

Thesis Abstracts

Author: Alessia Artesani
Thesis Title: Surface dating of bricks, an application of luminescence techniques
Grade: Masters
Date: April 2014
Supervisors: M. Martini, A. Galli
Address: Dipartimento di Scienza dei Materiali, Università degli Studi di Milano-Bicocca, Milano (Italy)

Luminescence techniques are nowadays a powerful tool to date archaeological ceramic materials and geological sediments. In particular thermoluminescence (TL) is widely used for brick dating, to reconstruct the building chronology of urban complexes. However, it can be sometimes inconclusive, since TL assesses the firing period of bricks that can be reused in different structures, even several centuries later. This problem can be circumvented by using a dating technique which uses a resetting event different from the last heating of the material: an ideal candidate is OSL, exploiting the last exposure to sunlight of the brick surface, which resets the light sensitive electron traps until the surface is definitely shielded by mortar and superimposed bricks. This advanced application of the OSL technique (surface dating) has been successfully attempted on rocks, marble and stone artifacts, but not routinely on bricks.

A recent conservation campaign at the Certosa di Pavia complex (Italy) gave the opportunity to sample some bricks belonging to a XVII century collapsed wall, still tied to their mortars. This thesis work aimed at testing the surface dating technique, by having the opportunity to compare the dating results with precise historical data. The study was carried out in two steps; in the first part the material behaviour after sunlight exposure has been checked. A non-rapid decrease of surface signal as consequence of a brief exposure to light, results in a limit the applicability of surface dating technique. In the case of samples examined here, a reduction of the luminescent signal by 75 % was found after 6 hours of exposure to sunlight, and a decrease of 90 % after 60 days of exposure. The response times of the material are in agreement with those reported in the literature for other types of materials.

The dependence of OSL/IRSL signal on the penetration depth of sunlight, on the exposure time and temperature has been studied. Freshly exposed

surfaces, cut in the laboratory at the middle of bricks, were exposed to sunlight for different periods (from 60s to 2 months), and the external 0.5 mm layer appeared to be fully bleached after a few hours of exposure. The bleaching of the deeper layer needed at least 1 month of exposure.

Five bricks were dated applying both TL (MAAD technique) and OSL (SAR protocol) on bulk and surface portion of the samples. The results showed that the bulk OSL EDs well matched the TL EDs. They were however systematically and significantly higher than the surface ones, shielded by the mortar layers. This was a strong evidence of the reuse of the material: the bulk date (XI century) is associated to firing in kiln, while the surface date (1530-1650 AD) was in agreement with the known age of the wall.

Author: Trine Holm Freiesleben
Thesis Title: Developing a Method for Luminescence Dating of Rock surfaces
Grade: Masters
Date: September 2014
Supervisors: Søren Hvidt, Bo Jakobsen, Andrew Murray, Reza Sohbati
Address: Roskilde University & The Nordic Centre for Luminescence Research

Interest in the optical luminescence dating (OSL) of rock surfaces has increased significantly over the last few years, as the potential of the method has been realised. In this study we investigate the information available in blue-stimulated luminescence depth profiles into the surfaces of 4 quartz-rich cobbles from a Neanderthal site (Les Roches d'Abilly) in western France, and IR stimulated luminescence depth profile from a feldspar-rich granite whetstone from an Iron Age villages near Aarhus in Denmark.

These profiles show qualitative evidence for multiple daylight exposure and burial events. To quantify both burial and daylight exposure events a new model is developed. The existing model describing the evolution of luminescence depth profiles is expanded to include burial before and after light exposure, and the possibility of repeated sequential daylight exposure and burial events. By determining the burial ages from the surface layers of the cobbles and by investigating the fitted luminescence profile, it is concluded that all cobbles were apparently well

bleached before burial. This indicates that the estimated burial ages are reliable. In all cases the burial age of the most recent burial event is consistent with the expected age (quartz OSL on sediments from Les Roches d'Abilly and archaeological context for the Aarhus site). In addition, a recent known daylight exposure event provides an approximate calibration for daylight exposure events.

This study thus confirms the suggestion that rock surfaces contain a record of daylight and burial history. Rock surfaces can therefore be dated with confidence, and it may be possible to determine a daylight exposure history using a known natural light exposure as calibration. Besides developing and applying the mathematical model, a preparation method for the samples used in this study has been developed. This development was based on knowledge of the chemical structure and properties of quartz and feldspar, together with X-ray fluorescence (XRF) measurements of full rock slices before and after chemical treatment.

