# Luminescence profiling of postglacial eolian dunes in central and northern Alberta using a portable OSL reader

Ken Munyikwa[1], Selena Brown[2]
[1]Centre for Science, Athabasca University, 1 University Drive, Athabasca, Alberta T9S 3A3
[2]Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, T6G 2E3

ABSTRACT
The luminescence profile of a depositional sequence depicts the variation of luminescence signals measured on sediments collected with depth. Though such profiling does not necessarily provide an absolute chronology by itself, it allows for the differentiation between sediments that will yield useful luminescence data and those that will not. When performed before regular luminescence dating, this saves both time and resources. In this study, we construct luminescence profiles of postglacial eolian dunes in central and northern Alberta using a portable optically stimulated luminescence (OSL) reader developed by the Scottish Universities Environmental Research Centre (SUERC). With the SUERC portable OSL reader, measurement can be performed on bulk sediments, negating the need for laborious separation procedures to isolate pure mineral fractions, as is required in regular luminescence dating. Measurements can also be carried out in the field, permitting quicker decision making during sample collection. Results in this study show that luminescence profiling enables one to distinguish between eolian deposits that make up the dunes from the non-eolian sandy substrate that underlies the eolian sands in some places. This differentiation is possible because the bleaching histories of the deposits are dissimilar. The delineation of the dune bases allows targeted sampling for luminescence dating that is designed to yield best approximations of the initiation of postglacial eolian deposition. Luminescence profiling of eolian sequences would also, in theory, permit the identification of depositional breaks of extended duration.

RESUME
Les profils de luminescence décrivent la variation des signaux luminescents des sédiments dans une séquence stratigraphique en fonction de la profondeur. Ce type de profils ne fournit pas de datations absolues à proprement parler, mais ils permettent de distinguer les sédiments propices à la datation par luminescence de ceux qui ne le sont pas, tout en réduisant le temps et les ressources nécessaires à la réalisation de ces datations. Dans cette étude, nous avons recours à système portatif d'analyse de luminescence optique stimulée (OSL) mis au point par le Scottish Universities Environmental Research Centre (SUERC), afin de produire des spectres de luminescence de sédiments éoliens (dunes) postglaciaires dans le centre et nord de l'Alberta. Le lecteur luminescent du SUERC permet d'effectuer des mesures directement sur des sédiments en vrac et donc, de s'affranchir des procédures laborieuses de séparation des éléments minéraux purs requises par les méthodes classiques de datation par luminescence. Les mesures peuvent également être réalisées sur le terrain accélérant, par la même, la prise de décision durant la collecte des échantillons. Cette étude démontre que la méthode des profils de luminescence permet de distinguer les dunes éoliennes du substrat sableux non éolien qui repose parfois en dessous. Une fois la base des dunes identifiée, un échantillonnage ciblé offre une meilleure évaluation de la formation des séries sédimentaires éoliennes postglaciaires. En théorie, les profils de luminescence de séquences éoliennes permettraient également d'identifier les lacunes de sédimentation de longue durée.

## 1 INTRODUCTION

Regular luminescence dating is a lengthy procedure that entails elaborate sample preparation as well as multiple measurements to arrive at an age of a given sample. In practice, not all samples that may appear datable in the field actually yield useful information in the lab. Problems usually arise from heterogeneous dose distribution in samples or partial bleaching of sediment prior to burial (Sanderson and Murphy, 2010). Dose saturation due to old age or low luminescence sensitivity of sediment grains also pose problems in some settings. Consequently, because sample luminescence measurement is only carried out near the end of the dating procedure, a significant amount of time and resources could be expended on samples that ultimately produce no useful data. A technique that can be used to discriminate between samples that could potentially yield useful information and those that would not is luminescence profiling (e.g. Sanderson et al., 2001; 2003; Burbidge et al., 2007; Sanderson and Murphy, 2010). Luminescence profiling does not necessarily provide absolute ages. Instead, it enables one to construct a profile that shows a variation of the luminescence signal with depth.

