18th Windy Day Abstracts

Reproducibility of dune luminescence chronologies in the northeast Rub’ al Khali, UAE
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Amalgamation of chronologies of dune accumulation is necessary in order to establish regional dune responses to past environmental changes. However, advances in dating have produced chronologies of increasing complexity. In particular, questions regarding the interpretation of dune ages have been raised, including over the most appropriate method to evaluate the significance of suites of optically stimulated luminescence (OSL) ages when local ‘noisy’ and discontinuous records are combined. OSL ages from dunes are not solely the result of external palaeoenvironmental changes, but also a product of complex dune dynamics and sampling strategy (Stone and Thomas, 2008; Telfer et al., 2010). In this presentation, the reproducibility of dune chronologies is assessed. OSL ages from multiple profiles in the northeast Rub’ al Khali, United Arab Emirates (UAE), are presented and compared, alongside previously published dune ages. Distinct periods of aeolian activity and preservation are identified within the last 30 ka, which can be tied to regional climatic and environmental changes. This case study is used to address fundamental questions that are persistently asked of dune dating studies, including those regarding the localised nature of dune chronologies, whether chronological hiatuses can be interpreted, and how to most appropriately display datasets.


Dune Transformations Driven by Vegetation Changes in the Ordos Plateau, Inner Mongolia, China
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Despite growing perception of the significant role of vegetation in shaping distinct landscapes in aeolian systems, the complex eco-geomorphic interrelationship between vegetation and dune landforms are not well understood. Meanwhile, projections of future climatic change in particular increased temperature and drought severity raise concerns that widespread aeolian activity may take place as a result of more active dune transformations from semi-fixed or fixed dune forms such as parabolic dunes to highly mobile dune forms such as barchanoid dunes. Therefore, the present research focuses on a possible transformation pattern from a semi-fixed parabolic dunefield with shrubs and nebkhas to a highly mobile barchanoid dunefield in the North of Ordos Plateau, China, and tries to clarify the fundamental mechanism underlying
dunefield reactivation and transformations driven by vegetation changes through combining field investigations with computer simulations.

Here we present some preliminary results from fieldwork in 2011 and some promising modelling simulations from the modified DECAL (Discrete Eco-geomorphic Aeolian Landscape) model. Vegetation distribution of typical parabolic dunes were investigated by setting up vegetation quadrats. Sampling transects were established along longitudinal sections, cross sections and lee slopes. Within each quadrat, morphologic parameters of individual plants or aggregated plant groups were measured by steel tapes including the species, the height, the length, the width, the vitality and the height of sand mount trapped by plants. Meanwhile, the topography of each dune and the location of quadrats investigated were recorded by a Differential-GPS. Hence, by analysing vegetation parameter change (e.g. roughness density) over parabolic dunes, DEM and vegetation effectiveness maps of idealized parabolic dunes were abstracted to use in the computer modelling, which represent generic characteristics of semi-mobile parabolic dunes in the study region. In addition, migration rates of two semi-mobile parabolic dunes were acquired by interpreting three aerial satellite images in 2005, 2007 and 2010, which provides evidence on historical trajectories of vegetation and morphologic change of active parabolic dunes. Then, the potential transport rate in the study region was estimated by combining the DEM acquired from the field and the migrating rate calculated from the remote sensing image interpretation of a semi-mobile parabolic dune. Based on fieldwork investigation, remote sensing image interpretation, and local climatic context analysis, the DECAL model was modified to incorporate impacts of climate (e.g. seasonality) and groundwater change on the growth of vegetation.

Preliminary results show the Ordos Sagebrush dominates the study region and plays a significant role in the formation of parabolic dunes because of its strong capability to withstand sand burial and cold. On one hand, it is distributed continuously in the depression basins between trailing arms of parabolic dunes, although distinctive band zones are formed along the longitudinal axis towards the head of parabolic dunes. On the other hand, individually separated big nebkhas are formed on the arms, which is crucial to maintain the parabolic shape of dunes. Under the dominance of northwest and southwest winds throughout the year, active parabolic dunes are characterized by a large digitate-shaped bare sand lobe with evident slip faces. Most intensive erosion occurs on both sides of windward slopes connecting arms and the head of parabolic dunes, which is likely to result in a transformation to barchanoid dunes. Computer simulations have proved the robustness of the modified DECAL model, although realistic simulations and the parameter space exploration are needed in future work.