It is concluded that, in order to extract pure quartz grains from the French samples, hydrogen chloride (HCl) should be added before etching with hydrofluoric acid (HF). If HCl is not used first to remove calcium carbonate from the rock slices, HF cannot attack and remove feldspar grains. It is also shown that the absence of feldspar in XRF analysis does not necessarily indicate that there is no infrared luminescence sensitivity, indicating that feldspar has not been completely removed.

Author: Marine Frouin
Thesis Title: Feldspars as support for the luminescence dating of archaeological deposits and quaternary sequences of Aquitaine
Grade: Ph.D.
Date: December 2014
Supervisors: Norbert Mercier and Christelle Lahaye
Address: Université de Bordeaux Montaigne, Esplanade des Antilles, 33607 Pessac cedex, France

Currently available chronological information for Middle Palaeolithic sites in southwestern France precludes the establishment of a robust chronological framework. For these early periods, developing such a framework relies upon important methodological advancements in numerical dating techniques.

The results of this study are essentially based on OSL dating of sedimentary feldspars and quartz. Focusing on the most commonly employed luminescence signals (IRSL, pIR-IRSL), it was possible to more clearly evaluate the reliability of dates obtained on K-feldspars. A dating protocol for these materials based on their radioluminescence signal (IR-RF) was also developed.

Optical luminescence dates were produced for six major archaeological sites: (Marillac, Charente), Combe Brune 2 (Creysse, Dordogne), Roc de Marsal (Campagne, Dordogne), Artenac (Saint-Mary, Charente), La Quina (Gardes-le-Pontaroux, Charente) et La Ferrassie (Savignac-de-Miremont, Dordogne). Collating the results for each archaeological level allowed the coherence of the dates to be tested and a reliable chronological sequence to be proposed for each site.

The different human occupations, characterised by their industrial attribution, could be placed within a chronological framework that incorporates regional palaeoenvironmental and palaeoclimatic variations. Finally, several observations provide new insights for our understanding of Neanderthal cultures.

Keywords: *Middle Palaeolithic, chronological framework, potassic feldspars, quartz, optical luminescence, radioluminescence, palaeoclimate, palaeoenvironment, Neanderthal cultures.*

Author: Xiao Fu
Thesis Title: Development of luminescence dating using feldspar and its application to river terraces in north piedmont of Chinese Tian Shan
Grade: Ph.D.
Date: October 2014
Supervisor: Sheng-Hua Li
Address: Department of Earth Sciences, the University of Hong Kong, Hong Kong, China

This thesis study focused on developing luminescence dating procedures for feldspar, and applying the luminescence dating technique to fluvial terraces of Anjihai River in the northern piedmont of Tian Shan range, China, to evaluate the deformation rate of the Anjihai anticline in the late Quaternary.

In development of luminescence dating methods, a low temperature multi-elevated-temperature post-infrared stimulated luminescence (MET-pIRIR) protocol has been proposed for measuring the Holocene samples using K-feldspar. Progressively

increasing IR stimulation temperatures from 50 to 170 °C in step of 30°C were used in the protocol. The residual doses for the MET-pIRIR signals were generally less than 1 Gy. This protocol was further simplified to a three-step pIRIR method, with three stimulation temperatures of 110, 140 and 170°C. It has been shown that these new pIRIR methods can be applied successfully to aeolian samples within the Holocene.

A high temperature MET-pIRIR dating protocol was initially applied to polymineral fine grains (4-11 µm), recovered from Chinese loess samples collected at Luochuan that accumulated within the last glacial-interglacial period. The MET-pIRIR ages for fine grains were compared with the coarse grain (63-90 µm) K-feldspar MET-pIRIR ages and the coarse grain quartz OSL ages, and the stratigraphic age controls. The results show that the MET-pIRIR protocol can be applied to fine grains from these loess samples without fading correction.