In this study, we use luminescence profiling to help demarcate the bottoms of postglacial eolian dunes. The work forms part of investigations that aim to extract chronological records contained in Late

Wisconsinan dunes in central and northern Alberta (e.g. Munyikwa et al., 2011a). Because the upper parts of the dunes are often reworked, they don't always yield chronologies that are representative of timing of the dune's initial emplacement. Hence, the objective is to collect samples from the lower part of the eolian deposits and date them using full-fledged OSL procedures. In places, however, the dunes overlie glaciofluvial sands which possess textures similar to those of the eolian deposits. This renders the eolian deposits difficult to differentiate from the underlying sediments which could lead to erroneous sampling. Furthermore, we have incorporated the use of an hydraulic auger to access the lowermost depositional units of the dunes (Munyikwa et al., 2011b). Unfortunately, augering introduces the possibility of overshooting the dune base during sampling. By characterizing the dune stratigraphy using luminescence profiling, we aim to explore the possibility of delineating cryptostratigraphic boundaries in the depositional sequences so that the transition from the dune sediment to the underlying non-eolian deposits can be identified.

## 2 PRINCIPLES BEHIND LUMINESCENCE PROFILING

Luminescence, in this context, refers to the energy given out in the form of light by minerals such as quartz and feldspar when stimulated by a light (or heat) source. The energy (or dose) accumulates in the mineral grains when radiation damage to lattices of the grains traps electrons. The radiation emanates from environmental isotopes within the surroundings of the sample such as potassium ($^{40}K$), uranium ($^{238}U$) and thorium ($^{232}Th$). Cosmic radiation contributes a small but notable fraction. Exposure to sunlight erases (bleaches) the accumulated energy. Thus, for any dose to build up in the grains, the sediment has to be buried. The number of electron traps within any mineral grain is finite and as long as these traps are not exhausted (saturated), the luminescence signal in a sample increases with burial age.

As a result, the luminescence signal given out by any sample depends on variables such as the burial age and the luminescence sensitivity of the sediment, as well as the local dose rates and level of bleaching experienced prior to burial (Lian and Roberts, 2006, Wintle, 2008). In settings where the burial age is the main variable determining the luminescence signal, the luminescence profile can be seen as a proxy for the chronostratigraphy and it enables one to identify changes such as significant age differences between successive strata within a given section, or age variations across erosional contacts.

Vertical luminescence profiling is carried out by collecting samples up stratigraphic sequences and measuring the luminescence signal given out after stimulation with an appropriate source. Signal measurement can be performed using regular laboratory based OSL readers. Alternatively, portable OSL readers can also be used. When using a portable reader, measurements can be carried out rapidly in the field. Furthermore, with the portable systems, analysis can be done on bulk samples containing both feldspar and quartz, negating the need to perform time consuming mineralogical separations as is required in regular OSL dating.

Luminescence profiling as an aid to sample collection in geochronological dating has been in use for almost a decade. Sanderson et al. (2001) used luminescence profiling to characterize cover sands that mantle large parts of South East Asia in an effort to determine their mode of genesis as well as their datability using luminescence methods. Also in South East Asia, Sanderson et al. (2003) used luminescence profiling to outline an ancient canal bed by delineating the luminescence contrast between the base of the canal and archaeological infills that now filled the former waterways. In these earlier studies, the luminescence measurements for profiling were carried out using regular laboratory based luminescence readers. Signalling a major development for field based luminescence measurements, the Scottish Universities Environmental Research Centre (SUERC) introduced a prototype of their portable OSL reader (1$^{st}$ generation) in 2005. Bishop et al. (2005) used this reader in the field to determine the effectiveness of bleaching (or zeroing of accumulated signal) of coastal sediment that occurred during the 2004 Indian Ocean Tsunami. Subsequently, Burbidge et al. (2007) used an improved (2$^{nd}$ generation) SUERC portable reader to conduct luminescence profiling of a Paleolithic archaeological site in Russia to determine the datability of the sediments as well as reconstruct a tentative depositional history of the site. SUERC portable OSL readers have since developed further and, as of 2010, 3$^{rd}$ generation portable systems were in production. A review of luminescence profiling using the SUERC portable OSL readers has been given by Sanderson and Murphy (2010) including case studies in which the systems have been employed. In all instances, the studies demonstrate that luminescence profiling is a useful technique for characterizing complex depositional sites as a precursor to full-fledged luminescence sample collection and dating.

