Thesis Abstracts

Author: Xiang-Jun Liu
Thesis Title: The Late Quaternary lake level history of Qinghai Lake in NE Tibetan Plateau based on optically stimulated luminescence dating
Grade: Ph.D.
Date: July 2011
Supervisors: Zhong-Ping Lai
Address: Luminescence Dating Group, Qinghai Institute of Salt Lakes, Chinese Academy of Sciences, XiNing, P.R. China

Qinghai Lake is located near the junction of three climate systems (the East Asian monsoon, the Indian monsoon, and the Westerlies) and its location makes it one of the most sensitive regions to climate change in the world. During the past 3 years, we identified paleoshoreline deposits, lacustrine deposits and near shore sands around the lake, and these deposits were covered by later alluvial gravels and loess. Finally, 73 optically stimulated luminescence (OSL) samples were collected from paleoshoreline deposits, lacustrine deposits and near shore sands, 11 OSL samples were collected from fluvial deposits, 6 OSL samples were collected from sand wedges, 23 OSL samples were collected from aeolian sands, and 28 OSL samples were collected from loesses and paleosols. In total, 144 OSL samples were collected.

In this thesis, we report the OSL ages of paleoshoreline deposits, lacustrine deposits, fluvial deposits, alluvial deposits, sand wedges and aeolian deposits around Qinghai Lake. The elevation of paleoshoreline deposits were measured by differential global positioning system (GPS). A lake level fluctuation curve was then constructed from the above measurements. It is concluded that:

(1) Shoreline deposits and lacustrine sediments all accumulated below 3260 m above sea level (asl) (~66 m above modern lake level).

(2) The highest lake level for the past 140 ka occurred during MIS 5a (3260 m asl, and ~66 m above modern lake level), the lake level in early MIS 3a is 3209 m, ~5 meter higher than the highest Holocene lake level. The highest lake level of Holocene occurred between 8 and 6 ka (3204 m asl, and ~9.4 m above modern lake level). Lake levels during MIS 2 and MIS 4 were lower than present, with the lowest lake level occurring during the Last Glaciation Maximum (LGM).

(3) Use GIS software and digital elevation model (DEM), lake areas in MIS 5a, early MIS 3a, LGM, and Holocene highest period were calculated, the areas were 6753 km^2, 5238 km^2, 1225 km^2 and 4938 km^2, respectively.

(4) The oldest aeolian deposits around Qinghai Lake are in excess of 165 ka. Aeolian deposition then began at ~14 ka. Periods of palaeosol formation occurred at ~16.9 ka, ~12.2-11 ka, ~10-9 ka, ~5.2-4 ka, and ~3.9-0.7 ka. The accumulation intervals of palaeosols are generally consistent with drilling-core-based environmental change proxies, indicating that palaeosols were formed during wet periods with higher vegetation cover.

(5) Sand/ice wedges in Qinghai Lake area formed between 15 and 30 ka, at ~45.5 ka and ~62.4 ka, corresponding to the cold stages. We deducted that the mean annual air temperature (MAAT) would have been depressed by at least ~7 ^{o}C during the past sand/ice wedge formation periods in Qinghai Lake area.

Author: Davinia Moreno
Title: Datation par ESR de quartz optiquement blanchis (ESR-OB) de la région d'Atapuerca (Burgos, Espagne). Application au site préhistorique de Gran Dolina (contexte karstique) et aux systèmes fluviatiles quaternaires de l'Arlanzón et l'Arlanza
Grade: Ph.D.
Date: October 2011
Supervisor: Christophe Falguères, Alfredo Pérez-González and Robert Sala i Ramos
Address: Muséum National d'Histoire Naturelle / UMR 7194 du CNRS Paris, France; Universitat Rovira i Virgili (URV) Tarragona, Spain; Institut Catalá de Paleoecologia Humana i Evolució Social (IPHES) Tarragona, Spain.

The Sierra de Atapuerca, located in the north-east of the Duero Basin (Northern Spain), is a Mesozoic eroded hill characterized by a well-developed karst system. After the construction of a railway trench

"Trinchera Atapuerca" by a British mining company at the end of the XIX century, an almost continuous hominid occupation has been documented since ~1.2 Ma, through the discovery of a series of major archaeological cave sites, such as Sima del Elefante, Gran Dolina, Sima de los Huesos or Galería, among others. Previous investigations combining geomorphological evolution analysis of the Sierra de Atapuerca landscape and the study of the karst system revealed a connection between the karst formation and the regional fluvial network, particularly on the nearby Arlanzón, Arlanza and Pico rivers.

The chronological framework of the archaeological sites is currently limited to biochronological, palaeomagnetic data and a few absolute dates, while geochronological data are still missing on the fluvial systems. In order to refine the chronological framework of this region and to improve the knowledge of the connexions between the karst system and the fluvial network, we applied the Electron Spin Resonance dating method to optically bleached quartz (ESR-OB) extracted from sediments. These samples were collected from the karstic deposits of the 18m-thick sedimentary sequence of Gran Dolina site and from the terraces systems of the Arlanzón, Arlanza and Pico rivers. While this method has already been successfully used in fluvial context, its application to sediment extracted from karstic infill was still a challenge.

From a methodological point of view, the ESR dating results derived from the analyses of almost 40 samples from Gran Dolina site are consistent with the previous chronostratigraphical framework and thus demonstrate the potential of the ESR-OB for karstic contexts. In addition, these new results provide for the first time absolute dates for the lowermost layers of the Gran Dolina stratigraphic sequence, and suggest that sedimentation in Gran Dolina cave started ~1.2 Ma years ago and it was almost continuous until its complete infilling ~200 ka years ago. It confirms that Gran Dolina site is one of the most important archaeological sites in understanding the earliest occupation of Western Europe. Lastly, the ESR-OB results obtained for the terraces systems are consistent and reinforce the previous chronostratigraphic framework established by the combination of geomorphologic and palaeomagnetic data. These dating results confirm the contemporaneity of the terraces $T4_{AZN}$ and $T5_{AZN}$ in the Arlanzón valley and the human-bearing deposits of Gran Dolina site and help to refine the correlation between the Arlanza and the Arlanzón river systems.

