Quaternary archives in the Iberian Peninsula
&
WestMed

PROCEEDINGS
OF THE MEETING
Progress in Quaternary archive studies in the Iberian Peninsula
Sevilla (Spain), 12. – 13. 03. 2015

F. Díaz del Olmo & D. Faust
(Editors)

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INQUA International Union for Quaternary Research

Contribution of the INQUA Spanish committee

A contribution to Past4Future: European interdisciplinary research on past warm climate periods
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<td>Almeida Paiva, Andre</td>
<td><a href="mailto:andrealemidapaiva@gmail.com">andrealemidapaiva@gmail.com</a></td>
<td>Portugal</td>
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<tr>
<td>Antoine, Pierre</td>
<td><a href="mailto:ANTOINE@cnrs-bellevue.fr">ANTOINE@cnrs-bellevue.fr</a></td>
<td>France</td>
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<tr>
<td>Baena Escudero, Rafael</td>
<td><a href="mailto:baena@us.es">baena@us.es</a></td>
<td>Spain</td>
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<tr>
<td>Bardají, Teresa</td>
<td><a href="mailto:teresa.bardaji@uah.es">teresa.bardaji@uah.es</a></td>
<td>Spain</td>
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<tr>
<td>Bartz, Melanie</td>
<td><a href="mailto:mbartz1@uni-koeln.de">mbartz1@uni-koeln.de</a></td>
<td>Germany</td>
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<tr>
<td>Baumgart, Philipp</td>
<td><a href="mailto:philipp.baumgart@tu-dresden.de">philipp.baumgart@tu-dresden.de</a></td>
<td>Germany</td>
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<tr>
<td>Borja Barrera, César</td>
<td><a href="mailto:cesarborja@us.es">cesarborja@us.es</a></td>
<td>Spain</td>
</tr>
<tr>
<td>Borja Barrera, Francisco</td>
<td><a href="mailto:fborja@dgf.uhu.es">fborja@dgf.uhu.es</a></td>
<td>Spain</td>
</tr>
<tr>
<td>Brueckner, Helmut</td>
<td><a href="mailto:h.brueckner@uni-koeln.de">h.brueckner@uni-koeln.de</a></td>
<td>Germany</td>
</tr>
<tr>
<td>Cáceres Puro, Luis Miguel</td>
<td><a href="mailto:mcaceres@dgeo.uhu.es">mcaceres@dgeo.uhu.es</a></td>
<td>Spain</td>
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<tr>
<td>Calvo Zapata, Fco. Rubén</td>
<td><a href="mailto:fruben85@hotmail.com">fruben85@hotmail.com</a></td>
<td>Spain</td>
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<tr>
<td>Clemente Pérez, Mª José</td>
<td><a href="mailto:paula.gomezgutierrez@hotmail.com">paula.gomezgutierrez@hotmail.com</a></td>
<td>Spain</td>
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<td>Costa, Ana</td>
<td><a href="mailto:acosta@dgc.pt">acosta@dgc.pt</a> <a href="mailto:anamcncosta@hotmail.com">anamcncosta@hotmail.com</a></td>
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<td><a href="mailto:scotero@ualg.pt">scotero@ualg.pt</a></td>
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<tr>
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<td><a href="mailto:pcunha@dct.uc.pt">pcunha@dct.uc.pt</a></td>
<td>Portugal</td>
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<tr>
<td>Díaz del Olmo, Fernando</td>
<td><a href="mailto:delolmo@us.es">delolmo@us.es</a></td>
<td>Spain</td>
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<tr>
<td>Dinis, Pedro</td>
<td><a href="mailto:pdinis@dct.uc.pt">pdinis@dct.uc.pt</a></td>
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<td>Domínguez Llosa, Ricardo</td>
<td><a href="mailto:ricardo.dominguez@undp.org">ricardo.dominguez@undp.org</a></td>
<td>Equatorial Guinea</td>
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<tr>
<td>Faust, Dominik</td>
<td><a href="mailto:Dominik.Faust@mailbox.tu-dresden.de">Dominik.Faust@mailbox.tu-dresden.de</a></td>
<td>Germany</td>
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<tr>
<td>Fletcher, William John</td>
<td><a href="mailto:will.fletcher@manchester.ac.uk">will.fletcher@manchester.ac.uk</a></td>
<td>United Kingdom</td>
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<tr>
<td>Fontes, Lisa</td>
<td><a href="mailto:fonts.lisa.marie@gmail.com">fonts.lisa.marie@gmail.com</a></td>
<td>United States</td>
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<tr>
<td>Fornos Asto, Joan J.</td>
<td><a href="mailto:joan.fornos@uib.cat">joan.fornos@uib.cat</a></td>
<td>Spain</td>
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<tr>
<td>Freitas, Maria Conceição</td>
<td><a href="mailto:cfreitas@fc.ul.pt">cfreitas@fc.ul.pt</a></td>
<td>Portugal</td>
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<td>G. Silva, Pablo</td>
<td><a href="mailto:ggsilva@usal.es">ggsilva@usal.es</a></td>
<td>Spain</td>
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<tr>
<td>Gil Garbi, Héctor</td>
<td><a href="mailto:hecgilgarbi@gmail.com">hecgilgarbi@gmail.com</a></td>
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<td><a href="mailto:albgomes@gmail.com">albgomes@gmail.com</a></td>
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<td><a href="mailto:lgomez-pujol@uib.cat">lgomez-pujol@uib.cat</a></td>
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<td><a href="mailto:mnczn65@mncn.csic.es">mnczn65@mncn.csic.es</a></td>
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<td><a href="mailto:grupquaternari@hotmail.com">grupquaternari@hotmail.com</a></td>
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<td><a href="mailto:grupquaternari@hotmail.com">grupquaternari@hotmail.com</a></td>
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<td>Muñoz García, María Belén</td>
<td><a href="mailto:mbmunoz@geo.ucm.es">mbmunoz@geo.ucm.es</a></td>
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<td><a href="mailto:h.reddad@usms.ma">h.reddad@usms.ma</a></td>
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<td><a href="mailto:k.reicherter@mug.rwth-aachen.de">k.reicherter@mug.rwth-aachen.de</a></td>
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<td><a href="mailto:grixhon@uni-koeln.de">grixhon@uni-koeln.de</a></td>
<td>Germany</td>
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<td><a href="mailto:jrvidal@dgeo.uhu.es">jrvidal@dgeo.uhu.es</a></td>
<td>Spain</td>
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<td><a href="mailto:christopher-bastian.roettig@tu-dresden.de">christopher-bastian.roettig@tu-dresden.de</a></td>
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<td><a href="mailto:elvira.roquero@upm.es">elvira.roquero@upm.es</a></td>
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<td><a href="mailto:Jesus.SVizcaino@uclm.es">Jesus.SVizcaino@uclm.es</a></td>
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<td><a href="mailto:jsanjurjo@udc.es">jsanjurjo@udc.es</a></td>
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<td><a href="mailto:juancho@ucm.es">juancho@ucm.es</a></td>
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<td><a href="mailto:Heike.Schneider@uni-jena.de">Heike.Schneider@uni-jena.de</a></td>
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<td><a href="mailto:t.schroeder@mug.rwth-aachen.de">t.schroeder@mug.rwth-aachen.de</a></td>
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<td><a href="mailto:shulte@ub.edu">shulte@ub.edu</a></td>
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<td><a href="mailto:asuncion@unizar.es">asuncion@unizar.es</a></td>
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<td><a href="mailto:M.Stokes@plymouth.ac.uk">M.Stokes@plymouth.ac.uk</a></td>
<td>United Kingdom</td>
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<td><a href="mailto:salmatifratine@yahoo.fr">salmatifratine@yahoo.fr</a></td>
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<td><a href="mailto:jvanthof@uni-koeln.de">jvanthof@uni-koeln.de</a></td>
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<td><a href="mailto:juan.vazquez@uam.es">juan.vazquez@uam.es</a></td>
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<td><a href="mailto:geert-jan.vis@tno.nl">geert-jan.vis@tno.nl</a></td>
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<td><a href="mailto:daniel_wolf@tu-dresden.de">daniel_wolf@tu-dresden.de</a></td>
<td>Germany</td>
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<td><a href="mailto:mcnzze65@mnecn.csic.es">mcnzze65@mnecn.csic.es</a></td>
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<td><a href="mailto:godotz@gmx.de">godotz@gmx.de</a></td>
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<tr>
<td>Zöller, Ludwing</td>
<td><a href="mailto:ludwig.zoeller@uni-bayreuth.de">ludwig.zoeller@uni-bayreuth.de</a></td>
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PREFA