In this study, we employ a 3$^{rd}$ generation portable OSL reader we acquired from the SUERC in 2010 to construct luminescence profiles of postglacial eolian dunes in Alberta.

## 3 THE SUERC PORTABLE OSL READER AND ITS OPERATIONAL MODES

The basic components of a portable OSL reader include a detector head containing a photomultiplier tube which is mounted over a sample drawer system (Figure 1). Housed in a separate box is the control unit which has the switchgear for operation. Power for the system can be derived from mains or, alternatively, from batteries housed in the control box. A laptop computer provides a user interface and data logging capabilities. Samples are introduced into the unit through the drawer in 50 mm diameter petri dishes (Sanderson and Murphy, 2010). The latest version of the SUERC portable reader is capable of both continuous wave (CW) as well as pulsed stimulation. The stimulation source outfit contains both an infrared source (IRSL) centred around 880 nm (intended for feldspars) and a blue OSL source centred around 370 nm (intended for quartz). The stimulation collar comprises 6 clustered diode ports in conjunction with RG780 long pass filters for the IR diodes and CG420 long pass filters for the blue diodes. Signal detection occurs through UG11 filters. In the pulsed mode, the pulse duration and the interlude between pulses can be varied between 1-99 µs. Signal detection occurs through a 24-bit photon counter which can be set for either unidirectional counting or for synchronous lock-in up/down counting. In synchronous pulsed mode counting, the unit can detect signals below the dark count rate of the instrument (Sanderson and Murphy, 2010).

Since the portable OSL reader can be used on bulk sediment, often containing both feldspars and quartz, it is necessary to maximize the signal yielded by the mineral targeted for stimulation. IRSL stimulation of feldspars in bulk samples is not usually problematic because the fast luminescence component of quartz does not appear to be significantly affected by IR stimulation at temperatures below around 125 °C (e.g. Spooner and Questiaux, 1989; Short and Huntley, 1992; Bailey, 1998; Jain and Singhvi, 2001; Wallinga et al., 2003). Blue light stimulation, however, also causes luminescence in feldspar such that if a bulk sample were to be subjected to blue OSL stimulation, the resultant signal would comprise signals from both feldspars and quartz. It is the case that a large proportion of the blue sensitive traps in feldspar are also emptied by extended exposure to IR stimulation (e.g. Duller and Botter-Jensen, 1993; Galloway, 1994; Jain and Singhvi, 2001). Thus, when the blue-OSL stimulation of a bulk sample containing feldspars and quartz is carried out after first exposing the sample to an IR source, a quartz dominant signal is obtained. This blue-OSL signal obtained after first stimulating the sample with an IR source is referred to as post-IR blue-OSL (e.g. Wallinga et al., 2002; Roberts and Wintle, 2003). It is the fact that IR sources do not stimulate all the blue-OSL sensitive traps in feldspars and that the post-IR blue-OSL signal from bulk samples will also have a feldspar contribution, albeit a reduced one (e.g. Thomsen et al., 2008). However, in luminescence profiling we are dealing with relative intensities of signals up the depositional sequence. Hence, the contamination of a quartz signal by feldspar may not be a problem in itself unless the feldspar vs. quartz ratios vary dramatically up the depositional sequence.

When operating the portable reader in CW mode, one can configure the system to make measurements of the dark-count as well as signal counts following IRSL or post-IR blue-OSL stimulation. These can be presented as integrated signal intensities of either IRSL or post-IR blue-OSL stimulation. From these one can derive signal depletion rates, calculated as the ratio of the signal intensity during the first half of the period of stimulation to that of the second half (Sanderson and Murphy, 2010). Another parameter that can be derived in the ratio of the IRSL signal ratio to that of the post-IR blue-OSL signal and this would be dependent on the mineralogy of the sample, largely the proportion of feldspars to quartz (Sanderson and Murphy, 2010).