Pattern and Distribution of Complex Dune Structures using Residual Relief Separation, Central Saudi Arabia

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The complex Nafud (dune field) al Thuwayrat around the Wadi al Rimah, Central Saudi Arabia, encompasses some of the most unusual and remarkable dune formations, described in the literature as ‘dome’ dunes (e.g. McKee, 1979). These ‘dome’ dunes have a circular shape in plan view, with radiating arms; but they do not have the same form as star dunes mainly due to a lack of slip faces. Remote sensing offers a way to investigate the curious nature of these dunes. The method of residual relief separation, first undertaken by Hiller and Smith (2008) in their research of drumlins, has been used to analyse the
dome dunes of Nafud Thuwayrat. Using ASTER Global Digital Elevation Model data, cross sections of DEM
data have been taken from the terrain, producing topographic dune profiles. The computational method of
residual relief separation has been used to ‘unstack’ and reveal the complexity of the dune form. Initial
findings from this process are presented suggesting that the underlying terrain is made up of larger dune
forms with superimposed smaller dune ridges and limbs. The original classification of dome dunes is now
under scrutiny in this area leading to further investigation of process form relationships in the Nafud
alongside future fieldwork methods such as ground penetrating radar to more fully understand these
complex dune forms.


**Dune redness investigations in central Saudi Arabia using remote
sensing and laboratory techniques**

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To date sand seas (nafuds) in the Kingdom of Saudi Arabia have been poorly studied. Initial investigations
using satellite images, geographical information systems and field surveys show that the central Nafuds Al
Thuwayrat and Al Mazur display distinct variations in form and redness. Our research aims to comprehend
the geomorphic complexity of these nafuds. Previous research has shown colour can be related to
provenance, degree of chemical and physical weathering and questionably age. We have tested these ideas
in our study area taking into consideration potential source areas, dune form, thickness of sediment
accumulation, sediment size and sorting and sediment mineralogy.

Satellite remote sensing was used to map the present variation of dune redness and to assist in directing
sampling transects for laboratory analysis. In the laboratory, Munsell colour was recorded, particle size and
magnetic susceptibility was determined, X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) was used to
determine chemical properties, a Scanning Electron Microscope (SEM) was used to summarise physical and
chemical properties of the grains and a spectro-radiometer was also used to verify the satellite image
reflectance.

Initial findings appear to indicate that the main control on both redness and form is due to the rate of sand
movement and dune activity which appear to be the key controls in redness in this area.
The Namib Sand Sea constitutes a major zone of the Namib Desert on the west of Namibia, covering a region between Luderitz (26°39’ S, 15°09’E) and Walvis Bay (22°58’S 14°30’E). It is widely considered to be one of the oldest desert regions, with a Tertiary-aged fossil desert underlying the modern sand sea. The sand sea has been well studied, and has benefited from the presence of the Gobabeb Training and Research Centre over the past 50 years. Whilst much is understood about its sediments and geomorphology there is a relative paucity of chronological evidence from which to provide detailed understanding of the age and landscape development of the sand sea. However, since 2005 new chronological information from studies using luminescence dating (Bristow et al., 2005; 2007; Stone et al., 2010) and cosmogenic-nuclide dating (Versmeesch et al., 2010) offer useful new insights. This presentation reviews these developments and considers the insights they provide into the history and dynamics of the sand sea during the Quaternary period.


Averaging interval selection for the calculation of Reynolds shear stress for studies of boundary layer turbulence.

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It is widely recognised that boundary layer turbulence plays an important role in sediment transport dynamics in aeolian environments. Improvements in the design and affordability of ultrasonic anemometers have provided significant contributions to studies of aeolian turbulence, by facilitating high frequency monitoring of three dimensional wind velocities. Consequently, research has moved beyond studies of mean airflow properties, to investigations into quasi-instantaneous turbulent fluctuations at high spatio-temporal scales. To fully understand, how temporal fluctuations in shear stress drive wind erosivity and sediment transport, research into the best practice for calculating shear stress is necessary.
This paper builds upon work published by Lee and Baas (2012) on the influence of streamline correction techniques on Reynolds shear stress, by investigating the time-averaging interval used in the calculation. Concerns relating to the selection of appropriate averaging intervals for turbulence research, where the data are typically non-stationary at all timescales, are well documented in the literature (e.g. Treviño and Andreas, 2000). For example, Finnigan et al. (2003) found that underestimating the required averaging interval can lead to a reduction in the calculated momentum flux, as contributions from turbulent eddies longer than the averaging interval are lost. To avoid the risk of underestimating fluxes, researchers have typically used the total measurement duration as a single averaging period. For non-stationary data, however, using the whole measurement run as a single block average is inadequate for defining turbulent fluctuations.