A plateau test, termed the $D_e(T, t)$ plot, was proposed as a self-diagnosing tool for the pIRIR dating protocols. The pattern of the $D_e(T, t)$ plot was shown to be affected by non-bleachable signal, partial bleaching and anomalous fading effects. The achievement of a plateau in the $D_e(T, t)$ plot indicates that the non-fading signal has been achieved, and the effects of non-bleachable dose and partial bleaching are negligible. The $D_e(T, t)$ test was successfully applied to different pIRIR protocols.

A series of loess and fluvial sand samples were collected from the north piedmont of Tian Shan range to determine appropriate dating procedures for samples in this area. Luminescence properties of quartz and K-feldspar grains extracted from these samples were investigated. The extent of bleaching for the samples and the reliability of the measured ages were assessed based on equivalent dose distribution and age comparison between chronometers. Optimized dating procedures for samples in north Tian Shan have been proposed. K-feldspar MET-pIRIR dating is recommended for the loess samples, while single aliquot quartz OSL dating is suggested for the fluvial sand samples, after consideration of signal brightness and the extent of signal resetting.

The dating procedures proposed above were applied to the deformed fluvial terraces of Anjihai River in the north flank of Tian Shan. Combined with topographic measurements, the deformation rate of the Anjihai anticline was evaluated. The average shortening rates of the Anjihai anticline since 3.6 ± 0.1, 9.0 ± 0.6 and 53.3 ± 2.2 ka were calculated to be 1.4 ± 0.3, 1.2 ± 0.3 and 0.5 ± 0.1 mm/a, respectively. It suggests that the northern Tian Shan region was tectonically active during the late Quaternary, especially in the Holocene.

Author: Sebastian Kreutzer
Thesis Title: Luminescence dating of heated silex – Potential to improve accuracy and precision and application to Paleolithic sites
Grade: Ph.D.
Date: August 2012
Supervisors: Alexandra Hilgers, Ulrich Radtke
Address: Institute for Geography, University of Cologne, Otto-Fischer-Str. 4, 50674 Köln, Germany

Understanding morphological processes that sculpt former terrestrial landscapes is one of the driving rationales in Quaternary research. Loess records have been found to be valuable archives for reconstructing paleoenvironmental conditions. However, once identified, characterised and classified by fieldwork, the stratigraphic significance of such records has to be revealed by numerical dating. Luminescence dating, especially optically stimulated luminescence (OSL), is the leading dating approach for establishing chronologies on loess archives. Furthermore, the development of luminescence dating techniques on sediments is closely connected with the history of loess research and vice versa.

As part of the European loess belt the Saxonian Loess Region is located in a transition zone between oceanic dominated western and continental dominated eastern climates. The Saxonian Loess Region comprises up to 20 m thick Weichselian loess accumulations, with intercalated paleosols. For the first time, during the work on this thesis, high-resolution numerical chronologies were established in the Saxonian Loess Region on five loess sections using OSL dating on quartz separates. The dating was employed as a comparison of three quartz grain size fractions commonly used for luminescence dating: (1) coarse (90–200 µm), (2) middle (38–63 µm) and (3) fine grain (4–11 µm). As a survey on four loess sections, three from Germany (Saxony and Saxony-Anhalt) and one from the Czech Republic, these studies investigate the question whether the use of different grain size fractions from one sample yield consistent luminescence characteristics and age results. In summary, seven studies are presented along with an extended summary.

Four studies present numerical chronologies using OSL dating techniques on different grain size and (mineral) fractions. Two studies deal with technical issues that arose during the dating applications. Firstly, an R package for luminescence dating data analysis ('Luminescence') was developed and

secondly, the cross-bleaching behaviour of IR-LEDs of Risø luminescence readers were quantified. One study treats the question whether the common practice of using an identical alpha-efficiency (a -value) for the conventional IR50 and pIRIR225 dating is justified under theoretical and empirical viewpoints. It was found that for the established numerical chronologies on loess the fine grain quartz fraction results in reliable age estimates up to the Eemian (MIS 5e, 5d). The high-resolution dating in Saxony uncovered a prominent hiatus of ca. 30 ka between the early and the late Weichselian found in all investigated loess sections in Saxony. The fine grain quartz age results are confirmed by the polymineral fine grain dating. For lower dose ranges ($De < 100$ Gy) age results of all three grain size fractions agree within uncertainties. However, the coarse and middle grain fractions show highly scattered distributions. For higher doses ($De > 180$ Gy) the luminescence signals of the coarse and middle grain fractions are in saturation. In contrast, the luminescence signal of the fine grain fraction still grows and is reproducible as shown by test measurements.