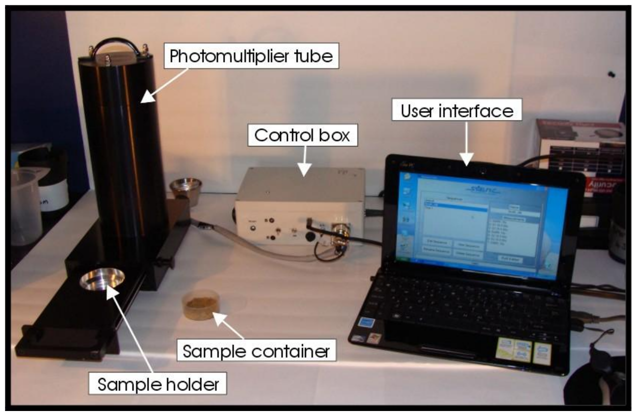


Figure 1 Basic components of a portable OSL reader system.

## 4 CASE STUDY: LUMINESCENCE PROFILING OF EOLIAN DUNES IN CENTRAL AND NORTHERN ALBERTA

### 4.1 Study area

The landscape of western Canada features in excess of 130 discrete eolian dune fields (Wolfe, 2007) the majority of which occur in the province of Alberta (David, 1977) (Figure 2). The dunes are largely stabilized and support significant vegetation. As fossil landforms, they are believed to be important records of environmental change that occurred in the past (Wolfe et al., 2004; 2007). Luminescence dating suggests that eolian deposition was active in central Alberta from as early as 15 ka (Wolfe et al., 2004; Munyikwa et al., 2011a). To date, however, the dating has been, for the most part, confined to the upper 1 to 3 m of dunes that attain heights of up to 20 m. Because the upper parts of eolian dunes are more susceptible to reworking, it would be desirable to also sample their bottoms in order to extract the complete chronological records that they contain. Samples from the lower parts of the dunes would serve as more accurate constraints for the timing of the initiation of eolian deposition in the region following the retreat of the ice sheets (Munyikwa et al., 2011a). During initial sampling exercises targeting the bottoms of the dunes, two complicating factors have been noted.

First, in places, the eolian dunes overlie glaciofluvial sands that are similar in texture such that the bases of the dunes are not always easy to delineate in open profiles. Second, to facilitate access of eolian units close to the base of the dune where open profiles do not exist, we have employed a portable hydraulic auger that can extract core samples from depths of up to 30 m (Munyikwa et al., 2011b). However, when extracting dune samples by drilling there is the possibility of inadvertently surpassing the stratigraphic base of the dune. This could lead to the extraction of sediments from the underlying non-eolian substrates. In either case, faulty sample collection would lead to erroneous paleoenvironmental interpretations. It is for this reason that luminescence profiling is being evaluated in this study as a methodology to differentiate between the two types of sediments.

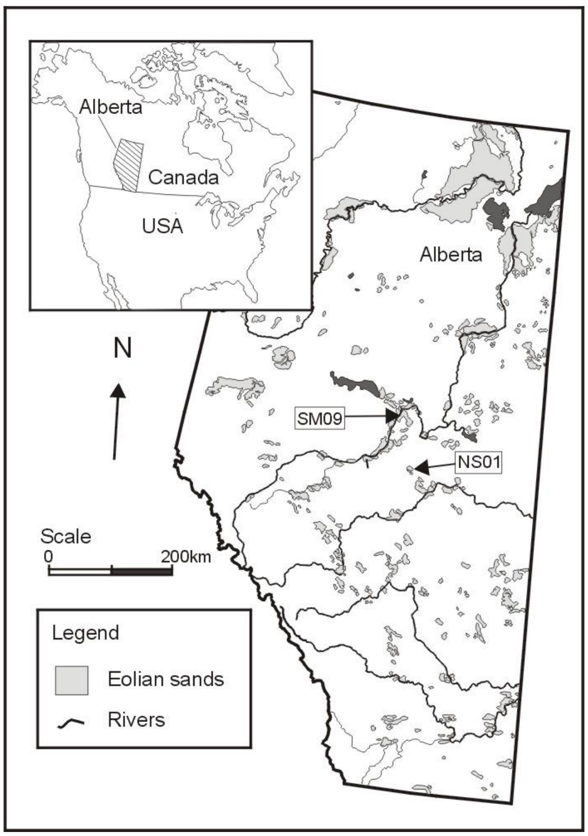


Figure 2 Study area in central Alberta showing sites SM09 (Hondo dune field) and NS01 (Nestow dune field).

