

## Thesis Abstracts

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**Author:** Yorinao Shitaoka  
**Thesis Title:** Contribution of luminescence dating to the Paleolithic studies in East Asia  
**Grade:** Ph.D.  
**Date:** March 2005  
**Supervisor:** Masayoshi Mizuno, Tsuneto Nagatomo  
**Address:** Department of Literature, Nara University, Misasagi 1500, Nara, Japan

The objective of this study is to apply optically stimulated luminescence (OSL) dating to archeological sediments in order to establish a chronological framework of paleolithic archeology in East Asia. Moreover, thermoluminescence (TL) dating of Japanese marker-tephras (e.g. Aira-Tanzawa pumice, AT) was carried out. 64 samples were collected from 27 locations from Nihewan basin, China, Imjin-Hantan basin, Korea, Russian Far East (the Maritime region), Sakhalin and Japan. The paleodose of each sample was estimated using quartz coarse grains, polymineral fine grains and quartz fine grains.

For make luminescence measurements, an original TL/OSL system (NRL-99-OSTL) was developed. It has two assemblies for temperature control, one can raise the temperature to 500 °C and the other is cooled at -150 °C by flowing liquid nitrogen. The TL/OSL system automatically measures the TL and OSL up to 32 aliquots. For OSL measurements, a stimulation source that consists of 32 blue light emitting diodes (LEDs) at 470 nm (Nichia Chemical Industries Co., Ltd., Japan) is installed. This LED unit is exchangeable with another unit with 32 infrared LEDs at 890 nm (Hamamatsu photonics Co., Ltd., Japan). Luminescence signal is detected by a photomultiplier tube (Hamamatsu R1140P) which is cooled to -20 °C through two condensing lenses and optical filters.

OSL ages of archeological sediments were obtained between 220 ka and 6 ka. TL ages of marker tephras ranging between 530 ka and 26 ka were obtained. These luminescence ages are in agreement with the various paleoenvironmental data. These ages will contribute to understand the paleo-human activity and paleolithic industry in East Asia.

**Author :** Ya-Wen Chen  
**Thesis Title:** Luminescence dating on Quaternary sediments: Cases of active structures in western Taiwan  
**Grade:** Ph.D.  
**Date:** July 2008  
**Supervisor:** Yue-Gau Chen, Andrew S. Murray  
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Hundred thousand years is only a short period in the history of earth, however, it is the most momentous period for human being. If scientists would like to predict the future, to learn the trend of the past is the key and reliable chronological data are needed. This study presents the feasibility and application on luminescence methods. After multiple tests this method has been confirmed to provide confident results to interpret regional tectonics. Sequence stratigraphy and continuous chronological framework, especially from the luminescence dating, are integrated to investigate the accommodation space for specific drill site in southwestern coastal plain of Taiwan. It concludes the tectonic subsidence has been on-going since very late Pleistocene with a depo-centre located further southwestwards. Also a tectonic uplift due to detachment westward migration is proposed to occur after 100 ka. Furthermore, with the anticipation to diminish losses during earthquake disaster, multiple dating methods, in particular focusing on luminescence dating method, are employed in the studies to explore the details of active faults. The Chiuchungkeng Fault and Chelungpu Fault have been both tested in this study to deduce the long-term slip rate and fault behavior. Based on the proper experiment criteria for each different area, luminescence dating method is acceptable to be adopted for the Quaternary researches in western Taiwan.

**Author:** Procopios Kouremenos  
**Thesis Title:** Testing the use of OSL on cobbles from the raised beaches of King George Island, Antarctica  
**Grade:** MSc  
**Date:** December 2008  
**Supervisors:** Alexander Simms, Regina DeWitt  
**Address:** Boone Pickens School of Geology, Oklahoma State University, Stillwater, USA