The results of a cross-bleaching survey on 10 luminescence readers revealed substantial cross-bleaching behaviour of the IR-LEDs (mean cross-bleaching: ca. 0.026 %), which is an order of magnitude higher than for blue LEDs. The investigation on the a -values of polymineral fine grain samples gave evidence for significant differences between the mean a -values obtained with the IR50 and the pIRIR225 signals. The a -value obtained with the pIRIR225 signal was found to be always higher, but further investigations are needed.

A PDF of this thesis can be downloaded from:
<https://epub.uni-bayreuth.de/1673>

Author: Jillian Moffatt
Thesis Title: Testing the TT-OSL Single-Aliquot Protocol for Quartz Sediment Dating
Grade: Masters
Date: June 2014
Supervisors: Nigel A. Spooner and Barnaby W. Smith
Address: Institute for Photonics and Advanced Sensing (IPAS), School of Chemistry and Physics, University of Adelaide, Australia

Thermally-transferred optically stimulated luminescence (TT-OSL) is a form of optically

stimulated luminescence that saturates at much higher doses than conventional OSL (Wang et al, 2006b). Luminescence sediment dating is a technique whereby the natural radiation dose given to a sample is measured. This is divided by the environmental radiation rate of the sample site to give the sample's age. As TT-OSL is able to measure higher doses than conventional OSL, it has been considered a candidate for long range luminescence sediment dating, beyond one million years. In this thesis, TT-OSL single-aliquot sediment dating protocols were tested on selected samples from the south-east of South Australia (SESA) stranded dune sequence, a sequence of ancient dunes ranging from 0 to 900 thousand years of age that have previously been independently dated using luminescence and non-luminescence dating methods. A young sample with a high natural dose from Baldina Creek, Burra, South Australia was also dated. Measurements of the thermal depletion of the TT-OSL signal were also made.

It was found that, for the SESA samples, TT-OSL dating results do not agree with previous independent measurements above 200 ka. The results for the young Baldina Creek sample were within the expected range.

Author: Muhammed Zeynel Öztürk
Thesis Title: Quaternary Geomorphology of North Cyprus Coasts (between Cape Kormakiti-Cape Apostolos Andreas-Cape Elea)
Grade: Ph.D.
Date: May 2013
Supervisor: Dr. Ahmet Evren ERGİNAL
Address: Department of Geography, Niğde University, TR-51240, Niğde, Turkey

Cyprus Island located in the Eastern Mediterranean has strongly been affected by tectonic activities resulting from plate movements, and the uplift of the island continues at the present. The Island has also been affected by the Late Quaternary and Holocene climatic and sea level changes. These changes have had great impacts on the development of the coastal geomorphology. Proofs of these changes are preserved in the beach rocks, marine deposits, wave-cut platforms and eolianites that formed along the coastline. Beachrocks in 23 localities, fossiliferous marine deposits in 3 localities, eolianites in 3 localities, wave-cut platforms in 5 localities were investigated at NCTR coasts in this thesis. Based on

the analysis of the samples collected from the above mentioned localities, the significance of these forms were investigated in terms of the geochemical, geostatistical and dating studies to evaluate the Late Quaternary and Holocene climatic changes, sea level fluctuations and tectonic controls.

The dip direction measurements from the eolianite beds indicate that the paleo wind directions are in accordance with present day wind characteristics. Thus, prevailing wind directions in the Eastern Mediterranean have not showed any significant changes since the formation of the eolianites in Late Quaternary. The ages of the beach rocks, based on the OSL datings, are between 0.442 ± 0.079 and 5990 ± 0.341 BP. These beach rocks were formed in both intertidal and supratidal environments as recognized by calcitic cement types such as meniscus bridge, dogtooth, pore filling and micritic envelopes. Sea level curve shows that beach rocks were formed in two successive rising sea level periods that occurred in a low sea level condition between 0 m and -1m. At present these beach rocks are found well above the mean present sea level despite the fact they formed at 0 and -1 meters. This implies that the tectonic uplift is greater than sea level rise in North Cyprus and this tectonic uplift has occurred at a rate of 0.04 mm/year over the past 6000 years. As the results are compared with the beach rocks studies carried out at the southern coasts of Turkey, it is suggested that a considerable uplift has occurred in the Cilicia-Adana Basin, which is bordered by Misis-Kyrenia Fault Zone. Based on the analyses carried out on wave-cut platforms it is noted that, despite the considerable uplift in the area, the rates of uplift differs locally along the North Cyprus.