4.2 Methods

As a preliminary investigation to assess luminescence profiling before applying it on a large scale in central and northern Alberta, sampling was targeted at the Nestow and Hondo dune fields in the central part of the province (Figure 2). In the Hondo dune field, the arm of a parabolic dune was drilled at site SM09 (55° 08.781' N, 114° 01.237' W) down to a depth of 21 m using a Dormer Drillmite™ hydraulic auger (see Munyikwa et al., 2011b). Samples for luminescence analysis were extracted at selected intervals (approx. 1 m) by hammering opaque ABS pipes (5 cm in diameter and 30 cm long) into the base of the hole once the desired depth had been reached. When retrieved, the ends of pipes were immediately capped with airtight packaging. In the Nestow dune field, a hole was drilled at site NS01 (54° 14.375' N, 113° 35.061' W) and samples for luminescence analysis extracted similarly.

At both sites, approximate elemental concentrations of potassium ($^{40}$K), Uranium ($^{238}$U) and Thorium ($^{232}$Th), which are the main sources of the accumulated dose in luminescence dating, were measured on auger tailings from the hole using an RS-230 BGO Super-SPEC® portable gamma-ray spectrometer. Even though the luminescence measurements on the samples could have been done in the field, the analyses were carried out in the lab using an SUERC portable OSL reader because the field visits were only single-day trips. For each measurement, about 10 grams of the bulk sample was introduced to the portable OSL reader in a 50 mm diameter petri dish under subdued amber lighting conditions. All measurements were carried out in CW mode. Runs were configured to automatically perform a 15 second dark count (background) first followed by a 60 second IRSL measurement (aimed at feldspar) after which another dark count was carried out followed by a 60 second post-IR blue-OSL measurement (aimed at quartz). A final dark count was performed to conclude each cycle.

4.3 Results

Results for the luminescence analysis and gamma ray spectrometry for sites SM09 and NS01 are listed in Tables 1 and 2 respectively. For each sample, a minimum of four aliquots were analysed and the readings averaged out. The luminescence signal is recorded as an IRSL total photon count (integrated intensity over a 60 second cycle) targeting the signal from feldspar and a post-IR blue OSL total photon count (also integrated over a 60 second measuring cycle) mainly targeting the signal from quartz. Also shown are the IRSL vs. post-IR blue OSL signal ratios. Figures 3 and 4 show the stratigraphic profiles discerned from open cuttings at each respective site.

4.3.1 Luminescence profile for Site SMO9

For Site SM09, the stratigraphy comprises sub-horizontally stratified sands. Grain size analysis shows that, save for minor variations, the sands throughout the 21 m section are fine grained (Table 1). From about 21.5 m downwards, the sediments change suddenly into silty clay which transitions into massive clay with depth. This part of Alberta was submerged under glacial lake Chisholm as the Laurentide Ice Sheet retreated during the Late

Wisconsinan (St-Onge, 1972). Hence, the clayey sediments are most likely glaciolacustrine deposits.