Archive investigation for the purpose of environmental and climate change is a large interdisciplinary research field in geoscience. Twenty-five years ago (1989-2014) a group of young quaternarist researchers published the first progress in quaternary archive studies on Western Andalusian Region.

Then, twenty-five years later, this conference aims to follow up research in Quaternary science of the Iberian Peninsula and to give insight into new methodological and conceptual approaches. New results of different archive studies should be presented in a broader context.

We would like to discuss standpoints and perspectives of researchers from different geoscientific disciplines.

Five leading TOPICS of Quaternary archives are been proposed as organization-criterion of the communications (oral and poster presentations) sent by the researchers who attend this meeting:

Coastal and karstic archives
Methods applied to archives and open topics
Aeolian archives
Alluvial archives
Human occupation archives and climate change

The organizing committee is pleased that Dr. Hartmut Heinrich had accepted our invitation to be our invited speaker, who will give insight in his research and discovery of the well-known “Heinrich-Events”.

Aswell, this committee has a double reason to be grateful.
The accompagnement of all the valiously international researchers that integrate the scientific committee:

Dr. Pierre Antoine (France)
Dr. Helmut Brückner (Germany)
Dr. José S. Carrión (Spain)
Dr. Ian Candy (Great Britain)
Dr. Norm Catto (Canada)
Dr. Clive Finlayson (Gibraltar; Great Britain)
Dr. Will Fletcher (Great Britain)
Dr. Vincent Ollivier (France)
Dr. Pablo G. Silva Barroso (Spain)
Dr. Heinz Veit (Switzerland)
Dr. Yurena Yanes (USA)
Dr. Cari Zazo (Spain)
Dr. Christoph Zielhofer (Germany)

And on the other hand, the inestimable support that the Journal Quaternary International (QI) has offered to the Proceedings of both oral and poster presentations to be peer-reviewed for a publication in the journal.

QI already accepted our proposal for a special volume titled:

Progress in Quaternary archive studies in the Western Mediterranean (with the short title: “Quat archives West Med”).

Finally, to stand out the support of the meeting crew (C. Pacheco, S. Vélez, A. Sigüenza, V. Varo, C. Ortega, A. Zumárraga) in the organization of this meeting.

All the information and contents of this meeting is set-up on the meeting Website http://congreso.us.es/Quaternaryspain

The organizing committee
Fernando Díaz del Olmo
Dominik Faust
José Manuel Recio Espejo
Joaquín Rodríguez Vidal
César Borja Barrera
Daniel Wolf
In most cases research is targeted to prove or disprove a scientific hypothesis within a research interest. However, sometimes it is the case that – surprisingly – an unintended observation is made that subsequently has a remarkable influence on one or even more scientific fields. It is even more surprising when a scientist who is not familiar with the research field makes such an important observation. Such a case is the discovery of the so-called Heinrich events (HEs), which was a by-product of a research programme within an oceanographic feasibility study on nuclear waste disposal.

HEs were catastrophic collapses of continental ice sheets during the last glacial that had a remarkable influence on the global climate during their occurrence and, in consequence were dominating physical and biogeochemical processes on land and in the seas, as well as all kind of life on Earth. Besides the analytical capacity for understanding processes the global occurrence of the climatic consequences makes HEs also a perfect stratigraphic tool. Therefore, HEs had and still have an imprint on a large variety of research fields. Since one of the presumable physical triggers of HEs was ocean warming the present trend of anthropogenic climate warming bears the risk of triggering extraordinary large ice discharges from Greenland or the Antarctic, with probably unwanted effects on nature and human societies. Research on ice shield dynamics and on all kind of consequences of possible collapses is therefore imperative.

The evening talk will give insight into the discovery of the HEs and points to some scientific and other consequences.
TOPIC INDEX

Coastal and karstic archives
Oral presentation chair: William Fletcher
Poster presentation chair: Christoph Zielhofer

Methods applied to archives and open topics
Oral presentation chair: Helmut Brückner
Poster presentation chair: Christoph Zielhofer

Aeolian archives
Oral presentation chair: Pablo G. Silva Barroso
Poster presentation chair: Christoph Zielhofer

Alluvial archives
Oral presentation chair: Pierre Antoine
Poster presentation chair: Christoph Zielhofer

Human occupation archives and climate change
Oral presentation chair: Vincent Ollivier
Poster presentation chair: Christoph Zielhofer
Coastal and karstic archives

Oral presentation chair: William Fletcher

**Leira M.**, Freitas M.C., Andrade C., Cruces A., Paio V., Moreira S., Connor, S: *Links between Holocene environmental change and paleolimnological development in wet dune slacks (SW Portugal)*.