Author: René Rojas Rocca
Thesis Title: Study of luminescent centers of quartz crystals applied to sediment dating by using Optically Stimulated Luminescence.
Grade: Ph.D.
Date: December 2012
Supervisor: Sonia Hatsue Tatumi
Address: Physics Institute of São Paulo University, São Paulo, Brazil. (Present address: Marine Science Department, Federal University of São Paulo, São Paulo, Brazil.)

The principal aim of the presented work is to study the Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL) of quartz crystals obtained from sediments located at the coast of the state of Maranhão. The analysis of OSL and TL properties was carried out after gamma and beta irradiation, pre-heating, and exposure of samples to solar radiation, having in mind the dating of these sediments. EPR measurements were performed to investigate the possible paramagnetic centers in the sample, as well as establishing some correlation with the OSL and TL centers.

Measurements of single grain dating showed an unexpected behaviour. This result could be evidence that the centers responsible for TL and OSL are not the same. Ages obtained by OSL depend only on the brightest grains, while ages obtained by TL depend on the contribution of multiple grains. The XRD measurements carried out at LNLS confirmed that all the separated grains were quartz grains, although different grains produced different OSL emission, suggesting that these properties are related to different intrinsic point defects and impurities in the grains. EPR signals were measured for quartz grains, using a microwave power of 0.161 mW. It was possible to isolate the signal of the E'1-center. This signal is known to increase from 120 to 300 °C and decreases by treatment beyond 300 °C up to 450 °C and may be related to the TL peaks at high temperatures. ESR measurements at 77 K showed the presence of Al centers. Annual Dose values were found to be between 0.7 to 3.0 mGy/year, and for some profiles the values were more constant (Location B: 1.77 to 1.95 mGy/year). The ages obtained with OSL and TL and the MAR protocol are quite similar, although those obtained by OSL usually are somewhat smaller than the ages obtained by TL. The stratigraphic depths of sediments are directly proportional to the ages obtained. The three ages of the second profile are within the Pleistocene, while the other profiles show ages starting in the Late Pleistocene to Holocene.

A PDF of this thesis can be downloaded from <http://www.teses.usp.br/teses/disponiveis/43/43134/td-27032013-135335/es.php>

Author: Rajendra Shrestha
Thesis Title: Optically Stimulated Luminescence (OSL) dating of aeolian sediments of Skåne, South Sweden
Grade: Masters
Date: 2013
Supervisors: Helena Alexanderson and Charlotte Sparrenbom
Address: Rajendra Shrestha, Department of Geology, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden.

Wind is an important agent of transportation of sediments and to change the landscape. Aeolian sediments can be inferred as a proxy for past climate. In Sweden aeolian sediments are not widespread and there are not so many studies on chronological and paleoenvironmental aspects. It is believed that aeolian sediments were deposited right after deglaciation and reactivated during recent times as a result of human impact and climatic deterioration. For this study, cover sand in Blentarp, south Sweden was selected. Twelve samples for OSL measurement, two samples for ¹⁴C and ten samples for grain size analysis were collected. The main aim of this study was to determine the timing of aeolian sand deposition and to relate it with past climate and environment. A widely accepted chronological technique for aeolian sediment, Optically Stimulated Luminescence (OSL) dating technique was applied to measure the age of the sand deposit. The result from this investigation suggested that there were five episodes of aeolian sedimentation. The oldest event recorded during this study was after deglaciation at ca. 15 200 a. The second episode was at ca. 14 500 to 13 000 a and the last date obtained in this event is at the beginning of the Younger Dryas. The third episode of deposition was at ca. 1900 -1700 a at the time of the Roman warm period. Fourth episode was at ca. 400 -300 a and the fifth or latest episode was at ca. 200 -160 a at the time of the Little ice age. The first episode was deposited right after deglaciation and the remaining four episodes were deposited probably due to climatic impact such as strong storminess or by human activities.