The data presented in this paper were collected in a field study of boundary layer turbulence conducted at Tramore beach near Rosapenna, County Donegal, Ireland. High-frequency (50 Hz) 3D wind velocity measurements were collected using ultrasonic anemometry at thirteen different heights between 0.11 and 1.62 metres above the bed.

A technique for determining time-averaging intervals for a series of anemometers stacked in a close vertical array is presented. A minimum timescale is identified using spectral analysis to determine the inertial sub-range, where energy is neither produced nor dissipated but passed down to increasingly smaller scales. An autocorrelation function is then used to derive a scaling pattern between anemometer heights, which defines a series of averaging intervals of increasing length with height above the surface. Results demonstrate the effect of different averaging intervals on the calculation of Reynolds shear stress and highlight the inadequacy of using the total measurement duration as a single block average.


**Comparison or Satellite and Ground Based Radar for Mapping Sub-Surface Features in the Ubari Sand Sea, Libya**

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Radar technologies are generally thought to be good for studying sand dunes because of their ability to penetrate through sand. Here we look at a variety of ground and satellite based radar systems, evaluating their ability to study subsurface structures in the Ubari Sand Sea, Libya; including the paleohydrology underlying the sand dunes. Radarsat, JERS-1 and ERS-1 radar imagery are compared to each other and to ground surveys using Ultra Ground Penetrating Radar (GPR) that has the ability to penetrate a hundred
meters or more through sand, revealing both the structures within the dunes and what lies beneath them. Results suggest that spaceborne radar penetration into the sands of the Ubari Sand Sea is at best only a few tens of centimetres, and is highly dependent on look angle. Notwithstanding this, under ideal conditions, Radarsat fine beam mode imagery can map paleochannels buried under thin sheets of sand on the margins of the Ubari Sand Sea. These channels are not visible on the ground, or in other forms of remote sensing imagery (e.g. ASTER or Landsat ETM). In contrast Ultra GPR has the ability to penetrate through both this sand and near surface alluvium, revealing a major paleo channel in places up to 30 m deep traversing the southern margins of the Sand Sea. Further into the dunes Radarsat can be used to discriminate sand from interdune paleolakes sediment exposures, but provides no discernible subsurface information. In contrast Ultra GPR shows that paleolakes sediments underlie much of the sand sea, confirming our hypothesis that a giant plaeolake, that we call Lake Megfezzan, once covered the region before desiccating and being covered by the sands of the Ubari Sand Sea.

One million years of aeolian dynamics recorded in the Serbian loess-palaeosol sequences

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Loess deposits in the Vojvodina region, northern Serbia, are among the oldest and most complete loess-paleosol sequences in Europe to date. These thick sequences contain a detailed palaeoclimatic record from the late Early Pleistocene. Based on the correlation of detailed magnetic susceptibility records from Vojvodina with the Chinese loess record and deep-sea isotope stratigraphy we here reconfirm and expand on a stratigraphic model of the Vojvodonian loess-paleosol chronostratigraphic sequence following the Chinese loess stratigraphic system. Variations in MS, dust accumulation rates, and the intensity of pedogenesis demonstrate evidence for a Middle Pleistocene climatic and environmental transition. The onset of loess deposition in Vojvodina also indicates a direct link between dust generation in Europe and that in the interior of Eurasia since the Early Pleistocene. The youngest part of the Early Pleistocene and oldest part of the Middle Pleistocene is characterized by relatively uniform dust accumulation and soil formation rates as well as relatively high magnetic susceptibility values. In contrast, the last five interglacial-glacial cycles are characterised by sharp environmental differences between high dust accumulation rates during the glacial phases and low rates observed during soil development. The data presented in this study demonstrate the great potential of Vojvodina’s loess archives for accurate reconstruction of continental Eurasian Pleistocene climatic and environmental evolution.

Reconciling the luminescence- and tephro-chronologies of the Palouse Loess, Washington State, USA

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Recent advances in luminescence dating have brought about a step-change in both the accuracy and precision of the ages generated using quality-control checked, optically stimulated luminescence (OSL) methods applied to single aliquots of quartz. At some sites within the Palouse loess region of Washington State, USA, there is agreement between such quartz OSL ages and independent age control provided by
chemical identification of tephra layers associated with known eruptions. However, at a number of other sites the quartz OSL ages and the tephra evidence do not agree. The cause of this discrepancy is not known, but given the hitherto reliability of many quartz OSL ages, attention must focus not only on the newly generated OSL ages, but also on re-evaluation and re-analysis of the tephra layers which were originally sampled and analysed more than 15 years prior to the collection of the samples for quartz OSL dating. This study will use paired major element geochemistry and LA-ICP-MS trace element geochemistry to re-evaluate and develop the existing tephrochronology. Additionally, the newly developed post-IR IRSL measurement protocol has been applied to feldspars, to provide a further control on the quartz OSL ages. The implications of this study will be discussed.