**Heike Schneider**, Dana Höfer, Carmen Trog and Roland Mäusbacher: *Holocene environmental reconstruction along the southern Portuguese coastal region (Algarve)*


**M.A. Soriano**, H. Gil, A. Luzón, A. Pocoví, A. Pérez and M.A. Marazuela: *Usefulness of the study of palaeokarst affecting Quaternary deposits in the Central Ebro Basin*
**Poster presentation chair: Christoph Zielhofer**


Victor J. Polyak, Bogdan P. Onac, Yemane Asmerom, **Joan J. Fornós Asto**, Jeffrey A. Dorale, Paola Tuccimei: *Sea-level stability during Marine Isotope Stage 5e: Evidences from POS (Phreatic Overgrowths on Speleothems) in Mallorca, western Mediterranean.*

Oana A. Dumitru, Bogdan P. Onac, Victor J. Polyak, Yemane Asmerom, **Joan J. Fornós**: *Speleothem growth rate and stable isotope record during the last interglacial from a Campanet cave stalagmite (Mallorca, Western Mediterranean): evidences for significant hydro-climate changes.*


**Vincent Ollivier**: *Reading the sequences: A two-step look on Mediterranean Holocene fluvial tufa deposits evolution inferred by climatic and anthropogenic parameters.*
Juan Vázquez-Navarro: Inventory of large blanket tufa deposits in the Iberian Peninsula. Geomorphological response to paleoclimatic and tectonic changes during the Pleistocene.
Links between Holocene environmental change and paleolimnological development in wet dune slacks (SW Portugal).

Leira M.¹, Freitas M.C. ¹, Andrade C. ¹, Cruces A. ¹, Paio V. ¹, Moreira S. ¹, Connor S.²

¹ IDL, Universidade de Lisboa, Edifício C6, Piso 3, Campo Grande, 1749-016 Lisboa, Portugal ² School of Earth, Atmosphere and Environment, Monash University, Clayton, VIC 3800, Australia

Poço do Barbaroixa de Baixo (BB)is a shallow (<1m depth) and small (surface <0.4km²) open water dune slack of the SW Portuguese coast, which occasionally dries out in summer. A sediment core (330 cm) was analyzed for diatom content, TOC, TN, TS, δ¹³C, and δ¹⁵N, and an age model was constructed using AMS ¹⁴C dates. The core consists of peat and peaty sand sediments. The combined record extends back to 7,500 ¹⁴C BP and the age model suggests a three-stage sedimentation history. Sedimentation rates were relatively high in the earliest part of the record (~1 mm yr⁻¹) and continued in a linear fashion until at least 5,200 cal yr BP. After 5,200 cal yr BP (115 cm), sedimentation rate slows down (0.04 mm yr⁻¹). At this stage, organic carbon content results suggest a change toward more inorganic sedimentation. After 2,600 cal yr BP (102 cm), sedimentation rate increases again (0.4 mm yr⁻¹). The analyzed proxies behaved differently according to water body extension, watershed variation and/or changes in environmental conditions and allow the establishment of an evolutionary model. Eustasy was the dominating element on the evolution of BB during the early Holocene. Diatom and δ¹³C data showed that higher marine influence was recorded during this period. This is followed, during the mid Holocene, by a lengthy phase of relative stability in freshwater conditions, punctuated with several reversal pulses in the environmental conditions though, accompanied by more nutrient rich conditions according to TOC and diatom data. Local forcing factors seemed to play an increasingly major role coincident with the decrease of the mean sea-level rise rate. During the last period, which extends since 2,600 cal yr BP until present, a progressive return to more brackish conditions takes place while open water habitats remain. At the same time, the input of autochthonous organic matter to the system significantly increased, as indicated by the C/N record, and was accompanied by an intensification of aeolian activity, as reflected by the highest frequency of deposited sand layers during the whole studied period. In the most recent decades human intervention becomes evident.
Giant catastrophic cascade events induced by the Zanclean flooding of the Mediterranean in the Gibraltar Arc (South Spain).

P. G. Silva¹, P. Huerta¹, J. Elez¹, J. Civis¹², K. Reichert³, E. Roquero⁴, J. Fernández-Cobo¹, M.A. Perucha², T. Bardají⁵, C. J. Dabrio⁶, C. Zazo⁷, J. L. Goy¹

³Institute of Neotectonics and Natural Hazards, RWTH Aachen University, 52064 Aachen (Germany).
⁵Dpto. Geología, Universidad de Alcalá de Henares, 28871- Alcalá de Henares, Madrid, Spain.
⁶Dpto. Estratigrafía, Universidad Complutense de Madrid. 28040-Madrid, Spain.

For first time Pliocene Zanclean littoral deposits are documented in the Mediterranean side of the Gibraltar Strait axis (Algeciras Bay, South Spain). In spite of the limited extension of the exiting outcrops (Los Barrios, San Bernabé, Adalides hill), surveyed sedimentary sequences record the catastrophic consequences of the rapid refilling of the desiccated Mediterranean Basin during the Zanclean Flood after the Messinian Salinity Crisis (MCS).

During the MCS the Gibraltar Arc worked as a gigantic kilometric threshold damming the Atlantic waters. Evaluation of associated drawdown (-1000 m), time of refilling (c. 3 years) and associated rates of water re-loading (c. 10 m/week) available from recent models agree with the occurrence of a mega-case of Reservoir-Induced Seismicity (RIS) at the end, or soon after, the Zanclean Flood. Onshore geological data from the Algeciras Bay indicate the occurrence of outsized landslides and giant tsunami events during the Zanclean Period, as indicated by the biostratigraphy of the foraminifera in the disturbed littoral sediments (distinctive presence of G. nephentes in the disturbed sediments). The deca-kilometric dimensions of landslides and slumps, the metric-sized scale of the related soft-sediment deformation and slumped structures and subsequent tsunami-transported boulders (up to 3 m in diameter), points to the occurrence of strong seismic event(s) causing these outsized earthquake secondary effects.