Keywords: *Skåne, South Sweden, Vomb basin, Aeolian, Sediments, Grain size, Luminescence, OSL, Chronology*

Author: Lauren M. Simkins
Thesis Title: Antarctic raised beaches: Insight on geochronology, relative sea level, and coastal processes
Grade: Ph.D.
Date: September 2014
Supervisors: Alexander R. Simms, Regina DeWitt
Address: Department of Earth Science, University of California Santa Barbara, 1006 Webb Hall, Santa Barbara, California USA, 93106 (Present address: Department of Earth Science, Rice University, 6100 Main Street, Houston, Texas USA, 77005)

Beaches are preserved above sea level along ice-free portions of the Antarctic coastline due to post-glacial rebound associated with glacial isostatic adjustment since the Last Glacial Maximum. The ages and elevations of these beaches provide relative sea-level constraints for glacial isostatic adjustment models and ice-sheet histories. Due to harsh field conditions and difficulty dating Antarctic materials, a lack of geochronological constraints on raised beaches limits our understanding of relative sea level around Antarctica. The focus of the studies discussed here is on Antarctic raised beaches with goals to improve the methods of dating cobble surfaces from raised beaches using optically stimulated luminescence and use the dated beaches to reconstruct relative sea level and better understand Antarctic coastal processes throughout the Holocene. Through a series of cleaning methods applied to sample carriers used for optically stimulated luminescence measurements of sediment, the contamination of dose-dependent, variable signals from sample carriers previously assumed to have neutral signals is eliminated. An analysis of optically stimulated luminescence characteristics of quartz from cobble surfaces with sample petrology and cathodoluminescence provides insight on the suitability of Antarctic materials for optically stimulated luminescence dating. The limited amount of quartz (<10%) found in the majority of the samples often occurs as intergrowths in feldspars characterized by irregular, anhedral crystal form. A lack of discernible relationship between optically stimulated luminescence and cathodoluminescence properties and petrology suggest that cathodoluminescence behavior and petrology are not responsible for the poor luminescence characteristics observed from quartz extracted from cobble surfaces. A relative sea-level history of Marguerite Bay,

Antarctic Peninsula derived from optically stimulated luminescence-dated beach cobble surfaces further constrains post-glacial rebound since the Last Glacial Maximum. New ages suggest the Holocene marine limit for Marguerite Bay is 21.7 masl with an age of ~ 5.5-7.3 ka. Our favored hypothesis for the ages of the beaches from 21.7-40.8 masl at Calmette Bay is that the beaches formed prior to the Last Glacial Maximum. The temporal distribution of circum-Antarctic raised beaches throughout the Holocene is utilized to determine the relationship between wave-energy, sea ice, and coastal evolution. The distribution of raised beaches throughout the Holocene around Antarctica shows synchronous periods of beach formation in the Antarctic Peninsula and the Ross Sea centered at 2.0, 3.5, and 5.3 ky BP while East Antarctic (outside of the Ross Sea) beach formation is out-of-phase with the rest of Antarctica at 3.2, 4.2, 5.8, and 6.5 ky BP. The distribution of beaches in the South Shetland Islands is dominated by enhanced beach formation between 0.2 and 0.7 ky BP most likely due to rapid post-glacial rebound associated with the Little Ice Age with minor peaks in beach formation from 1.3-2.2, 5.1-5.6, and 6.0-6.5 ky BP. Beach formation results from higher wave exposure during periods of reduced sea ice observed from comparison with Holocene sea-ice proxies. The anti-phasing of beach formation in the Antarctic Peninsula and Ross Sea compared to East Antarctica is markedly similar to the phasing of modern and Holocene climate forcing around Antarctica. The findings of these studies focused on Antarctic raised beaches have implications for understanding sea-level, glacial isostatic adjustment, ice-sheet histories, and coastal processes since the Last Glacial Maximum.

Contact L.M. Simkins for a copy of the dissertation at lsimkins@rice.edu or download from Ancient TL.