Author: Richard Lyons
Thesis Title: Chronology and controls of Late Quaternary sedimentation, pedogenesis and erosion across interior South Africa
Grade: Ph.D.
Date: February 2012
Supervisors: Stephen Tooth and Geoff Duller
Address: Institute of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, United Kingdom

Soil erosion is one of South Africa's most pressing environmental problems. Across the interior, many river channels are presently incising and dongas (gullies and badland-type terrain) have formed extensively in colluvial and alluvial deposits. However, the chief driver(s) of this present incisional phase is contested. Donga formation has traditionally been attributed to human disturbance (e.g. livestock overgrazing), but evidence for the role of humans is largely circumstantial due to limited knowledge of when present incision initiated. Further, there is a paucity of late Quaternary chronologies of sedimentation, pedogenesis and erosion with which to contextualise present channel and donga incision.

To establish chronologies of sedimentation, pedogenesis and erosion across interior South Africa, and to constrain when present incision initiated, optically stimulated luminescence (OSL) ages have been determined for colluvial and alluvial sediments associated with dongas at three sites: i) Erfkroon, middle Modder River, Free State; ii) Steelpoort region, Limpopo Province; and iii) upper Blood River region, KwaZulu-Natal. These widely spaced sites are associated with contrasting climates, lithologies, soil types, physiographies and land use histories. Inter-site comparison of the OSL chronologies, and correlation with late Quaternary environmental and land use changes, provides a novel opportunity to examine the relative importance of local (e.g. local base level fall, soil type) and regional (e.g. climate change) drivers of incision.

The OSL chronologies indicate that alluvial and colluvial sedimentation, with intervening episodes of pedogenesis, have been dominant for at least the last 44 ka, 117 ka and 100 ka at the Modder River, Steelpoort and Blood River sites, respectively. In contrast, channel and donga incision initiated at all three sites within the last 2.7 ka, and no later than 0.22 ka. The present phase of incision appears to be of a greater magnitude than any previous phases of incision in the late Quaternary sedimentary records at the three sites.

Contrary to the traditional view that incision is driven by human disturbance, the broadly regionally synchronous onset of incision at all three sites predates the main phase of landscape disturbance associated with European population expansion and agricultural intensification during the second half of the 18th century. Instead, incision coincides with abrupt climate changes associated with the Medieval Warm Period (MWP) and the Little Ice Age (LIA). In particular, reduced temperatures, precipitation and vegetation cover during the LIA, combined with the likely occurrence of high-magnitude storms and floods, appears to have resulted in the destabilisation of landsurfaces and the shift from long-term net sedimentation to net erosion. The abruptness of climatic change associated with the LIA appears to have been a crucial factor in initiating incision. Additional controls on the patterns, magnitude and timing of channel and donga incision include soil type and local base level falls that are related to the breaching of resistant rock barriers in channel beds.

Author: Reza Sohbati
Thesis Title: Optically stimulated luminescence dating of rock surfaces
Grade: Ph.D.
Date: May 2012
Supervisors: Andrew Murray (Nordic Laboratory for Luminescence Dating, Department of Geoscience, Aarhus University)
Address: Nordic Laboratory for Luminescence Dating, DTU Risø Campus, Roskilde, 4000 Denmark

There are many examples of rock surfaces, rock art and stone structures whose ages are of great importance to the understanding of various phenomena in geology, climatology and archaeology. Optically stimulated luminescence (OSL) dating is a well-established chronological tool that has successfully determined the depositional age of a wide variety of fine-grained sediments, from several years to several hundred thousands of years. However, there is no routine OSL dating method applicable to larger clasts such as cobbles, boulders and other rock surfaces.

The thesis is a compilation of six articles, an introduction, and a summary chapter. The application of quartz OSL to the dating of rock surfaces is successfully tested by application to two different quartz-rich rock types (sandstone and quartzite). Together with the measurement of infrared stimulated luminescence (IRSL) signals as a function of depth into the surface of different granites it is clear that both OSL and IRSL can be fully reset in the two mm closest to the rock surface. However, it appears that the sensitivity of quartz from the granitic rocks (the most common surficial rock type) cannot be relied on. Na-rich feldspar is suggested as an alternative dosimeter, using a yellow-emission elevated-temperature IRSL signal.

Based on the studies of residual luminescence as a function of depth into a rock surface discussed above, a model is developed that relates this increase in residual luminescence to the exposure time. The model is then further developed using the quartz OSL signal from buried quartzite cobbles to include the effects of the environmental dose rate. By fitting the model to the dose-depth variation from a single clast, four events (two light exposures of different durations each followed by a burial period) in the history of a single cobble are identified and quantified. However, the use of model parameter estimates based on first principles does not result in the expected exposure times. In an alternative approach a known-age quartz-rich sandstone is used for calibration, and the model is then used to constrain the likely age of an important Native American rock-art style.

It is concluded that the OSL dating of large clasts and rock surfaces in routine applications is practical, and in some ways may be preferable to the dating of finer-grained sediments. Both burial ages and exposure ages can be quantified using this approach, and in a final illustration of this, the model is made suitable for space application by including simultaneous light exposure and irradiation. This offers, for the first time, a practical approach to the establishment of a recent exposure chronology for non-terrestrial surfaces, such as on Mars.