The tsunami reached a maximum height up to 95 m (Adalides Hill, Algeciras), only comparable to those occurred in the Lituya Bay in Alaska during the first half of the 20th century. The evaluation of the equivalent column of water (EQCW = 204.8 m) and associated water overloading (2.08 MPa) on the ancient offshore slope of the Gibraltar Strait triggered by the rapid Zanclean flood, exceeded by several orders of magnitude those related with
common cases of RIS (EQCW= 100 m; 0.3 - 0.5 MPa) causing moderate events of magnitude 5.5-6.0 Mw. Evaluations from regression relationships of RIS parameters and earthquake magnitude developed in this study agree with the occurrence of strong seismic events (Mw ≥ 8.5) as a consequence of the Zanclean flood triggering catastrophic secondary effects, such as the outsized landsliding of the nearly entire western margin of the Algeciras Bay (7 km long), triggering a giant tsunami up to 95 m high. These catastrophic giant cascade events earthquake – large scale landsliding and subsequent giant tsunami, originated and shaped the Algeciras Bay Basin allowing the onset of the following Plio-Quaternary sedimentation in the area.

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Geological records of Holocene extreme wave events (EWE) in SW Iberia: Tsunami and storm surge deposits


*Facultad de Ciencias, Universidad Nacional de Educación a Distancia (UNED), Spain.

Geomorphological and sedimentological features generated by extreme wave events (EWE) are common along the coasts of the Gulf of Cadiz, and have been assigned to either tsunami or storm surges (Lario et al., 2010, 2011). During recent years, numerous studies intended to characterize the sedimentological features of tsunami and storm events concluded that the deposits generated by both types of events exhibit similar textural, structural and sedimentary properties (Morton et al., 2007, 2008a, 2008b; Jaffe et al., 2008). A common conclusion is that, as such deposits indicate only the occurrence of a high energy event, the marine origin of the event, and the inundation of coastal areas by sea water, they can only be referred to as extreme wave events or EWE.

In SW Iberia, the studies of the on-shore record of these events have also attempted to distinguish features produced by tsunami and other extreme wave events (EWE), such as severe storm surges. Most surveys of EWEs in the area have concentrated on Guadalquivir, Tinto-Odiel and Guadalete estuaries, the littoral lowlands of the south-eastern coast of the Gulf of Cadiz, the area around Algeciras, and the Algarve. These studies described the sedimentary record of high energy events in the Gulf of Cadiz and concluded that a majority of them were of tsunamigenic origin. Lario et al. (2010, 2011) summarized these studies and concluded that highly destructive EWE events in this area occur with a periodicity of 1200-1500 yr, but not all were tsunamigenic.

In this work we review the last studies about tsunami and other EWE in SW Iberia, supported by on-shore and off-shore geological and geomorphological evidence, covering the last 7000 yr. The more recent events also incorporate archaeoseismic evidence for Roman times, and historical written reports, such as the Lisbon Event, which have been recently checked and validated with various palaeoseismological and archaeoseismological analyses. However, the causative seismic source, or sources, for damaging tsunami in the area remains obscure, even in the case of the most recent historical event, the well-documented 1755 AD tsunami of the Lisbon earthquake.

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Group of IGCP Project 588 and of the 1299 INQUA Project “EEE Parameterization”.

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Holocene environmental reconstruction along the southern Portuguese coastal region (Algarve)
Heike Schneider, Dana Höfer, Carmen Trog and Roland Mäusbacher
Friedrich-Schiller-University Jena, Institute of Geography, Löbdergraben 32, D-07734 Jena, Germany

The importance of multi-proxy analyses for detailed reconstructions of environmental evolutions increases with the request to understand the complex earth evolution processes. In coastal areas the comparison of neighbouring estuaries enables the understanding of the natural preconditions, the vegetation, settlement and climate conditions in the surrounding areas as well as the sedimentation processes influenced by the sea, by the catchment or high energy events.

Reconstruction of the early and mid-Holocene evolution of four estuaries along the Algarve coast reveals a similar development with fluvial sedimentation until marine transgression at around 8000 cal BP. Depending on morphology of the palaeovalleys the begin of transgression process is different. A very different evolution is visible after transgression maximum, although the siltation of the most estuaries is finished at about 2000 cal BP. After this time flood plain sedimentation characterises this areas. At about 1000 cal BP wide parts were drained to gain meadows and arable land. In the catchments erosion rates drastically increase according to rising human impact. Only large systems (cf. Alvor estuary) are characterised by tidal marshes until present.

In addition to anthropogenic influences also climate signals are detectable. Dryer periods are proven according to pollen indication and charcoal counting between 6500 and 6100 cal BP, between 5200 and 4600 cal BP, between 4200 and 3100 cal BP, at around 2700 and 1800 cal BP and between 1300 and 800 cal BP. These periods are correlated with higher sediment input from the catchments. Furthermore the formation of natural barriers in front of the estuaries force the increasing accumulation of fine clastic material, whereas high energy events cause both – erosion as well as accumulation processes.

In Addition, our experiences show that only a sufficient number of 14C-datings reveal the identification of changes in sediment input and accumulation rates. Short term high energy events also effect a change in frontal barrier systems and so the accumulation regime in the estuaries. In the course of investigation it was also possible to determine some tsunamis, so the tsunami of the earthquake of Lisbon from 1755.
From fabric microstratigraphy of stalagmites to environmental changes affecting the process of calcite precipitation. A case study from two caves in N Spain.

M.B. Muñoz-García¹, J. Cruz¹,², J. Martín-Chivelet¹,², A.I. Ortega³, M.J. Turrero⁴
¹Dpto. Estratigrafía, Fac. CC. Geológicas, Universidad Complutense de Madrid, 28040 Madrid, Spain.
²Instituto de Geociencias IGEO (CSIC-UCM). C/ José Antonio Novais 12, 28040 Madrid, Spain.
³CENIEH. Paseo Sierra de Atapuerca s/n, 09002 Burgos, Spain.

Speleothems have been broadly studied as archives of the Quaternary climate. One of the proxies preserved in stalagmites corresponds to the stratigraphic patterns of carbonate microfabrics. These fabrics are strongly dependent of a wide range of factors that include environmental parameters from outside the caves (such as rainfall, vegetation type, and soil thickness), from the epikarst (residence time of the water in the aquifer and water-rock interactions) and from within the cave itself (e.g. humidity, microbial activity…). As these are modulated by global, regional, and local climatic/environmental changes, the fabric microstratigraphy of the speleothems can be used as a tool for their reconstruction.