Author: Rachel K Smedley
Thesis Title: Testing the use of single grains of K-feldspar for luminescence dating of proglacial sediments in Patagonia
Grade: Ph.D.
Date: November 2014
Supervisors: Geoff A.T. Duller, Neil F. Glasser
Address: Department of Geography and Earth Sciences, Aberystwyth University, UK

In recent years single-grain dating of quartz has been used to provide luminescence ages of proglacial sediments but the poor sensitivity of the optically stimulated luminescence (OSL) signal of quartz can make dating in some geographical regions challenging. The main aim of this study is to improve luminescence dating in glacial environments by developing and testing methods of single-grain dating of K-feldspars from proglacial sediments using the post-IR infra-red stimulated luminescence (pIRIR) signal. The Lago Buenos Aires valley in Patagonia was chosen as the study site because the existing chronology in the valley that constrains the ages of moraine deposition provides a rare opportunity to compare luminescence dating of proglacial sediments with ages determined using independent dating techniques.

A number of challenges associated with single-grain luminescence dating of K-feldspar are addressed in this study in order to provide accurate ages using the technique. This includes developing a procedure using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to directly measure the internal K-content of individual grains of K-feldspar, and provide an average internal K-content appropriate for single-grain dating where geochemical measurements of individual grains are not available. Experiments are also performed in this study to demonstrate that the reproducibility of single-grain pIRIR luminescence measurements can be optimised by reducing the disc location temperature from an elevated temperature to room temperature and using the IR LEDs to bleach the grains during the SAR cycle. Laboratory bleaching experiments also demonstrate that the bleaching potential of the pIRIR signal is not expected to be a barrier for single-grain dating of samples in this study.

Finally, IRSL ages are provided for single grains of K-feldspar from two aeolian dune sand samples that were taken from above and below the Kawakawa tephra from North Island, New Zealand, and for a suite of ten proglacial samples from the Lago Buenos Aires valley that are associated with the deposition of moraine ridges dated using cosmogenic isotope dating and $^{40}\text{Ar}/^{39}\text{Ar}$ dating. The ages ranging from 15 – 111 ka presented in this study agree with the independent numerical age control within dating uncertainties. Therefore, this study suggests that the technique can be used to provide accurate ages for aeolian and proglacial sediments.

Author: Ruochen Wang
Thesis Title: Optical Dating of Young Lacustrine Sediment from Lake Manas in Northwestern China
Grade: Masters
Date: August 2014
Supervisor: Sheng-Hua Li
Address: University of Hong Kong

Manas Lake is a closed and dried lake in the Junggar Basin with catchment area of 11,000 square kilometers. The lake is particularly sensitive and important to the study of paleo-climate changes, because the climate in the catchment area is dominantly influenced by the Westlies. Dating of lake paleo-shorelines and lacustrine sediments can provide chronological evidence of water level and climate changes. No evidence for Holocene high lake level was found by previous studies.

The ages of samples were determined using Optically Stimulated Luminescence methodologies. The slope method was used for the determination of the equivalent dose of quartz. Series of Lx and Tx from a number of aliquots for each regenerative dose are analysed to obtain an averaged slope value of the Lx/Tx, by separately fitting Lx-Tx plots under each regenerative dose. In this thesis, the slope method was tested for a series of young lacustrine sediment. It is found that using the slope method can save 40% of the time used needed the conventional SAR procedure. The errors were reduced by measuring a large number of natural aliquots. This approach can effectively improve the reliability of optical dating. It is preferred for dating of young samples, because of weak signals and poor precision.

Fifteen lacustrine sediments and shoreline deposits were dated. These samples were from a borehole, a profile section and shoreline deposits of the latest high lake level. High-resolution data were achieved by using the slope method of OSL signals from quartz for the lacustrine sediments. Magnetic susceptibility of these samples was measured as a proxy for revealing paleo-climate changes. The OSL ages suggested that the lake had experienced a rapid deposition process during 200~600 years ago. Such ages agreed well with the ages of the last high lake level, which was the age of the little ice age. It is concluded that the paleo-climate of Lake Manas was cold and wet during the little ice age. Sedimentation gaps with age gap of 70ka were found between sediments of the little ice age and sediments beneath, from both the lacustrine borehole and paleo-shorelines. It implies that Lake Manas probably drained for a considerable time.

