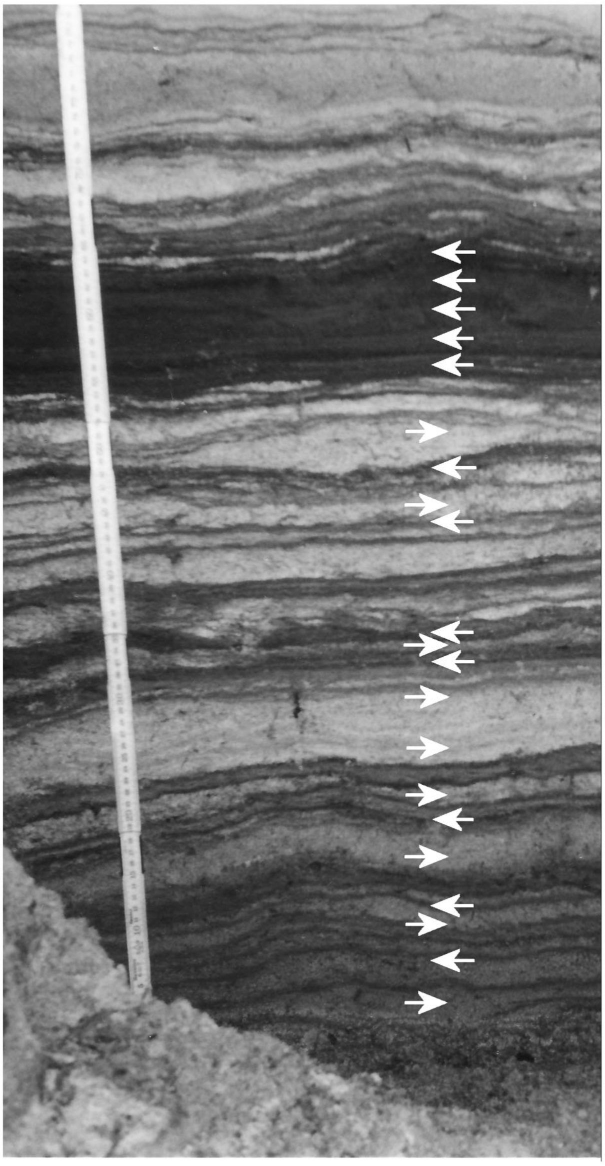

Fig. 2. Part of the profile in Sig as an example for both Sig and Orten. The Sig profile is shown here because it has better defined and higher frequency of organic layers than the Orten profile. The visible part of the profile is a little more than ½ m deep. ^{14}C and OSL sample locations are indicated with white arrows pointing to the left and right, respectively. Owing to undulations of the laminae, the levels are approximate. For further information see Kolstrup et al. (2007).

were collected are both Lateglacial in age, and both sequences represent time intervals of less than 2000 years. Those radiocarbon ages that are regarded as reliable range between 10 605±110 yr BP (12 600±210 cal. yr BP) and 12 390±110 yr BP (14 400±250 cal. yr BP) in Sig (Fig. 3, Table 1) and between 11 510±100 yr BP (13 350±100 cal. yr BP) and 12 490±120 yr BP (14 550±300 cal. yr BP) in Orten (Fig. 4, Table 2).

The OSL results from Sig and Orten clearly differ from the radiocarbon ages. In most cases they are younger and, besides, they are less precise (see also the discussion in Kolstrup et al. 2007). Problems arose also with some radiocarbon ages, for example repeat sampling and dating revealed contamination of a peat sample with early Holocene beetles that had dug into the Lateglacial deposit, and also other minor deviations (Kolstrup et al. 2007). Such erroneous ^{14}C ages are excluded from the present discussion. Similar repeat sampling could unfortunately not be done for the OSL dating. In spite of this it seems that the ^{14}C series are more consistent and precise than the OSL ages for this time interval, with the latter giving generally younger ages (see Kolstrup et al. 2007).