In the last few years, some progress has been done in the task of deciphering speleothem microstratigraphy (Muñoz-García et al., 2006; Martín-Chivelet et al., 2013). Lately, Frisia (2015) has summarized her previous works to generate a method for obtaining “standardized” microstratigraphic logs of fabrics to allow comparison of records obtained from different stalagmites. The codes proposed by Frisia (2015) comprise all the so-far known microfabrics in calcitic and aragonitic stalagmites and flowstones. Hence, the factors invoked to explain the genesis of the different fabrics are of very different nature (drip rate, Mg concentration, presence of organic matter…).

This work aims to test this method in four calcite stalagmites that present only some of the most common fabrics. This designedly narrowing in the variety of fabrics allows introducing a slight alteration to the codes proposed by Frisia (2015) in order to obtain microstratigraphic logs that can be related to changes in humidity only, likely derived from shifts in the hydric balance above the cave. This enhances the possibility of comparing these logs with independent proxies, such as stable isotope or trace element records. The studied specimens were recovered from two different karst systems: Sierra de Atapuerca and Ojo Guareña, both located in the province of Burgos, in northern
Spain. For this preliminary test of the method a relatively short period of time has been selected (2200 to 900 yr BP).

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Usefulness of the study of palaeokarst affecting Quaternary deposits in the Central Ebro Basin

M.A. Soriano, H. Gil, A. Luzón, A. Pocoví, A. Pérez and M.A. Marazuela

Studies in the Quaternary sediments of the central Ebro Basin that overlie Miocene evaporites, illustrate the existence of deformation at least since the Early Pleistocene. Very often, fluvial, alluvial and aeolian architectural elements are affected by deformation structures that reflect the actuation of mechanisms different to the sedimentary processes. Most of these anomalous patterns have been interpreted as karstic in origin both syn and post-sedimentary. In previous works, some structures interpreted as palaeodolines were used to establish a genetic classification of present dolines. However, such deposits involve much more information of karst as it offers wider time window for the analysis of these processes, help to better understand its evolutionary pattern and, at the same time, reveal a close interaction between karstification and sedimentation. For this reasons, we have studied these palaeostructures applying a multidisciplinary approach.

In general, these deformation structures have been studied in artificial sections (quarries, roads, railway). This permits a direct access to its inner structure, and then to analyse the sediment characteristics, the deformation structures affecting them as well as sampling for dating. The geometry of each structure and the above mentioned data facilitate the determination of the type of palaeoform to which corresponds the analysed palaeostructure, the genetic mechanisms that cooperated in their development, the evolutionary stages involved, contextualize the palaeoenvironmental conditions under which the structure was developed and, finally, determine the influence of karstification in sedimentation. In addition, dating of materials can inform about periods of more intense karstification and also how long extended the natural evolution of that palaeoforms under investigation.

Most of the studied shapes have been interpreted as corresponding to diverse type of palaeo-dolines, depressions of variable size and conduits. Processes that generated these palaeoforms were mainly dissolution, suffosion and collapse. It is frequent the temporal succession and repetition of those processes causing alternating episodes of subsidence or collapse of the affected materials. Depressions of decametric length arean example of evolution pattern, in which tilted and fractured deposits have been affected in the central area by later collapses with vertical o sub-vertical walls. In other cases, synforms hundreds of metres length, filled by detrital facies, show important changes on thickness and growth strata in the margins revealing the existence of
synsedimentary depocentres. Besides, previous to sedimentation of Quaternary materials, dissolution processes affected the Neogene evaporites. In this framework, discontinuities, both stratigraphic and structural, were preferential paths for water circulation.

Moreover, these studies reveal different examples of the influence of karst activity on sedimentation. Karstification caused the generation of subsiding areas that if placed below the sedimentary surface could have risen to the generation of depocentres as small lacustrine zones or aggrading areas as thick channels, among others. Subsidence contributes to increase of accommodation space given rise the preservation of easily erodible fine grain-size sediments and well-sorted non-cemented aeolian sands, in an area where gravel braided channels dominated.
The evolution of the Guadalfeo submarine delta (northern Alboran Sea) during the last ca. 200 years
Mendes, I.1.*, López-González, N.2, Lobo, F.J. 3, Bárcenas, P.4, Fernández-Salas, L.5, Schönfeld, J.6, Ferreira, Ó.1

1CIMA, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal
2Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, 29640 Fuengirola, Spain
3Instituto Andaluz de Ciencias de la Tierra (CSIC-Universidad de Granada), 18100 Armilla, Granada, Spain
4Dpto. Análisis Matemático, Facultad de Ciencias, Universidad de Málaga, 29080 Málaga, Spain
5Instituto Español de Oceanografía, CentroOceanográficode Cádiz, 11006Cádiz, Spain
6GEOMAR Helmholtz-ZentrumfürOceanforschung Kiel, Germany

The Guadalfeo submarine delta is located on the northern Alboran Sea shelf in the western Mediterranean Sea. The sedimentary dynamics of the deltaic system is governed by the discharge of one of the major rivers in this area draining the western sector of the near-coastal Sierra Nevada Mountains. The area is under the influence of a Mediterranean climate, with high spatial and temporal (i.e., inter- and intra-annual) rain variability. Major anthropogenic forcing affected the river system during the 1930’s, with the deviation of the main river channel 2.5 km to the west, to its present position. More recently, the construction of Béznar (1977-1985) and Rules (1993-2003) dams have also contributed to limit the amount of sediments exported to the deltaic system.

In order to understand the interaction between river discharges and the evolution of the submarine delta at different timescales, sediment cores were collected off the ancient (core 13) and present-day (cores 12 and 15) river courses. A chronological framework was performed and combined with sedimentological and benthic foraminiferal analyses.

Radiocarbon dating of plant debris from the base of the cores indicates that the sedimentary record goes back 200 years. In core 13, the variations between coarse and fine fractions along the core and the upward increase of benthic foraminiferal population density, would indicate that deposition possibly occurred until the deviation of the main river course to its present position. In the lower part of core 12, the strong alternation between coarse and fine sediment textures and the variable amounts of benthic foraminiferal species are interpreted as the result of an active fluvial regime.