**Author:** Abigail E. C. Stone  
**Thesis Title:** Multi-proxy reconstructions of late Quaternary environments in western southern Africa.  
**Grade:** DPhil  
**Date:** August 2009  
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The purpose of this thesis is to find a new method for dating raised-beach deposits in order to create more accurate sea-level curves for the Antarctic Peninsula. Reconstructions of the Antarctic Peninsula Ice Sheet (APIS) at the Last Glacial Maximum remain poorly constrained due to a lack of geologic data, which has resulted in a variety of ice-sheet models for the APIS during the Late Pleistocene and Holocene. Sea-level data can be used to estimate the past thickness and volume of ice sheets by comparison with geophysical models of the response of the Earth to ice and water loading. The few sea-level curves that do exist along the Antarctic Peninsula are taken from areas of known tectonic activity or are limited by the use of radiocarbon dating. Radiocarbon dating is limited by the availability of organic material, the poorly constrained radiocarbon reservoir for Antarctica, and the possibility of reworking. We test the use of optically stimulated luminescence (OSL) in dating cobbles from raised beaches within the South Shetland Islands of the Antarctic Peninsula. OSL is commonly used for sediment, but the application to rocks is in its infancy. Methods were developed to isolate quartz grains from the shielded undersides of cobbles from raised beaches last exposed to sunlight in the intertidal zone.

Of the 12 samples obtained from the shores of Maxwell Bay, 8 contained enough material for OSL analysis. The corrected OSL ages for the beaches range from 0a (modern beach) to 2048a  $\pm$  123 (9.0m beach) and are in agreement with calibrated radiocarbon ages from the same deposits. In addition, the OSL ages are all internally consistent in that ages obtained from higher ridges are always older than lower ridges and ages obtained from the same ridges overlap one another. In conjunction with their elevation, the OSL ages were used to reconstruct sea-levels for the South Shetland Islands. Because of the large radiocarbon reservoir in Antarctica, OSL is shown to be a more precise method for dating raised beaches than radiocarbon techniques.

The position of the southern African subcontinent in the mid-latitudes means this region was influenced by fluctuations in a number of atmospheric and oceanic climate circulation systems during the late Quaternary. Whilst the reconstruction of palaeoenvironmental and palaeoclimatic conditions in southern Africa has developed rapidly over half a century, our understanding remains limited by poor spatial coverage and sources of uncertainty within our existing data. The availability of terrestrial proxy archives is restricted by the arid nature of the environment. Sedimentary landforms, such as aeolian dunes and the silt, mudstone and tufa deposits associated with fluvial systems are vital sources of palaeoenvironmental information.

This thesis considers the dimensions of uncertainty in three key terrestrial proxy archives. Linear sand dunes, interdune water-lain deposits and tufa are used to reconstruct palaeoenvironmental conditions at three sites in Namibia. The uncertainty relates to sampling strategies, chronological control and palaeoenvironmental interpretation. Optically stimulated luminescence (OSL) dating has been applied to linear dunes in the west of the southern Kalahari linear dunefield and to interdune deposits in the northern Namib Sand Sea, whilst the utility of  $^{234}\text{U}$ - $^{230}\text{Th}$  dating was tested for tufa deposits in the Naukluft Mountains.

This study demonstrates the influence of sampling strategy on the dunefield-scale record of linear dune accumulation; the choice of vertical sampling interval is important, a young bias is introduced in datasets with a shallow sampling bias, and small datasets demonstrate a reliance on individual sites. This study also provides a revision of radiocarbon based chronologies for water-lain units in the northern Namib Sand Sea. This adds further evidence to avoid radiocarbon-based humidity-proxy histograms using inorganic carbonates for reconstructing palaeoenvironments. This study establishes a rigorous methodology for increasing confidence in  $^{234}\text{U}$ - $^{230}\text{Th}$  dating of fluvial tufa deposits. The record of

environmental change preserved at these three sites provides insight into the dynamic response of these terrestrial proxy archives to Quaternary climatic fluctuations since MIS 5. Southern Kalahari linear dunes record a period of accumulation at the transition from MIS 2 to the Holocene, centred on ~10 ka. The Tsondab River progressively retreated eastward from MIS 5 to present. The Naukluft tufa include deposits of considerable antiquity, deposition of barrages prior to MIS 5 and some Holocene deposition inside the channel.