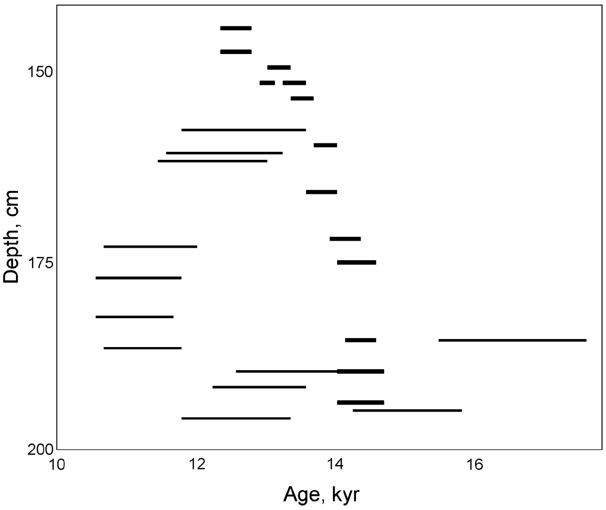

Fig. 3. Overview of the ^{14}C (thick lines) and OSL (thin lines) ages in Table 1 from Sig, Denmark. The data are from Kolstrup et al. (2007).

Table 1. ^{14}C and OSL ages from Sig, Denmark. The data are from Kolstrup et al. (2007), where further details on the ages and methods can be found

Depth, cm	Sample ID ^{14}C	Risø sample ID OSL	^{14}C uncal. age, yr BP	^{14}C cal. age, yr BP	OSL average age, kyr	Level dose rate measurements
142.5–144	Ua-18325		10 645±95	12 615±205		
145–147	Ua-18327		10 605±110	12 600±210		
148–149	Ua-18328		11 405±135	13 270±130		148
150–151	Ua-18329		11 605±160	13 465±165		
152–153	Ua-18331		11 645±160	13 505±165		
155–158		992122			12.7±0.9	
158–159.5	Ua-16263		12 045±110	13 905±115		
159.5–161		002114			12.4±0.8	
159.5–161		992123			12.3±0.8	
163.5–166.5	Ua-16264		12 025±140	13 890±150		
171–172	Ua-18332		12 250±120	14 170±230		
172.5–173		002115			11.3±0.7	
174–176	Ua-16040		12 360±140	14 350±300		175
176–178		002116			11.2±0.7	
181.5–184		002117			11.1±0.6	
184–186.5	Ua-16041		12 390±110	14 400±250		
184–186.5		002118			16.6±1.1	
186–187.5		002119			11.2±0.6	
188–191	Ua-16042		12 385±185	14 400±350		
188–191		002120			13.3±0.7	
191–193.5		002121			12.9±0.7	
193–195	Ua-16043		12 350±155	14 375±325		
193–195		002122			15.1±0.8	
195–196		002123			12.6±0.8	
205						205

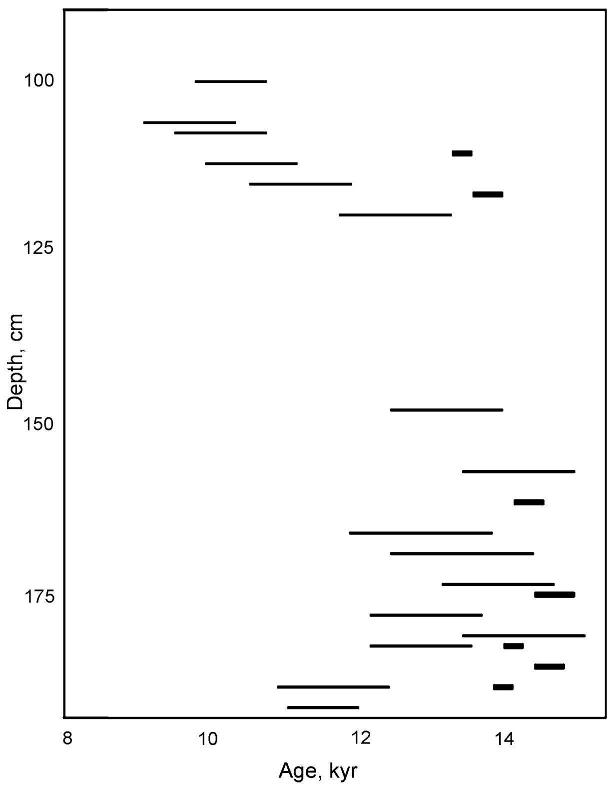

Fig. 4. Overview of the ^{14}C (thick lines) and OSL (thin lines) ages in Table 2 from Orten, Denmark. The data are from Kolstrup et al. (2007).

