

Thesis Abstracts

Author: Ágnes Novothny
Thesis Title: Luminescence dating of Quaternary aeolian sediments from Hungary
Grade: Ph.D.
Date: December 2008
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Loess, loess-like sediments and aeolian sand cover great areas of Hungary. The study areas of this thesis are located in the Gödöllő Hills and along the right bank of the Danube in North-Hungary, both areas are covered by young aeolian sediments.

Different luminescence methods and techniques were applied in order to find the most appropriate protocol to date the sediments of these regions. First IRSL multiple aliquot methods were used for feldspar and polymineral fine grain samples at Albertirsa, Süttő and Tura. The results were in agreement with the previous dating results from Hungary during the 1990s, mostly measured with the same protocol. However, significant age underestimation was observed in all cases, possibly due to anomalous fading of the feldspars. In the next step single aliquot regeneration protocols were applied for quartz and feldspar. The uncorrected IRSL SAR results basically yielded the same results like those of the IRSL MAAD protocol. However, more precise results were obtained by the SAR protocol, especially for very young samples. The main advantage of the SAR protocol over the MAAD method for the samples investigated in this thesis, that fading tests and corrections can be achieved. The fading corrected IRSL ages are more reliable and fit better to the stratigraphical expectations. The younger fading corrected ages (up to 50-60 ka) are consistent with the OSL ages of some quartz samples and with the radiocarbon results. The older fading corrected IRSL ages (90-130 ka) are still underestimated, very likely due to the applied correction method, which is suitable and set up for young samples, or due to the early saturation of the IRSL signal hindering the exact dating of these old samples.

Theoretically OSL dating of the quartz yields more precise ages contrary to the feldspar ages, since the quartz does not suffer from anomalous fading. Unfortunately the OSL properties of the quartz were poor in all samples. Some samples yielded results

from the Tura section despite of their dim OSL signal. It is likely, that the glacial material from the Alpine region, carried by the palaeo-Danube, is responsible for the poor luminescence properties of the quartz minerals in both investigated regions.

Summarising the results, the dating of the Süttő and Tura profiles using IRSL MAAD and SAR protocols makes connection between the dating carried out in the past and will be carried out in the future. In a stratigraphical point of view the most important result, that the age of the last interglacial soil, can be found at Süttő, seems to be confirmed by chronological methods like amino acid racemization and luminescence.

Author: Qi-Shun Fan
Thesis Title: Quartz optically stimulated luminescence chronology for high lake level periods in the eastern Qaidam Basin, northeastern Qinghai-Tibetan Plateau since late Quaternary and its palaeoenvironmental implications
Grade: PhD
Date: June 2009
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Qaidam Basin is located in the northeastern Qinghai-Tibetan Plateau (QTP), which deposited many lakes (salt lakes now) and preserved a series of shorelines or highstand lacustrine sediments around some lakes. Controversy exists regarding the chronology for high lake levels of lakes in the QTP. Significant efforts have been invested to define the timing of palaeoshoreline deposits using radiocarbon dating on the QTP, and 'pan-lake period' (40~28 ka BP), 'the greatest lake period' (40~25 ka BP) or 'rather warm and humid period' (40~30 ka BP) has been proposed in Late Marine Isotope Stage (MIS) 3. Also using ¹⁴C dating, similar observations were reported from adjacent regions, such as the Tengger Desert, the Badain Jaran Desert and the Taklamakan Desert in western China. In recent years, however, others argued that Qinghai Lake, located in the east

of Qaidam Basin on the northeastern QTP, developed a large lake in the period of 110–75 ka (corresponding to MIS 5). Lake level is even lower than present during MIS 3.

Therefore, the aim of this study is to establish the quartz OSL chronology, using SAR protocol, for high lake level periods in the eastern Qaidam Basin and discuss evolution history of Gahai Lake, Toson Lake and Shell Bar based on the geomorphic evidence of lakeshore sediments and environmental proxy (carbonate content) of Shell Bar section. It is concluded that:

(1) By analyzing laboratory tests (such as preheat plateau, dose recovery test, growth curves and scatter of D_e for samples), the results indicate that the SAR protocol is appropriate for D_e determination for lacustrine deposits in the eastern Qaidam Basin.

(2) OSL dating results show that high lake levels of Gahai Lake, Toson Lake and Shell Bar in the eastern Qaidam Basin occurred in MIS 5, MIS 3 and early–middle Holocene. By comparison high lake level records of lakes in study region with other lakes (Qinghai Lake, Namco Lake) on the QTP, we found that they are almost synchronous, and high lake levels are gradually dropped since MIS 5. The possible mechanism for the formation of high lake levels in the eastern Qaidam Basin was strong Asian summer monsoon.

Author: Alexander Kunz
Thesis Title: Coastal and dune evolution in south east India revealed by optically stimulated luminescence dating: Reconstruction of sediment dynamic, event history, climatic and environmental change for the last 3500 years
Grade: PhD
Date: October 2010
Supervisors: Brigitte Urban (Leuphana University Lüneburg), Manfred Frechen (Leibniz-Institute for Applied Geophysics)
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Sediments in drylands or coastal areas are good archives for palaeoenvironmental studies. They preserve and reflect changes in climate, events like storms or tsunamis and human impact. The application of dating methods allows establishing a geochronological framework which can be used, e.g.,

to correlate periods of dune and soil formation to past dry and wet climate conditions or to estimate a recurrence interval for events like storms, tsunamis and earthquakes. The investigation of coastal areas is important as coasts are one of the most dynamic landforms and in many parts of the world densely populated. The impact of events like storms and tsunamis or climatic change has severe consequences on the ecosphere, geosphere and anthroposphere. The knowledge about coastal processes and their timing can help in developing plans for coastal protection and risk assessment.