**Dust Storm Forecasting at the Met Office**
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As well as representing the climate impacts of mineral dust the Met Office has been producing dust storm forecasts, initially for Defence applications in South Asia since 2008, and this was extended to a global forecast capability in 2011. In this presentation we will give a brief overview of the current status of the Met Office’s dust storm forecasting capability and present results of recent and upcoming enhancements to it. These modifications include a representation of dust emission from seasonal vegetation and the assimilation of dust Aerosol Optical Depth observations from MODIS and SEVIRI.

**RAIN4DUST: A multi-observational characterisation of dust emission from alluvial sources**
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Recent studies using satellite observations show that numerous dust sources are located in the foothills of the Saharan mountains. Generally, dust emission is closely related to sediment supply and surface wind. Thus, dust emission can be inhibited by either lack of high wind speeds or by unsuitable surface characteristics. Significant rainfall and flash flood events have been proposed to lead to changes in pluvial sediment supplies in mountain drainage systems. These sediments are suitable for dust uplift and assumed to have a main contribution to the dust emission fluxes over these areas. This mechanism could help to
explain the observed marked interannual variability of some dust sources, which is currently not well understood.

This study uses a novel combination of airborne and space-borne measurements to explore dust sources within complex terrain. It consists of two main parts: First, dust emission forced by the break-down of nocturnal low-level jets is investigated by analysing data from the RAIN4DUST/FENNEC-France aircraft campaign in June 2011 based on Fuerteventura, Spain. Local dust emission over North Mauritania is observed using a combination of different measurement systems flying aboard the French Falcon FA20, such as high resolution aerial ground camera, high-resolution lidar instrument and dropsondes. The orientation of the flight legs allows for the characterisation of the evolution of a developing dust plume in time and space combining information on ground surface structure and vertical dust distribution. Supplementary analysis of model simulations and satellite remote sensing products provide additional information on the location of dust sources and dust transport paths. Second, the role of pluvial sediment supply for dust emission in desert valleys is investigated. For a selected area over West Africa ENVISAT SAR (synthetic aperture radar) measurements from 2003-2010 are analysed to identify changes in surface sediments through loss of coherence between two consecutive images. Results from this study highlight the contribution of flash floods for dust sources located within complex terrain. Together the two approaches provide a detailed picture of dust emission from sources within complex terrain revealing controls on dust emission from both atmospheric factors and sediment supply.

**Applied aeolian research in South Africa: a way forward?**
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Considerable attention has been focused on aeolian processes within the context of late Quaternary palaeoenvironmental reconstruction in South Africa. Coastal environments have been systematically researched over the last decade, in particular by UK based researchers. There is, however, a real need to focus on an improved understanding of aeolian processes and their association with wind erosion in the interior of South Africa. Recently published research on wind erosion in the Free State Province (the granary of South Africa) has indicated that sediment has been more mobile in the past, and that the potential for more severe wind erosion probably exists for the future. A combination of friable topsoil, the likelihood of changes to both land ownership and land management practices and, above all, the possibility of climate change, suggests that a better understanding of the potential for severe wind erosion be addressed. Unfortunately, there is little local awareness of issues, be they biophysical or policy issues, which may well impact on this landscape in the foreseeable future. This might be a good time for UK based researchers who are looking for new research opportunities to engage, preferably in collaboration with South African colleagues, with issues around applied aeolian research in the breadbasket of South Africa.

**Monitoring Aeolian Transport Events at Sefton Dunes**
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Despite recent advances in both coastal science and coastal management scale issues and modelling uncertainties often prove to be major constraints on communication between the two communities. Models of dune evolution provide some guidelines for best management practices but they do not analyze process dynamics, making them insufficient for predictive purposes. Ironically, despite numerous studies,
researchers are still unable to provide a straightforward answer when managers asks how much sediment will be delivered to a particular coastal dune over a period of time of weeks, months, or years.