The upper part, with high percentages of fine sediments and high values of population density, could be attributed to the stabilization of the river course in its present-day location. Core 15, located at 11 m water depth, showed the highest content of gravel in the lower part of the core, high contents of silt at
two core depths and increased percentages of sand to the top, indicating the strong influence of human interventions in the river basin and consequent changes in the sediment supply to the Guadalfeo submarine delta.
Sea-level stability during Marine Isotope Stage 5e: Evidences from POS (Phreatic Overgrowths on Speleothems) in Mallorca, western Mediterranean.

Victor J. Polyak¹, Bogdan P. Onac², YemaneAsmerom¹, Joan J. Fornós³, Jeffrey A. Dorale⁴, PaolaTuccimei⁵

1) Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131-0001, USA
2) School of Geosciences, University of South Florida, 4202 E. Fowler Ave., NES 107, Tampa, FL 33620, USA
3) Departament de Ciències de la Terra, Universitat de les IllesBalears, Crta. Valldemossa km 7.5, 07122 Palma (Mallorca), Spain
4) Department of Earth and Environmental Sciences, University of Iowa, USA.
5) Department of Earth Sciences, “Roma Tre” University, Italy

Sea level behavior during marine isotope stage (MIS) 5e of the last interglacial (LIG) is of great interest because it serves as an analogy for Holocene sea level behavior. Unlike the stable Holocene, significant rises of several meters have been reported during MIS-5e.

Caves and their deposits are important contributors to sea-level studies. Phreatic overgrowths on speleothems (POS) and submerged vadose speleothems from coastal caves have been used to reconstruct past sea levels. Cave sites along the southern and eastern coasts of Mallorca host abundant vadose speleothems encrusted by carbonate overgrowths making them ideal for reconstructing at high precision past high and low sea level stands. The LIG sea-level record of western Mediterranean had been constructed from U-series analyses of 23 POS samples from 13 littoral caves.

Assuming that POSs are accurate indicators of past sea-level positions, and Mallorca is dominated by an eustatic sea-level signal with minimal influence from glacio-hydro-isostatic effects, our results suggest that MIS-5e was exceptionally stable at ~2.25 ± 0.75 m apsl for 11,000 yrs starting at 127.5 kyr b2k. The MIS-5a highstand (~1 m apsl) at ~81 kyr b2k was short-lived (~1,500 years), which may explain why it has been so elusive. We note fast ~20 m sea-level fluctuations bounding both MIS-5e and MIS-5a; explanations for these abrupt and rapid rising and falling are necessary for modeling future changes in sea level.

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Speleothem growth rate and stable isotope record during the last interglacial from a Campanet cave stalagmite (Mallorca, Western Mediterranean): evidences for significant hydro-climate changes.

Oana A. Dumitrut, Bogdan P. Onac, Victor J. Polyak, Yemane Asmerom, Joan J. Fornós

1) Department of Geology, Babes-Bolyai University, Kogălniceanu I, 400084 Cluj-Napoca, Romania

School of Geosciences, University of South Florida, 4202 E. Fowler Ave., NES 107, Tampa, FL 33620, USA

3) Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131-0001, USA

4) Departament de Ciències de la Terra, Universitat de les Illes Balears, Crta. Valldemossa km 7.5, 07122 Palma (Mallorca), Spain

The Campanet Cave lies on the foothill of Serra de Tramuntana, in the NW part of Mallorca. Developed in Late Triassic (Rhaetian) dolomites, shows a total length of 397 m, descending to a depth of 50 m from the surface. The cave is well-decorated with a variety of speleothems. The CAM stalagmite (22.5 cm tall) was collected from a poorly ventilated chamber (Sala del Llac) near the far end of the cave. The mean annual cave temperature and relative humidity are 21°C and >95%, respectively. Sample powders hand drilled out from the CAM-01 stalagmite were analyzed and dated on a Thermo Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) at the Radiogenic Isotope Lab of the University of New Mexico in Albuquerque. 448 carbonate subsamples (80-120 μg each) were drilled out along the growth axis using a Sherline Micro-mill. The $^{13}$C/$^{12}$C and $^{18}$O/$^{16}$O ratios were measured using a Thermo Delta V isotope ratio mass spectrometer at the Stable Isotope Laboratory, School of Geosciences, University of South Florida. Twenty-five U-Th ages constrain the stalagmite growth from 120,143 to 4,656 (±0.3) yr BP, with a large range in growth rates, from 0.76 to 7.6 μm/yr.

The beginning of a 14 kyr hiatus occurring between 66.7 and 53.1 kyr BP coincides with the onset of Heinrich Event 6 (HE-6). The coupled $\delta^{13}$C and $\delta^{18}$O evidence from CAM-01 stalagmite suggests moisture source and availability in western Mediterranean have undergone major shifts within MIS 5. Effective precipitation must have remained above a threshold value over the investigated period to allow the growth of the stalagmite. Significant differences are observed between growth rates during glacial, stadial, and interglacial periods, with maximum rates occurring during MIS 5e and 5a, coincident with maximum summer insolation. Significant drop in growth rate occurs at the beginning of stadial MIS 5d and remained low during MIS 5c and b, likely in response to a decrease in the amount of precipitation. The growth rate dramatically decreased during the shift towards colder and/or dryer conditions at
the onset of MIS 4. Except for the 14 kyr hiatus, CAM-01 stalagmite maintained low but stable growth rate during MIS 4 and 3. Our CAM-01 growth rate data suggest dropping SSTs as a cause of reduced transport of moisture to the Mediterranean region.

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Estuarine coastal barriers as archive of high-energy events during the mid-late Holocene (Gulf of Cádiz, SW Spain): Human implications.

Clemente, M.J.¹, Rodríguez-Vidal, J.¹*, Cáceres, L.M.¹, González-Regalado, M.L.¹, Gómez, P.¹, Toscano, A.¹, Abad, M.², Ruiz, F.¹, Campos, J.³, Bermejo, J.³, Gómez-Toscano, F.³, González-Regalado, E.⁴

(1) Departamento de Geodinámica y Paleontología, Facultad de Ciencias Experimentales, Campus del Carmen, Av. Tres de Marzo s/n, 21071 Huelva, Spain.
(2) Departamento de Geología, Facultad de Ingeniería, Universidad de Atacama, C/ Copayapu 485, Copiapó (Chile).
(3) Departamento de Historia I, Facultad de Humanidades, Av. Tres de Marzo s/n, 21071 Huelva, Spain.

During the mid-late Holocene many coastal changes have occurred with rising sea-level and with terrestrial environmental changes affecting run-off and sediment transport.