The sampling intervals of both the Sig and Orten series are small and the number of samples for both OSL and ^{14}C dating is high. So far these two Danish localities provide the only NW European Lateglacial aeolian series from which parallel ^{14}C and OSL datings have been carried out in such detail. Especially the Sig profile shows a very neat series of AMS ages against which the OSL ages can be assessed.

From Tables 1 and 2 and Figs 3 and 4 it can be seen that the OSL ages tend to form subgroups of ages. An imaginary example of the use of OSL ages follows here, based on the Sig example: If the OSL age subsets had been from four different profiles, which were to be chronologically correlated for palaeoenvironmental development on the basis of the OSL ages alone, the age from 185 cm would be the oldest; the three almost identical (therefore apparently reliable) ages from between 188 and 195 cm would come next (with the older sample at 194 cm being explained as a result of insufficient bleaching). This set would be followed by a series of three (therefore also seemingly reliable) ages from 155–160 cm and by fairly similar ages of three samples between 172 and 184 cm turning out to be the youngest. If palaeoenvironmental information resulting from investigations of these four different, imaginary profiles had been correlated chronologically in order to be used for reconstructions of climatic and palaeoenvironmental conditions and changes through time, the resulting succession of events would have been wrong.

If the question to be answered by means of the OSL ages in this investigation had been whether the deposits were Lateglacial or not, the OSL results would have been useful. But for the relatively short time span of the Lateglacial with its stratigraphic units of short duration, the OSL method cannot be expected to give sufficiently reliable results that could be confidently used in detailed dating of sedimentary sequences (see also the discussion in Kolstrup et al. 2007) even if more than one sample from each layer is OSL dated and even if the three or four resulting age groups agree well. The reliability of the luminescence method for correlation between different areas as a basis for palaeoenvironmental reconstruction is therefore too limited in this case.

Nussloch

The Nussloch locality near Heidelberg in Germany contains an 18 m thick loess sequence, locally with organic carbon content up to 0.3%. Parallel series of AMS ^{14}C and IR-OSL dating results range in age from 15 to more than 50 ka (Antoine et al. 2001; Lang et al. 2003). The ^{14}C and OSL ages from the upper ca 13 m, which have the best dating record, cover the time between ca 15 kyr and 30 kyr and are outlined in Fig. 5. In the literature this locality has been drawn forward as a strong case for the use of OSL dating of loess, because within the uncertainty intervals there is good agreement between the chronologies (Wintle 2006).

As pointed out by Lang et al. (2003), the results from the long Nussloch series suggest high sedimentation rates, and with few exceptions the ^{14}C and OSL ages agree, yet the uncertainties of individual OSL ages are somewhat large. A snag to series like the one of Nussloch is that the loess accumulation may need to be seen on the background of particularly unstable soil surface conditions during the sedimentation phases. There is thus a possibility of more than normal reworking of older material, both organic and minerogenic. Such a situation might (apart from the low content of carbon and possible contamination) explain part of the inconsistencies in the ^{14}C ages and might also have influenced OSL age results owing to redeposition of incompletely bleached sediments. However, if the user can accept the error limits to the ages and can regard the sedimentary problems as minor, the OSL ages presented for this locality raise no serious doubt about the application of the method. If, on the other hand, the results are to be used in detailed

Table 2. ^{14}C and OSL ages from Orten, Denmark. The data are from Kolstrup et al. (2007), where further details on the ages and methods can be found