**Author :** Saiko Sugisaki  
**Thesis Title :** High resolution optical dating for marine sediments from North Pacific Ocean  
**Grade :** PhD  
**Date :** September 2009  
**Supervisors :** Yoshifumi Nogi, Hideki Miura, Andrew Murray, Jan-Pieter Buylaert, Tatsuhiko Sakamoto  
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Marine sediments contain important archives of past ocean and climate changes, but at high latitudes, such as the polar regions, the absence of carbonate has prevented the construction of accurate chronological models. To get an age model, a method which does not rely on carbonate is needed. In this thesis we have investigated the potential of optically stimulated luminescence (OSL) dating to establish a chronology for our deep sea sediment cores from the Northern Pacific area. OSL dating makes use of the omnipresent quartz and feldspar grains in the sediment so there is no limitation in the presence of the dosimeter. Optical dating is a widely accepted dating method for terrestrial sediments, but only few studies have tested its reliability in the marine environment.

A luminescence age reflects the time that has elapsed since the sediment grains were last exposed to sunlight. The luminescence age equation contains two equally important factors: the equivalent dose and dose rate. The palaeodose is the total radiation dose that crystals (quartz, feldspar) have absorbed during burial, and the dose rate is the rate at which the sample was exposed to ionising radiation in the

environment. Ionising radiation comes from the decay of natural radionuclides (the  $^{238}\text{U}$ ,  $^{232}\text{Th}$  series and  $^{40}\text{K}$ ) present in the sediment. Dividing the equivalent dose by the dose rate gives the luminescence age of the sample.

This study is focused on testing the reliability of the optical dating method when applied to marine sediments from the Northern Pacific ocean, more specifically in regions that are known for seasonal-sea ice. The aims of this thesis are (1) determine the accuracy of luminescence ages, e.g. by comparison with AMS  $^{14}\text{C}$  dating and marine oxygen isotope stratigraphy where possible, (2) produce a high resolution sequence of absolute ages which can describe changes in sedimentation rate through time, and (3) test whether it is possible to date back to marine isotope stage 5e (MIS 5e).

In this thesis we have made use of fine (4-11  $\mu\text{m}$ ) grains of quartz extracted from the marine sediment cores taken in the south-western Sea of Okhotsk, the Bering Sea and the Central Sea of Okhotsk. In the first study, a high resolution optical age dataset (64 samples) from the south-western Sea of Okhotsk showed continuous ages up to 24 ka and indicated clear sedimentation rate differences during glacial and interglacial periods. Also for the most northern located core in the Bering Sea (sub-arctic area), the OSL ages (12 samples) go back to 64ka and the ages are in good agreement with the  $^{14}\text{C}$  ages up to 25ka. The OSL ages from both of south-western Sea of Okhotsk and the Bering Sea are in good agreement with the  $^{14}\text{C}$  ages. In the third study in the central Sea of Okhotsk, a test of accuracy of the OSL ages back to MIS 5e was carried out. The OSL ages (40 samples) are in good agreement with the well-established oxygen isotope stratigraphy at this site back to the MIS 5e (130ka). In all these studies, the luminescence characteristics of the dosimeter are investigated in detail and extensive tests of the performance in the chosen measurement protocol are presented.

Despite the good agreement of the optical ages with the independent age control, it must be noted that the OSL ages are largely dependent on the water content. The evaluation of the appropriate water content model is discussed. It appears that the observed water content values, measured immediately after core extraction, seem to give the most accurate ages.

This thesis shows that OSL dating is a useful method for dating marine sediment in the North Pacific area. The data confirm that the OSL dating using fine-grain quartz that is distributed all over the ocean's sediments has very great potential in the establishment of an absolute chronology for deep sea sediments; because luminescence dating does not depend on the presence of carbonate for AMS  $^{14}\text{C}$  dating, it is now likely that we can establish a

chronology is regions of the ocean that were previously undatable.

**Author:** Daniel Rufer  
**Thesis Title:** Characterization and age determination of Quaternary volcanism in the southern Ankaratra region (central Madagascar) through novel approaches in luminescence dating  
**Grade:** Ph.D.  
**Date:** October 2009  
**Supervisors:** Guido Schreurs (Bern), Alfons Berger (Copenhagen), Edwin Gnos (Muséum d'Histoire naturelle de Genève), Frank Preusser (Bern)  
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This work introduces two novel approaches for the application of luminescence dating techniques to Quaternary volcanic eruptions: crystalline xenoliths from lava flows are demonstrated to be basically suitable for luminescence dating, and a set of phreatic explosion deposits from the Late Quaternary Vakinankaratra volcanic field in central Madagascar is successfully dated with infrared stimulated luminescence (IRSL).