The aim of this study was to establish a reliable chronological framework for the coastal development of the Andaman Islands and south east India. This framework was used to understand the timing of coastal processes and to reconstruct the genesis of sediments and connect them with events which are indicative for environmental and climatic changes. The dating was done using optically stimulated luminescence (OSL) and radiocarbon. Based on the physical properties of the OSL dating method it is an excellent tool to determine the depositional age of sediments.

On the Andaman Islands coastal sediments have been investigated to find evidence for palaeotsunamis and palaeoearthquakes and to reconstruct the recurrence interval for strong events like the Indian Ocean tsunami from December 2004. Sediment material from event-layers was dated using OSL and radiocarbon dating. The results show evidence for strong earthquakes at around 1000 and 3000 years before present and they reflect the storm activity for the last 1000 years. Also the complex pattern of co- and postseismic uplift and subsidence of the Andaman Islands could be reconstructed.

At the south east coast of India dunes in the Cuddalore area have been investigated. These dunes form a belt running parallel to the coast. A transect from the coast to the most western dune inland was investigated. The dunes show sedimentological features like unconformities, changes in the direction of bedding, erosional features, water escape structures and remnants of human settlement and soil-like horizons which are indicative for environmental changes. The results from the dunes show a connection between the monsoon activity for the last 3500 years and periods of sand movement and stabilisation of dunes. The younger dunes show a connection between periods of reduced rainfall and sand mobilisation for the last 200 years. The investigation of the younger dunes shows also that the dune system in the study area reacts very sensitive to changes in rainfall and disturbances in the landscape.

Based on the dating and sedimentological results of this thesis it can be concluded that the coastal areas

are very dynamic with rapidly occurring environmental changes. This research draws a clearer picture of the dynamics of coastal environments in south east India and the Andaman Islands and thus provides useful information for coastal zone management planning.

Author: Anni Madsen
Thesis Title: On the evolution of tidal basins - Absolute chronology, geomorphology and sedimentology
Grade: PhD
Date: May 2010
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Tidal basins and bar-built estuaries make up 13% of the world's coastlines. These areas act as important ecosystems for birds and wildlife. Low-lying sand flats within the inter-tidal zone and salt-marshes fringing these tidal basins may be severely threatened by anticipated global warming scenarios, which lead to a sea-level rise. This depends, however, to a large extent on how the sedimentation in these low-lying wetlands responds to an accelerated rate of sea-level rise.

The main objective of this study is to describe the spatial and temporal variability of sedimentation inside tidal basins in order to determine the role of sea-level variations on sedimentation in inter-tidal environments. More specifically, this study investigates whether variations in relative sea-level are the 'key driver' for sedimentation by attempting to compare inter-tidal sedimentation rates from three sites that have experienced different sea-level histories.

Sedimentation rates are determined by dating different layers in the sedimentary deposits. Absolute chronologies, obtained using luminescence dating are established from sediment cores, which were recovered in the Danish part of the Wadden Sea (Lister Dyb tidal basin) and in two estuaries in New Zealand (Whanganui Inlet and Parengarenga harbour). The luminescence dating technique assesses the period of time elapsed since quartz and/or feldspar grains were last exposed to daylight, for example as a result of sediment transport in the coastal environment. Radiocarbon dating of underlying peat deposits is used as independent age control to validate the luminescence chronology. The geomorphological and sedimentological evolution

during the past few millennia is then described based on investigations of these sediment cores and associated chronologies.

Bioturbation by lugworms lead to post-depositional mixing of the surface sediments that may hamper the establishment of an absolute geochronology. The effects of bioturbation processes on the luminescence ages are therefore investigated. This is done by looking at high-resolution age-depth trends which allows the maximum age offset, the bioturbation rate and a mixing depth of ~20 cm to be determined for a sandy tidal flat in the Wadden Sea. Consequently, the upper ~20 cm of the sediment package (corresponding to 100–200 years of deposition) cannot be used to evaluate temporal trends in sedimentation rates at sandy tidal flats with lugworms, and doing this will lead to serious misinterpretations. However, sedimentary archives from inter-tidal mudflats may be useful to describe the recent (<100 years) temporal trends in sedimentation rates, because preserved sediments are more complete and less disturbed at tidal mudflats than at sandy tidal flats.

High-resolution records of the sedimentation rates of both sandy and muddy tidal deposits have been obtained, despite post-depositional mixing processes. Luminescence dating provides one of the first absolute chronologies for recent to millennial inter-tidal sand deposition in the Wadden Sea, which has been obtained with this degree of detail in time and space. The long-term sedimentation rate averaged over the last few millennia is ~0.7 mm·a⁻¹ in Lister Dyb tidal basin. This is comparable to the relative sea-level rise, which has been observed for the last 2000 years (Szkornik et al., 2008). At a majority of the sites, the sedimentation on the tidal flats is able to keep pace with the relative sea-level rise.

The establishment of sediment budgets for sandy tidal flats is now possible, because the coarse-grained fraction of the sediment in tidal basins can be dated with luminescence dating. This offers new opportunities to the problem of determining contemporary sedimentation of sand. Budgets based on luminescence dating can provide estimates of the total sedimentation in tidal basins in contrast to previous fine-grained sediment budgets that were only based on ²¹⁰Pb dating.

The ratio between variations of relative sea-level and sediment supply controls the sedimentation on the tidal flats and determines whether there is a positive or negative sediment budget inside tidal basins. There is no reason to think that low-lying tidal flats are threatened in the future, as long as the sediment supply continues to be adequate. However, it is questionable whether sediment supply will be sufficient to keep up with an accelerated rate of sea-level rise as projected by all scenarios by the

Intergovernmental Panel on Climate Change (IPCC), and whether the findings from the sediment archive can be extrapolated into the future is still debatable.