Depth, cm	Sample ID ^{14}C	Risø sample ID OSL	^{14}C uncal. age, yr BP	^{14}C cal. age, yr BP	OSL average age, kyr	Level dose rate measurements
98–102		002101			10.2 ± 0.5	104
105.5–109		002124			10.1 ± 0.6	
105.5–109		992124			9.7 ± 0.6	
109–112	Ua-16033		11 510 ± 100	13 350 ± 100		
112–112.5		992125			10.5 ± 0.6	
114–116		002102			11.2 ± 0.7	
115–119	Ua-19114		11 850 ± 210	13 680 ± 230		
119–120.5		002103			12.4 ± 0.8	
141–153		002104			13.1 ± 0.7	
153–159		002105			14.1 ± 0.8	
159–164	Ua-16034		12 405 ± 125	14 425 ± 275		
164–167		002106			12.8 ± 1.0	
167.5–171		002107			13.3 ± 1.0	167
171–174		002108			13.8 ± 0.8	
174–176	Ua-16035		12 490 ± 120	14 550 ± 300		
174–179		002109			12.8 ± 0.8	
178–181		002110			14.2 ± 0.9	
179–183	Ua-16036		12 155 ± 120	14 000 ± 150		
181–183		002111			12.8 ± 0.7	
183–186	Ua-16037		12 460 ± 115	14 500 ± 300		
186–188.5	Ua-16262		12 050 ± 130	13 905 ± 135		
186–188.5		002112			11.6 ± 0.8	
188.5–191.5		002113			11.5 ± 0.5	

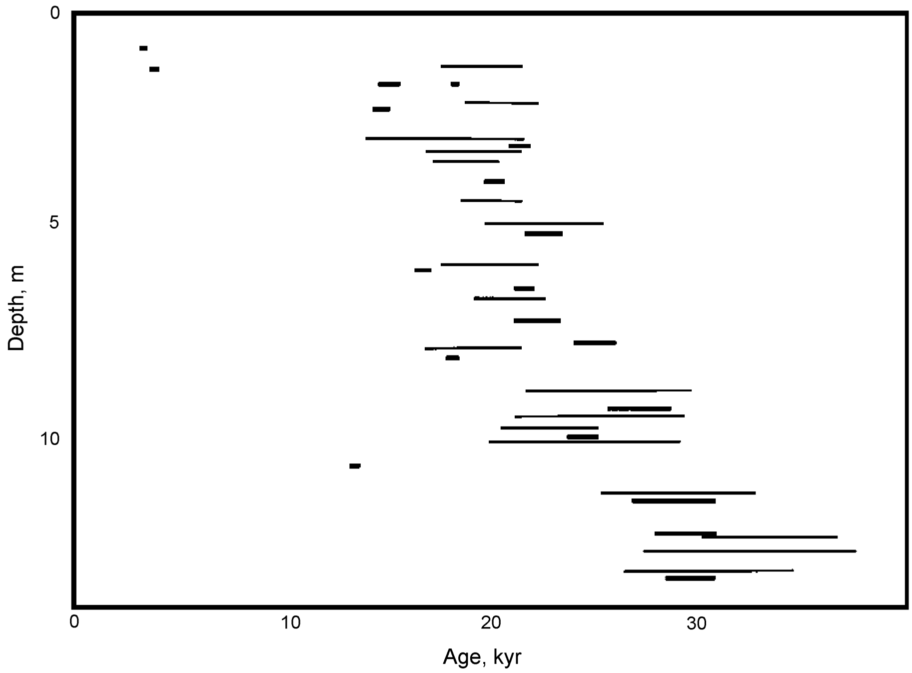

Fig. 5. Overview of ^{14}C (thick lines) and OSL ages (thin lines) from the Nussloch locality in Germany. The data are from Lang et al. (2003). See also Antoine et al. (2001) and Wintle (2006) for further details.

environmental reconstructions and correlations related to the rapid and pronounced climate changes of a few thousand years (e.g. Johnsen et al. 1995), the OSL method might be regarded as insufficiently informative for getting answers to questions related to continuity/discontinuity of sedimentation rates and associated instability/stability of soil surface conditions for various parts of the series.

Tjæreborg

A large composite thermal contraction crack (sand/ice wedge) near Tjæreborg in western Jutland contains separate subvertical sand fillings (Kolstrup 2004). The wedge (Fig. 6), which is located in a Saalian landscape, is presented in Kolstrup (2004), where further details of the wedge fill and samples are given.