Author: Yali Zhou
Thesis Title: Climate changes in the Mu Us and Otindag sand fields (north China) during the late Quaternary: An investigation based on optically stimulated luminescence dating and multi-proxy indicators
Grade: Ph.D.
Date: July 2008
Supervisors: Huayu Lu and Joseph A. Mason
Address: Institute of Earth Environment, Chinese Academy of Sciences, Department of Geography, University of Wisconsin-Madison, USA

The dune system in the Mu Us and Otindag sand fields of northern China is sensitive to climate change, where the local climate is controlled by the East Asian monsoon. It is one of the key sites to investigate the history of past environmental changes in China. Alternating sandy loam soils with sand layers in these sand fields indicate multiple intervals of dune activity and stability. In this study, twenty-one representative sand-sandy soil-sandy loess sections from the Mu Us and Otindag sand fields are investigated with optically stimulated luminescence (OSL) dating to establish the chronology of wet-dry climate variations during the Late Quaternary. On basis of 66 OSL ages and the proxies of grain size distribution, magnetic susceptibility, organic matter content, organic $\delta^{13}\text{C}$ value and Zr/Rb ratio from more than 300 samples, which are directly related to the climate variations, we refine the regional wet-dry changes and the warm-cold events in the past circa 60 ka.

The equivalent doses (De) were determined by the single aliquot regeneration (SAR) protocol with 90-125 (150) μm pure quartz particles. The OSL dating results provide a relatively complete and well-dated chronology for wet and dry variations from 57.1 ka to 0 ka. To some extent, the limitations of previous chronology are overcome.

Comparison of the grain-size distribution ($>63 \mu\text{m}$), the magnetic susceptibility and the total organic matter show that the latter two are positively related, and both are negatively related to the coarse grain-size ($>63 \mu\text{m}$) fraction. High sand ($>63 \mu\text{m}$) content is considered to be a direct indicator of the dunes' activity, while the total organic matter and the magnetic susceptibility are indicative of stable dunes. Furthermore, the total organic matter is more sensitive to climate change, especially wet-dry changes, than the magnetic susceptibility. Although

the stable carbon isotopes in soil organic matter (SOCI) can be used as a proxy index of intensity of the summer Asian monsoon in two sand fields, the SOCI variation within plants using a single photosynthetic pathway must be taken into account, especially when the vegetation is pure C₃ plants. Our study indicates that there is no linear relationship between SOCI and the summer monsoon intensity. Zr/Rb ratio, which is positively related to the coarse grain-size (>63µm) fraction and the mean particle size in the Mu Us sand field, may serve as a proxy index of the strength of the East Asian winter monsoon. However, this is limited to the Otindag sand field due to the difference of source rocks.

In the Otindag sand field, the widespread dune mobilization occurred at 17.7ka; from 9.9 ka to 8.2 ka, it was a dry climate. The dunes were mainly stabilized between 8.0 ka and 2.7 ka, implying a relatively wet climate, although there were short-term penetrations of dune activity during this wet period. After ~2.3 ka, the region became dry again, as inferred from widespread dune activity. The “8.2ka” cold event and the Little Ice Age climatic deterioration are detected on the basis of the dune records and OSL ages. During the Medieval Warm Period and the Sui-Tang Warm Period, climate in Otindag sand field was relatively humid and the vegetation was denser, and the sand dunes were stabilized again.

In the Mu Us sand field, the climate was relatively dry between 57.1 and 52.5 ka and the dune system was active. Sandy loess deposition occurred at around 41.2 ka and 37.7 ka, indicates the climate was relative humid and the sand dunes were in the relative stable condition. During the episode of 13.7 and 12.7 ka, coarse sand layers were deposited again, climate was relatively drought-prone, vegetation cover decreased, and the sand field expanded. It was humid as sandy soil developed at 11.6 ka. During the interval of 10.97- 8.67 ka, the total organic matter and the lithology show wet-dry alternate frequently, but the sandy dunes are still mainly active. The Holocene Optimum was revealed from 8.5-2.4 ka, the sandy soil was widely formed in this time. The uppermost aeolian sand layers yielded OSL ages of 0.15 and 0 ka respectively, suggesting the dunes are mobilized in modern times. Some abrupt environment changes, such as H5, Younger Dryas and MIS3 climatic events, were found in the Mu Us sand field.

These aeolian records reveal the climate changes at millennial time scales during the Late Quaternary in the two sand fields, and these climatic changes may be linked to climate variation elsewhere in the Northern Hemisphere, through atmospheric circulation.

Keywords: *OSL dating, Late Quaternary, Mu Us sand field, Otindag sand field, climate change*