Using a numerical model approach and experimental verification, the potential for thermal resetting of luminescence signals of xenoliths in lava flows is demonstrated. As microdosimetry is an important aspect when using sample material extracted from crystalline whole rocks, autoradiography using image plates is introduced to the field of luminescence dating as a method for detection and assessment of spatially resolved radiation inhomogeneities.

Determinations of fading rates of feldspar samples have been observed to result in aberrant g-values if the pause between preheat and measurement in the delayed measurements was kept short. A systematic investigation reveals that the phenomenon is caused by the presence of three signal components with differing individual fading behaviour. As this is restricted to short pauses, it is possible to determine a minimal required delay between preheating and measurement after which the aberrant behaviour disappears.

This is applied in the measuring of 12 samples from phreatic explosion deposits from the Antsirabe – Betafo region in the Late Quaternary Vakinankaratra

volcanic field. The samples were taken from stratigraphically correlatable sections and appear to represent at least three phreatic events, one of which created the Lac Andraikiba maar near Antsirabe. The obtained ages indicate that the eruptive activity in the region started in the Late Pleistocene between 113.9 and 99.6 ka. A second layer in the Betafo area is dated at approximately 73 ka and the Lac Andraikiba deposits give an age between 63.9 and 50.7 ka. The youngest phreatic layer is dated between 33.7 and 20.7 ka.

These ages are the first recorded direct ages of such volcanic deposits, as well as the first and only direct ages for the Late Quaternary volcanism in the Vakinankaratra volcanic field.

This illustrates the huge potential of this new method for volcanology and geochronology, as it enables direct numerical dating of a type of volcanic deposit which has not been successfully directly dated by any other method so far.

**Author:** Sally E. Lowick  
**Thesis Title:** Luminescence dating of long palaeoenvironmental records from the Alpine foreland  
**Grade:** Ph.D.  
**Date:** December 2009  
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Optically stimulated luminescence (OSL) was applied with the aim of constraining the chronology of long palaeoenvironmental records from the Alpine foreland. Preliminary work on samples from the Valeriano Creek on the southeastern Alpine foreland identified anomalous fading in the feldspar fraction, but was able to successfully date both coarse and fine grain quartz from the same samples to beyond 200 ka. These ages helped to constrain the deposition of sediments in order to understand the environmental response to climate change, and allowed a comparison of fluvial dynamics north and south of the Alps. The work then moved to dating a long sedimentary core taken from Azzano Decimo in the Friulian foreland of northeastern Italy, from which the palynostratigraphy required chronological constraint. Due to desiccation of the core, only the consolidated silty sediments were sampled to ensure they had not been exposed to light, and a method was formulated for retrospectively calculating the water content of the samples. This method was then tested on fresh samples and results suggested that it was a reliable procedure. Dating of the polymineral fraction proved unsuccessful and so the work focused on the

fine grain quartz and this was measured principally using a modified single-aliquot regenerative-dose protocol. Despite all samples meeting the performance criteria usually set for assessing the reliability of the protocol, the samples suffered significant age underestimation beyond ~ 70 ka when compared to independent age constraint. The determination of dose rates using both high resolution gamma spectrometry and instrumental neutron activation analysis compared well, suggesting that these were reliable, and also confirmed the absence of any radioactive disequilibrium. As age underestimation in quartz is now frequently reported in the literature, the study then focused on investigating its origin by comparing the behaviour of the Azzano quartz with that from the Niederweningen mammoth site, north of the Alps, where OSL ages agree well with expected ages up to 200 ka. The application of both a single-aliquot regeneration and added-dose, and a sensitivity-corrected multiple aliquot regenerative protocol, were not able to overcome the age underestimation seen at Azzano. Both the stability of the OSL signal used for dating, and the source traps of this signal were investigated, and suggest that it should be reliable for dating. Although the quartz OSL dose response is generally expected to fit well to a single saturating exponential function, samples from both sites displayed an additional linear growth at high doses. Several avenues of investigation were unable to identify the origin of this component, although analysis of the growth displayed by burial doses confirmed that this phenomenon was also present in the natural signal and not only generated within the laboratory. In all comparative analyses of samples that display both a significant age underestimation and those that agree well with expected ages, it was not possible to detect any variation in their behaviour, or an indication of when equivalent dose determination could be proved reliable.