Samples Tj 6, Tj 8, and Tj 10 (Table 3) were collected in 1998 from individual fillings of the wedge in order to test whether the crack system had been reused or reactivated during different Saalian and/or Weichselian permafrost periods (see also Kolstrup 1993; Murton & Kolstrup 2003). Most of the quartz sand particles, around 300–500 µm in size, were well rounded and frosted, some units were very well sorted, and accordingly most of the fill is regarded as aeolian; further the sedimentary structures pointed to discrete events of aeolian infill. Owing to the fact that two of the obtained ages were about 50 000 years older than the third, the results suggested that at least two separate phases of active thermal contraction with associated filling of open cracks had taken place during the Saalian.

Fig. 6. The profile at Tjæreborg with a large sand/ice wedge cast (black vertical arrow) in the upper central part. The three OSL samples of the fill were collected in this upper part of the wedge (more details are given in Kolstrup 2004). The arrows to the left give approximate locations of the host sediment samples.

Table 3. OSL ages from Tjæreborg. Samples Tj 6, Tj 8, and Tj 10 are from fillings of individual cracks within the large ice/sand wedge in Fig. 6. Samples A and B are from the host sediment to the left of the wedge and thus represent the age of the sediment into which the crack developed (further details are given in Kolstrup 2004)

Sample ID		OSL age, kyr
Risø Laboratory	Field	
992101	Tj 6	230 ± 18
992102	Tj 8	280 ± 23
992103	Tj 10	290 ± 20
992104	A	133 ± 12
992105	B	176 ± 16

In 1999 two additional samples were collected from the undisturbed, layered fluvial or glaciofluvial host sediment some metres away from where the wedge had been. Dr. Andrew Murray (Nordic Laboratory for Luminescence Dating, Risø National Laboratory) assisted in the field to ensure that the new samples were not exposed to light. The results from these samples, A and B in Table 3, turned out to be significantly younger than those from the fillings of the wedge, yet the wedge had developed into this sediment. The grain texture of the wedge fillings points to transport in saltation, i.e. a local sand source. The geographical extension of the sandy host sediment was sufficiently large to assume that the host material should be regarded as the source for the filling.

The older ages from Tjæreborg are at the limit of the OSL dating method. One of these samples was investigated in more detail using the individual mineral grain technique and, in spite of its probably aeolian origin, it seems to contain more than one age population (Duller et al. 2000). The surrounding sediment, on the other hand, is deposited in a fluvial or glaciofluvial environment, where the exposure to sunlight could be expected to have been less than for the aeolian wedge fill sediment. Yet, even if it might be argued that the older ages are towards the limit of the dating method, it is hard to accept this argument as the only reason for the resulting ages, especially when seen against the relatively limited uncertainties of less than 10% given with the ages (the older and younger ages far from overlap), and besides, the age gap between the host sediment and the filling is considerable. Owing to the fact that the filling most probably came from the surrounding host sediment (Kolstrup 2004), the reversal of the ages cannot be explained.

In relation to the ages from this locality it is noteworthy that if the host sediment had not been dated, the results of the fill would have been regarded as good. But the fillings cannot be older than the sediment into which the wedges developed and the two sets of ages therefore present a contradiction.

Possible explanations for such a reversal remain guesswork, but it was noticed in the field that the sediment filling in the wedge was ochre/brown in contrast to the surrounding white host sand, a fact that points towards locally different post-sedimentary hydrological histories of the layered host sand and the wedge fillings. The wedge extended laterally over at least some tens of metres and could have served as a local aquifer along which different water contents and rates of throughflow through time could also include the possibility that water came from different sources as compared to the host sediment. In relation to this it is not clear what the difference in iron-manganese precipitate, partly accumulated as coatings on quartz particles, could imply in relation to different local radiation conditions. In other words, the question is raised if different post-sedimentary histories of sediments can result in different ages.