The coastal plains and the near-shore environment offer a very dynamic archive which holds the possibility of better understanding the relationships between marine and terrestrial records.

This archive includes lagoonal, aeolian, intertidal and marine sediments preserved within a range of geomorphic features including dunes, barriers, back-barriers, and estuaries. As many key archaeological sites are coastal, the land-sea interaction is important for better understanding of historical human settlements. Geomorphological, sedimentological and palaeoenvironmental approaches in geoarchaeological studies frequently lack the integration of archaeological and historical data. This work therefore aims to provide a multidisciplinary platform to define the relationship between the coastal environmental evolution and the human population of some Atlantic Iberian estuaries in the Gulf of Cádiz.
Plio-Pleistocene archive of highstand sea-cave markers in the Rock of Gibraltar.

Rodríguez-Vidal, J.1, Cáceres, L.M.1, Gómez, P.1, Finlayson, C.2, Finlayson, G.2

(1) Departamento de Geodinámica y Paleontología, Facultad de Ciencias Experimentales, Campus del Carmen, Av. Tres de Marzo s/n, 21071 Huelva, Spain.

(2) The Gibraltar Museum, 18-20 BombHouseLane, Gibraltar.

Several sets of staircased Quaternary marine deposits can be observed along the Gibraltar coast ranging from 0 to 210 m above the present mean sea level (amsl). The geomorphological survey establishes both types of highstand marine markers, erosional and depositional, from 180–210 m amsl (Pliocene) to the present datum (Quaternary).

![Figure 1. Eastern flank of the Rock of Gibraltar. Morphotectonic steps representing staircased highstand history inside the sea caves and surficial lowstand record of climbing dune and scree breccias.](image)

Marine terraces are located inside the caves and along the Rock slopes, buried by lowstand scree breccia and climbing dunes. Former papers display at least 12 levels raised at heights of 1–3, 7–9, 15–17, 20–25, 30–40, 50–60, 80–86, 90–130, 180–190, about 210, and possibly 240–250 more even 300 m. Bioerosion marine markers are also staircased as single or composite sea caves and other minor features as notch, wave-cut platform, algal encrustations and lithophagid borings. The Gibraltar mean tectonic uplift value of 0.05±0.01 mm/yr is maintained from 200 ka to the present. Before this, at least to 250 ka,
the mean uplift rate was higher (0.33±0.05 mm/yr), possibly compatible with major tectonic events in response to a NNW–SSE compressive stress field between Africa and Iberia.

The rising rate history of the Rock peninsula is preserved as a staircased landscape with five main morphotectonic steps (Figure 1) between 1 and 25 m (mid-late Pleistocene), 30–60 m, 80–130 m (early-middle Pleistocene), 180–210 m (Pliocene), and above (late Miocene?). The higher are older than lower ones and all of them represent the Mediterranean high stand story during the Pliocene and Quaternary times.
Reading the sequences: A two-step look on Mediterranean Holocene fluvial tufa deposits evolution inferred by climatic and anthropogenic parameters
Vincent Ollivier
Aix Marseille University, CNRS, MCC, LAMPEA UMR 7269, 5 rue du Château de l'Horloge, 13094, Aix-en-Provence, France.

The Mediterranean Holocene fluvial tufa (MHFT) deposits are numerous and well-studied quaternary archives.

Tufa studies are generally concentrated on macro and micro facies, geochemistry, biochemistry, isotopic and various biologic macro remains analysis. But tufa environment (fig. 1) also produces complex stratigraphy inferred by climatic and anthropogenic factors that must be both spatially and sequentially analyzed. MHFT growth on the course of spring emergence environments but are frequently supplied by different watershed and coupled with detrital fluvial sediments and formations. Sequences are complex and generally reflect the paleohydrology and biotope changes. In some case, MHFT sequences follow a cyclic sedimentary pattern corresponding to geomorphic and environmental changes. An efficient reading and understanding of the carbonated sequences facies cyclic succession allows to identify morphogenic trend ruptures like incisions and stasis that had previously been unseen in the generic alluvial sequences deposits. The geometry of the formations and the morphogenic trend curve are thus redefined and the MHFT growth and decline chronology revisited. Formerly attributed to the Preboreal and Atlantic periods, with a decline during Neolithic to Roman times, the MHFT development is now attributed to the Lateglacial period with a main dismantlement during the Little Ice Age. Paleohydrological dynamic (stream speed and reservoir supply) is also specified by the concretion faciology into the sedimentary sequences.

Impact of the Human mode of occupation are also recorded at the scale of the sequence through macrofacies and paleoecological changes. Those different aspect underline the extreme complexity of the MHFT sedimentary archives portraying mosaic environments with various micro-response to environmental changes.

A two-step look is necessary to understand the complete system which offers a composite reading grid of the paleoenvironmental evolution. 1) Spatialization in the reading of the sequences, with 3D channel modeling/understanding is essential to determine the relative stream speed that characterize the facies, the “hidden sedimentary ruptures” (incisions) and their signification. 2) Stratigraphic succession on MHFT is generally cyclic and, due to their physico-chemical and bio-chemical origin, the systems are resilient and
frequently rebalancing to return to initial conditions, favorable to their development (optima). Question must be focused on the facies expression of these optima interval depending notably on geomorphological context and upstream-downstream interaction between formations of various origin (detrital vs. carbonated). In addition, our coupled analysis (palaeoecology, geomorphology and archaeology) shows that the MHFT development is very sensitive to biotope changes (connected or not to the Holocene Rapid Climate Changes) and strongly deals with the relationship between Man and riparian environment since Prehistory.

Fig. 1. MHFT environments and features.
Inventory of large blanket tufa deposits in the Iberian Peninsula. Geomorphological response to paleoclimatic and tectonic changes during the Pleistocene

Juan Vázquez-Navarro

Geography Department, UAM, Spain.