Table 1 Luminescence data and portable gamma-ray spectrometry for site SM09

| Depth (m) | Sample # | Grain Size (µm) | IRSL (photon counts) | Post-IR OSL (photon counts) | IRSL / Post-IR OSL | K% | U (ppm) | Th (ppm) |
|---|---|---|---|---|---|---|---|---|
| 1.5 | SM09-01 | 239 | 181408 | 426892 | 0.42 | 0.8 | 2.3 | 3.8 |
| 2.5 | SM09-02 | 200 | 267857 | 488296 | 0.54 | 0.7 | 1.5 | 3.0 |
| 3 | SM09-03 | 216 | 263807 | 478441 | 0.55 | 0.8 | 2.0 | 3.0 |
| 4 | SM09-04 | 203 | 254194 | 478755 | 0.53 | 0.8 | 1.0 | 3.7 |
| 5 | SM09-05 | 213 | 275706 | 543382 | 0.50 | 0.7 | 2.1 | 3.4 |
| 7 | SM09-06 | 215 | 264635 | 591166 | 0.44 | 0.7 | 1.4 | 4.0 |
| 8 | SM09-07 | 201 | 283298 | 594337 | 0.47 | 0.7 | 2.0 | 3.8 |
| 9 | SM09-08 | 200 | 257482 | 586085 | 0.43 | 0.8 | 2.0 | 3.1 |
| 10 | SM09-10 | 210 | 250950 | 565762 | 0.44 | 0.7 | 2.1 | 3.5 |
| 12 | SM09-12 | 185 | 265278 | 589506 | 0.45 | 0.8 | 1.6 | 3.3 |
| 13 | SM09-13 | 235 | 270853 | 601859 | 0.45 | 0.7 | 1.3 | 3.4 |
| 14 | SM09-14 | 202 | 276807 | 659064 | 0.42 | 0.7 | 1.7 | 4.0 |
| 15 | SM09-15 | 220 | 280432 | 652167 | 0.43 | 0.7 | 0.9 | 4.5 |
| 17 | SM13-01 | 196 | 293158 | 679136 | 0.43 | 0.7 | 1.7 | 4.2 |
| 18 | SM13-02 | 177 | 290544 | 614181 | 0.47 | 0.7 | 2.5 | 3.9 |
| 19 | SM13-03 | 188 | 280059 | 618502 | 0.45 | 0.7 | 1.9 | 4.0 |
| 20 | SM13-04 | 170 | 282087 | 592292 | 0.48 | 0.7 | 1,9 | 3.9 |
| 21 | SM13-06 | 177 | 287738 | 612286 | 0.46 | 0.8 | 2.5 | 3.2 |

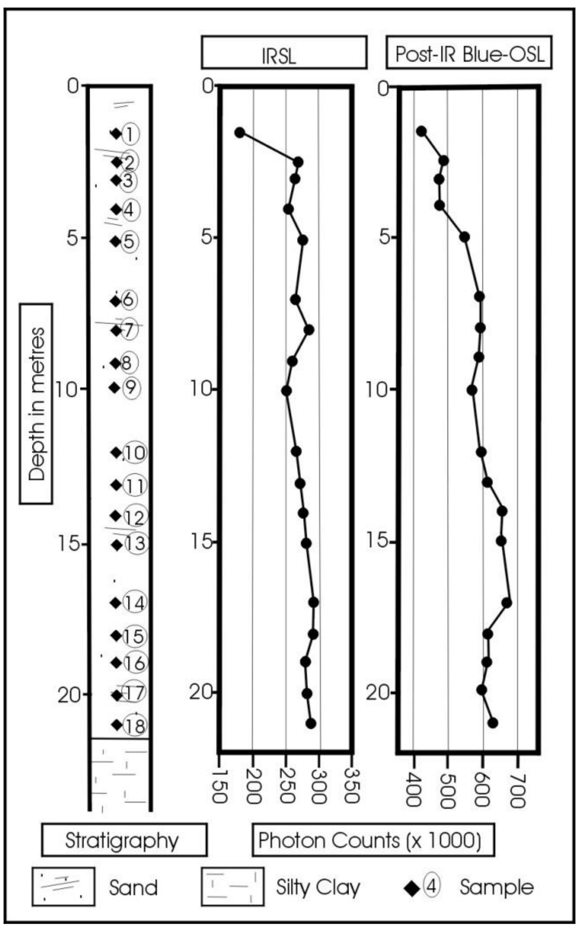


Figure 3 Stratigraphy and luminescence profiles (IRSL and post IR blue OSL) for site SM09.

The IRSL and post-IR blue-OSL signals increase by about 40% from depth 1.5 to 2.5 m. From about 3 to 21 m, the IRSL signal fluctuates but by less than 15% and, overall, the signal appears to increase with depth. One could consider this increase to be an aging-with-depth trend. However, taking experimental error into account, the signal could also be deemed relatively constant over the depth range of 3 to 21 m. The post IR blue-OSL signal, while it also fluctuates with depth, appears to increase by about 20% between depths 3 and 21 m.