The availability of new field and computer techniques has now made it possible to return to this issue, and to attempt to develop a quantitative understanding of the physical processes leading to sediment input to coastal dunes at a temporal scale that is meaningful to management (i.e., the meso-scale). Morphodynamic classifications predict general relationships between dune form and beach type and tidal range, but not detailed predictions of the rate of sediment delivery. Recent studies on a micro-tidal coast show that aeolian activity is significantly reduced during strong onshore wind events, leaving the largest percentage of sediment input to coastal dunes to medium magnitude/frequency wind events. This paper presents preliminary data from a long-term monitoring program designed to understand the nature of aeolian transport events on a macro-tidal beach-dune system. The monitoring station is located at Sefton Dunes, the largest coastal dune field in England, and includes an array of digital cameras and sensors that measure factors controlling sediment input to the dunes, such as wind and transport processes, surface moisture content, beach width and fetch distances. The working hypothesis is that the probability of strong onshore winds resulting in aeolian activity will still be reduced compared to the theoretical value and hence calculations of sediment input to coastal dunes based on wind speed and direction only will overpredict dune sediment budgets in macro-tidal coasts. The scope of the monitoring station will be expanded to include all aspects of interactions between the intertidal and beach zones and the dune system and the intention is to maintain the monitoring program over the next decade.

The genesis of Essex 'brickearth'

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Material described as ‘brickearth’ occurs in south-east England, including Essex. The early workers attempted to ascribe single origins to ‘brickearth’. More recent work has shown a general acceptance that the ‘brickearths’ may have multiple sources. Some material will be aeolian sourced loess. Other material will be derived from it, for example by solifluction or alluvial action.

A useful starting point is Smalley’s model of loess formation\(^1\). Smalley recognised that primary loess deposits could subsequently be eroded, transported and redeposited by rivers, such as the Rhine as an alluvial deposit. This in turn could be transported by wind and deposited as second-cycle loess. This concept was extended to England with a suggestion that an initial deposit of loess into the Thames and Medway catchments could be redeposited as floodplain deposits. Some of this material might then be blown into south Essex where they were deposited as second-cycle loess. Recent thoughts have given greater emphasis to the role for rivers with a suggestion that the loess in south-east England could have been Alpine material initially brought into the area by the proto-Rhine.

For this suggestion to be possible there must have been some period when material was deposited by the river and a period of emergence when the alluvial deposits could be subject to wind transport.

A number of questions therefore need to be addressed:
- Where did the initial alluvial deposition occur?
- When did it occur?
- When did the emergence of the alluvial deposits occur?
- When did the material get moved by the wind and deposited as loess?
The following model for the **initial formation** of 'brickearth' in Essex and North Kent is put forward in the context of Gibbard's palaeogeographical reconstructions of the rivers of north-west Europe during the Pleistocene\(^2\).

- Ponding of the northern European rivers into pro-glacial lakes in the region now occupied by the southern North Sea;
- Deposition of their sediment load into the beds of these lakes;
- Exposure of these sediments once the Straits of Dover outlet was established; and
- Subsequent aeolian erosion, transport and deposition of these materials.

Work, including comparative mineralogy and dating, is proposed to validate this suggested sequence of events.


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**Interesting results from a recently conducted set of Bromhead Glacial Grinding Experiments to study the generation of Loess Particles.**


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The glacial grinding process has been generally accepted as one of the main factors in the production of loess particles. However, previous work has left a lot of questions unanswered. All of the past work conducted using the Bromhead Ring shear apparatus used two opposing rings with a plain grinding surface or with a regular radial array of equally spaced slots. The results gained from grinding with plain surfaced grinding ring produced no loess while those with the regular array of slots did.

A new set of glacial grinding experiments was recently conducted with some very interesting and revealing results. The original starting material used for the past loess grinding experiments was 2 mm Leighton Buzzard washed and sieved sand although three experiments were conducted on pure vein quartz from Brazil which also produced loess sized particles. Of particular interest with the results from both the artificially produced loess and that from a number of locations around the world has been the dominate 20 and 40 \(\mu m\) peaks that occur in the analysis of both types of loess. At present there is no plausible explanation for this although it is suspected that Moss defects, (micro-fractures), play a part in this process. However, this has raised another question and that is, why did the loess produced from the pure vein quartz also show evidence of these two peaks at 20 and 40 \(\mu m\).

In addition two sets of other grinding experiments have been conducted with a disc and ball mill for comparison purposes. It is for this reason that a new and more carefully thought out new set of quartz grinding experiments have been conducted. These new result compare very favourably with those obtained in the field.