Wilczyce

Archaeological excavations at Wilczyce in southeast Poland (Fig. 1) revealed numerous Palaeolithic artefacts embedded in an ice wedge cast system (Fiedorczuk et al. 2007). Three samples were collected at around 1 m depth for TL dating from an exposed vertical section, one from the central filling of a wedge and two from within 2 m at either side of its adjacent host sediment. In all cases the sediment is well-sorted loess with mean particle sizes between 27 and 32 µm. The wedges can primarily be recognized by slight differences in colour as compared to the host sediment.

The TL samples were prepared under the auspices of Prof. A. Bluszcz at the Silesian University of Technology, Gliwice, Poland. The obtained ages are given in Table 4. The samples Wilczyce TL1 and TL2 were collected from the host sediment and TL3, which gave the oldest age, was taken from the wedge fill. In this locality the differences in age are less pronounced, and the older age of the wedge fill might be explained by sedimentation of reworked poorly bleached older loess as suggested by Prof. Bluszcz (information from Prof. R. Schild, Warsaw). On the other hand, it is striking that the ages of wedge fill and host sediment are reversed both in this locality and in Tjæreborg, in particular because it is only in these two localities that the attempts to date both wedge fill and host sediment were made at the same locality.

Table 4. TL ages from Wilczyce. TL1 and TL2 are from the host sediment just to the north and south of the wedge, respectively, and TL3 is from the wedge fill. The ages were provided by Jan Fiedorczuk, Warsaw, on 16 March 2001. Prof. R. Schild, Warsaw, kindly gave permission to use them in this paper. The samples were prepared under the auspices of Prof. A. Bluszcz, Silesian University of Technology, Gliwice, Poland

Sample ID		TL age, kyr
Laboratory	Field	
GdTL-607	Wilczyce TL1	41.0 ± 3.5
GdTL-608	Wilczyce TL2	40.0 ± 4.0
GdTL-609	Wilczyce TL3	47.0 ± 5.5

Danish coastal dunes

Subrecent coastal dunes near Vejers in west Denmark and at Skagen at the northern tip of Jutland, Denmark (Fig. 1) have been OSL dated to ages ranging from the last few decades to centuries (Clemmensen & Murray 2006). In as far as possible the samples were chronologically related to the history of local dune management and instrumental records of wind climate. Further details on environment and sedimentology are outlined in Clemmensen & Murray (2006).

The dunes were believed to represent the final phase of aeolian activity of relatively young dunes of a sedimentologically homogeneous nature over the areas (Clemmensen & Murray 2006). According to these authors, the sand was clean and incomplete bleaching was not regarded as significant in the investigated material. The post-sedimentary environmental conditions have most likely been fairly similar in different places, thus providing comparable conditions of burial, radiation, and preservation over the areas and through the investigated time interval.

The OSL age pairs that were obtained lie within a rather narrow subrecent time interval. At Vejers the single pair gave ages of 1782 ± 20 AD and 1712 ± 20 AD, i.e. they show a difference of 70 years. At Skagen there were three pairs which gave 1893 ± 11 and 1905 ± 8 AD, 1883 ± 13 and 1880 ± 12 AD, 1861 ± 17 and 1886 ± 13 AD, respectively. According to Clemmensen & Murray (2006), all ages fall within the expected time interval. In some cases it seems that the similarities of the ages might justify acceptance, but in the one from Vejers the percentage difference is somewhat large and in that case the authors suggest “that one sample may not always be sufficient to give an accurate age estimate” (Clemmensen & Murray 2006, p. 803).

The samples are from parabolic dunes, i.e. erosional landforms, and the timing of the depositional phase(s) may thus not be as clearly chronologically defined by climate records and historical data as the possibly younger blow out phases. From the investigation it is not possible to judge objectively about the reliability of the results, because individual OSL ages are not directly controlled by independent dating methods, and the proxy data are too coarse to be used for calibration at a sufficiently detailed scale. The age results lie within a narrow time interval and represent a very young set of samples. But this also means that differences of a few decades can represent relatively large uncertainties in percentages.

In accordance with the expectations, the OSL results clearly give ages from within the last few hundred years. This suggests that for an otherwise unknown area with subrecent dunes a series of OSL ages can provide a general chronological outline. On the other hand, the question may be raised to what degree the method can add detail to the records.