The IRSL signal vs. the post-IR blue-OSL signal ratio decreases gradually with depth to reach a minimum between 15 and 17 m before rising again from 18 to 21 m. The fluctuation, however, is relatively minor and could be seen as an artefact of variations in feldspar vs. quartz content of the sediments. The concentrations of $^{40}$K, $^{238}$U, and $^{232}$Th do not vary much throughout the section either (Table 1), though $^{232}$Th increases slightly between 14 and 17 m.

Since the dose rates and mineralogical characteristics throughout the section are relatively constant, it can be argued that the main variable controlling the luminescence signals (IRSL and post–IR blue-OSL) depicted in Figure 3 is the burial age of the deposits. The upper 2.5 m have the youngest sediment whereas the lower 3 to 21 m contain the older deposits which have a signal that increases gradually with depth. The grain size characteristics of the whole sequence are consistent with an eolian origin. It is plausible that the lower part of the profile (3 to 21 m) was deposited steadily by wind and represents the main dune building phase. The absence of any major fluctuations in luminescence signals also suggests no extended depositional hiatuses occurred during the deposition of this part of the sequence. The signal from the upper 2.5 m,

Table 1 Luminescence data and portable gamma-ray spectrometry for site NS01

| Depth (m) | Sample # | GrainSize (µm) | IRSL (photon counts) | Post IR-OSL (photon counts) | IRSL/Post-IR Blue -OSL | K% | U (ppm) | Th (ppm) |
|---|---|---|---|---|---|---|---|---|
| **1** | NS01-OSL1 | 197 | 323246 | 588474 | 0.549 | 0.7 | 1.8 | 5.4 |
| **2** | NS01-OSL2 | 204 | 332158 | 631127 | 0.526 | 0.7 | 2.3 | 3.1 |
| **3** | NS01-OSL3 | 195 | 310952 | 617451 | 0.503 | 0.7 | 1.5 | 3.0 |
| **4** | NS01-OSL4 | 219 | 340642 | 636230 | 0.535 | 0.7 | 1.4 | 4.2 |
| **5** | NS01-OSL5 | 196 | 322783 | 697801 | 0.462 | 0.7 | 1.7 | 3.1 |
| **6** | NS01-OSL6 | 205 | 315869 | 710529 | 0.444 | 0.7 | 1.5 | 4.2 |
| **7** | NS01-OSL7 | 220 | 514377 | 1446689 | 0.355 | 0.7 | 1.2 | 4.0 |
| **8** | NS01-OSL8 | 234 | 559304 | 1535887 | 0.364 | 0.8 | 1.3 | 3.3 |

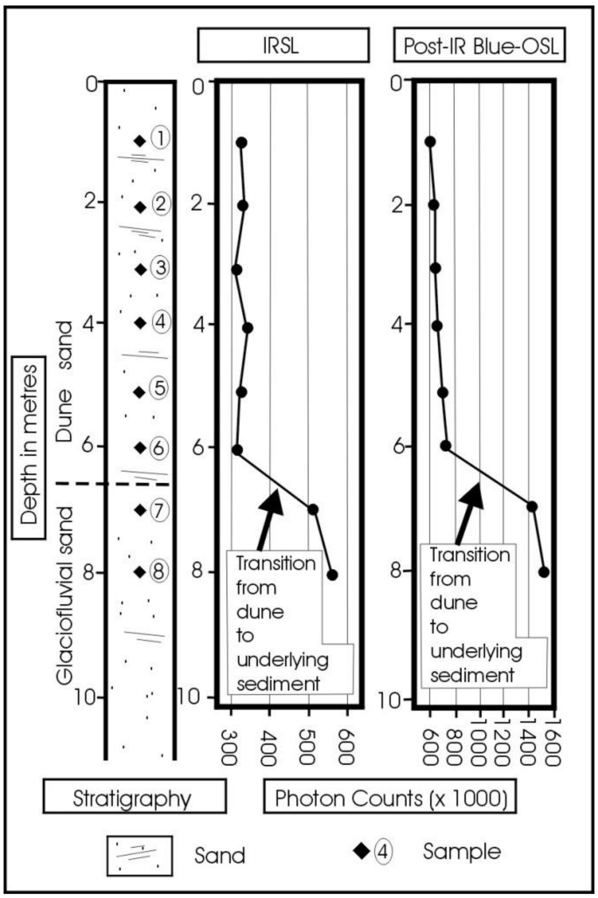


Figure 4 Stratigraphy and luminescence profiles (IRSL and post- IR blue OSL) for site NS01.

however, indicates that the upper part of the dune was deposited after a significant hiatus, possibly resulting from the reworking of the dune summit. The clayey substrate underlying the eolian profile indicates that the dune was emplaced directly on glaciolacustrine sediments. This information would be useful for sampling purposes for it demonstrates that the entire 21 m section of sands overlying the clayey substrate is eolian in origin and that any age obtained from the sequence would have to be interpreted accordingly.

4.3.2 Luminescence profile for Site NS01

Data for luminescence measurements as well as the gamma-ray spectrometry for site NS01 are given in Table 2. The IRSL vs. post-IR blue-OSL ratios as well as the isotopic concentrations of $^{40}$K, $^{238}$U, and $^{232}$Th are relatively constant throughout the profile. Hence any variations in IRSL and post-IR blue-OSL signals down the profile are mostly likely a function of the depositional age of the sediments. Figure 4 shows the lithostratigraphic section observed at the site as well as a graphical presentation of the IRSL and post-IR blue-OSL. The sediments are largely sub-horizontally stratified sands with grain sizes in the fine sand category (Table2). Notably, The IRSL and post-IR blue-OSL signals are relatively constant from 1 to 6m. From 7 to 8 m however, the signal almost doubles. Given the relatively constant dose levels and mineralogy, the sharp increase in the luminescence signals can be attributed to a significant difference is paleodose (or age of the deposits). The upper part of the landform is clearly a dune and if its age is considered to be postglacial but pre-Holocene (as has been determined from other dunes in the area - see Munyikwa et al., 2011a), the sands from the lower part of the profile would appear to have been deposited before the Last Glacial Maximum (LGM) (judging from the luminescence signal). Because the area was glaciated during the LGM, it is unlikely that the sands were deposited in-situ prior to the LGM. A more likely scenario is that the lower part of the section comprises glaciofluvial sands that were deposited as the ice sheets retreated. Because of the mode of deposition, the sands were poorly zeroed (partially bleached) such that the mineral grains they contain retained some pre-LGM dose in addition to the dose that accrued since the eolian sediments were deposited above them. Hence, the sharp increase in the luminescence signal between 6 and 7 m plausibly demarcates a transition from dune sediment to the underlying glaciofluvial sands. The identification of the bottom of the dune allows one to collect samples that would enable the approximation of the timing of the initiation of eolian deposition at the site.

5 CONCLUSIONS

Luminescence profiles of depositional sequences are influenced by variables such as mineralogy, luminescence sensitivity, dose rate and burial age. When all these variables, apart from time, are held constant, the relative variation of luminescence signals up a stratigraphic profile would be a function of the burial ages of the depositional units.

Accordingly, the two examples cited above demonstrate that by constructing luminescence profiles of sedimentary sequences, it is possible to gain an insight into the relative ages of individual depositional units. The ability to distinguish between the eolian sediments and the underlying glaciofluical sands at site NS01, for instance, was because the glaciofluvial sands had a luminescence signal that was significantly higher than that of the eolian sediments. This difference was most likely because the glaciofluvial sands were not well bleached prior to their emplacement. Using the same principles, it should also be possible to determine whether long chronological gaps exist within a given depositional facies such as an eolian dune. Such hiatuses would show up as a substantial difference between the intensities of luminescence signals yielded by deposits emplaced before and after the break. Apart from the upper part of the dune at SM09 where later reworking appears to have deposited younger sediments at the top of the profile, such depositional gaps are not apparent within the main eolian sequences at the two sites examined in this study.

Being able to delineate cryptostratigraphic boundaries in dune sequences in northern and central Alberta allows one to direct the collection of samples for detailed luminescence dating at formations that are likely to yield useful results. Carefully targeted sampling avoids the expenditure of time and resources on samples that are of limited scientific value. Given the abundance of eolian deposits in western Canada, it is arguable that luminescence profiling could play a valuable role in studies that aim to reconstruct Late Pleistocene environments of the region.

## ACKNOWLEDGEMENTS

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