Examples of OSL ages in localities without independent time control

Luminescence dating has so far been applied in many contexts, and in several cases the results are consistent in as far as the upper samples also provide younger ages, but, with few exceptions (e.g. Bateman & van Huissteden 1999; Vandenberghe et al. 2004), each locality or area is represented by very few ages. But even in more thorough investigations attempts are sometimes made to ascertain and/or verify the OSL age results by correlations between different localities on lithostratigraphic or palaeobotanical grounds. When these results are seen on the background of the results from Sig and Orten as well as from Tjæreborg and Wilczyce above, such correlations may need to be done with extra caution even if more ages have been obtained from a locality.

DISCUSSION AND CONCLUSIONS

The examples and comments above lead to questions about to what extent luminescence ages can be regarded as reliable in relation to the purposes they are often used for. The sediments in all examples above are of aeolian origin, except for the host sediment in Tjæreborg, and can therefore be regarded as best suited for the method; yet, it is well known that total bleaching even of aeolian sediments may not always have taken place. The importance of making several age estimates from each locality (e.g. Kolstrup et al. 2007) rather than relying on single datings has been sufficiently emphasized in the literature, but the examples above show that even series of datings may not provide accurate answers. The OSL method is now well above 10 years old and the TL method a good deal older. During that time luminescence dating has been used widely and has received much support. It might be argued that the possibilities of testing against other methods seem to be limited and that luminescence dating is the only possibility in many areas. As a consequence, luminescence datings may come to stand on their own and become compared with each other rather than with independent control. Understandably, many geologists are eager to apply a chronologic system to their data, but only few of us master the dating techniques sufficiently well to realize the pitfalls fully, so there is a danger that without a thorough discussion on the potentials and limitations of luminescence dating the method may continue to be used as it is currently done.

On the background of the examples above it seems justified to raise the question if OSL ages can primarily be reasonably relied upon in homogeneous profiles with independent age control for calibration of at least part of the sequence; i.e., once an appropriate correction/calibration has been found for a part of a profile, it can be extrapolated and used for the whole profile, provided this is sedimentologically and hydrologically uniform as it seems to be the case for the Nussloch profile. And if, on the other hand, such conditions of uniformity are not fulfilled, the method gives results that cannot be sufficiently relied upon as it is seen with the results from Sig, Orten, and Tjæreborg.

Following the outline above, it also seems justified to raise the question of how far standing wisdom in the form of well-established, classical stratigraphic schemes and palaeoenvironmental frameworks, such as those proposed by van der Hammen et al. (1967) and Mangerud et al. (1974), have steered subsequent stratigraphic investigations to, rightly or wrongly, make new results fit in. If the uncertainties of a set of new datings are not taken fully into account, there is a danger of self-fulfilling prophecy and best-fit “guesswork” under a cover of objectivity. In this way alternative possibilities might not be taken as challenges to be tested and discussed, but the new dating results are merely applied to well-known systems, thus further confirming standing wisdom (e.g. Bateman & van Huissteden 1999; Kjær et al. 2006; Kolstrup et al. 2007).

Hopefully the problems with the examples that are put forward above can give rise to increased awareness of the possibilities and limitations of the OSL method. Geology and palaeoenvironmental reconstructions should not become victims of a willingness to accept an age that (seems to) fit in. It seems that the time has come for a keen debate on the use and limitations of luminescence methods in environmental reconstructions.

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OSL-dateerimine möödaniku keskkonnaolude rekonstrueerimiseks. Diskussioon meetodi kasutusperspektiivist

Else Kolstrup

On dateeritud eoolsetteid OSL-meetodi usaldusväärsuse selgitamiseks. OSL-dateeringute kontrolliks on kasutatud radiosüsiniku määranguid, ajaloolisi andmeid ja proovide omavahelist vanuselist sobivust. On järeldatud, et meetodi täpsus ja usaldusväärsus on stratigraafiliste ning paleogeograafiliste järelduste tegemiseks ebapiisav.