Tufa deposits are associated with the dynamics of karstic systems and provide records of past hydrological and climatic conditions. When hard waters intersect the topographic surface, tufa precipitation occurs as a consequence of CO2 out-gassing. There is a type of tufa deposits rarely described until now: the blanket one. It’s a mixture of perched spring deposits and alluvial tufa staircase terraces and they consist in regularized platforms (glacis or piedmont in French terminology, Vaudour, 1982) ranging in magnitude from 1 to 40 km wide. Such landforms can aggradate regarding less the underlying topography, regularizing it. The biggest complex described in literature is located in Antalya (Turkey) and it has an estimated age from lower to middle Pleistocene. Until now, in the Iberian Peninsula, such outcrops has been neglected by regional geology, identifying them wrongly as lacustrine tertiary deposits sedimented in closed basins. However, a recent global inventory on tufa deposits of Spain (González Martín and González Amuchastegui, 2014), allowed the recognition of several new blanket surfaces covering great extension, being among the biggest known examples of its kind on Earth. Besides its relevance as geological heritage, those blanket deposits might represent alternatively a) reference geomorphic expression surfaces of wet periods, since they are correlated with the odd-numbered isotopic periods established in marine logs or b) geomorphic response to tectonic forcing due to aquifers disruption, when intersection of ground waters with the surface occurs as springs precipitating tufa carbonates.

In this contribution, an overall review of previously unreported sedimentary tufa blanket buildings in Spain has been summarized. Special focus has been done on the cases of the Iberian Range, an intraplatform thrust-belt formed in Cenozoic times and characterized by a dome-shaped topography. Its formation has been related to the Middle Eocene-Middle Miocene compressive inversion of a Mesozoic extensional basin. It is mostly composed of carbonates hosting extensive and continuous karstic aquifers which allowed the formation of pervasive tufa outcrops. In some cases, blanket deposits are clearly liked to extensional faults doming and uplifting in the eastern Iberian Chain, linked to the opening of the Valencia Trough and the Mediterranean margin.

Blanket tufa deposits have distinct behavior than detrital staircase river terraces in that their base level are not a reference of landscape evolution and measurement of incising rates as has been attempted regularly in bibliography, can be misleading. However, they do represent unequivocal exoreic drainage
pattern, and therefore, some are here claimed as evidence for inception of basin capture.

Fig. A) Upper: blanket tufa surface in the Cabriel Basin (cuenca), overlying in angular un conformity with Mesozoic and Tertiary deposits. It shows a slight slope, prograding downstream the paleodrainage, which is coincident to the actual one. It has been dissected 200 meters by Narboneta and Garaballa rivers. It does represent an exorehic behaviour of Landete sector in Tertiary Teruel Basin B) Lower: Example of “El Oro” blanket tufa surface perched 250 meters above the Jucar talweg (Valencia)
Methods applied to archives and open topics

Oral presentation chair: Helmut Brückner

Martin Kehl, Simone Klumpp, Jörg Linstädter, Gerd-Christian Weniger: Micromorphological features of in-situ or reworked shelter sediments of the Iberian Peninsula.

Davinia Moreno, Christophe Falguères, Pierre Voinchet, Jean-Jacques Bahain: On the potential of ESR dating of optically bleached quartz grains from karstic environment.

Roland Zech: Compound-specific radiocarbon dating of leaf waxes.

Johannes Hepp, Roland Zech, Kazimierz Rozanski, Wolfgang Zech, Bruno Glaser, Michael Zech: Coupling 18O and 2H biomarker analyses in paleoclimate research: potential, conceptual model and a first application study from East Africa.


M. Oliva; E. Serrano; A. Gómez-Ortiz; J.A. González Martín; A. Niewendam; D. Palacios; A. Pérez-Alberti; J. Ruiz-Fernández; M. Valcárcel & G. Vieira: The periglaciation of the Iberian Peninsula.


Poster presentation chair: Christoph Zielhofer

Martin Kehl, Nicole Klasen, Christoph Burow, Helmut Brückner, Gerd-Christian Weniger: Luminescence dating of Iberian cave sequences – potential and drawbacks.

L. del Valle, J.J. Fornós, L. Gómez-Pujol, F. Pomar, V. Anechitei-Deacu, A. Timar-Gabor: Luminescence Dating on Middle to Late Pleistocene Eolianites from Eivissa, Western Mediterranean.


Fritz Haubold, Maximilian Klöcker, Dominik Faust: Measuring soil erosion by means of a low-cost photogrammetry.
Micromorphological features of in-situ or reworked shelter sediments of the Iberian Peninsula

Martin Kehl¹, Simone Klumpp¹, Jörg Linstädter², Gerd-Christian Weniger²,³
¹ Institute of Geography, University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany.
² Institute of Prehistoric Archaeology, University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany.
³ Neanderthal Museum, Talstr. 300, 40822 Mettmann, Germany.

Iberian cave and rock shelter sequences provide invaluable archives of cultural and paleoenvironmental change with more than 150 palaeolithic sites documenting human occupation by Neanderthals or anatomically modern humans and at least 35 sites providing interesting palynological records.

The processes of sediment accumulation and post-depositional reworking within shelters are often not clearly understood. This shortcoming contributes to frequent dispute on the stratigraphic integrity of sediment sequences and of archaeological materials embedded therein and samples extracted for dating. In general, site formation may involve phases of strongly reduced sediment accumulation, partial sediment erosion and sediment mixing by natural and anthropogenic processes. Some of these processes may be readily identified in the field, but a microscopic approach may prove useful, in particular for distinguishing in-situ archaeological layers (and embedded finds) from reworked materials. In the framework of the CRC 806 „Our way to Europe“, we conducted micromorphological investigations at several Middle to Upper Palaeolithic sites in Iberia including the caves of Arbreda, Las Palomas de Teba, La Güelga and Morín.

Besides observation with the petrographic microscope under plain polarized light and crossed polarizers we used the feature analyst tool of ArcGIS to automatically estimate pore space and numbers of archaeologically relevant particles such as bone fragments. We found a set of micromorphological features which indicate in-situ preserved archaeological levels while others give strong evidence for post-occupational reworking or mixing. In-situ layers often show subhorizontal orientation of elongated rock fragments, an increased degree of compaction, remnants of surface seals, evidence for trampling and internal layering. Reworked deposits may show rolled aggregates and concretions, a low degree of compaction and lack of surface features. Internal layering is lacking. In addition, the amount of bone fragments is significantly lower in reworked layers. Micromorphology thus provides an important tool to distinguish in-situ and reworked layers and to thereby clarify site formation in order to set up more reliable (chrono-) stratigraphic frameworks of shelter deposits.
On the potential of ESR dating of optically bleached quartz grains from karstic environment
Davinia Moreno¹,², Christophe Falguères², Pierre Voinchet² & Jean-Jacques Bahain²

¹ Centro Nacional de Investigación sobre la Evolución Humana (CENIEH). Paseo de Atapuerca, nº 3 09002 (Burgos, Spain)
² Département de Préhistoire, Muséum National d’Histoire Naturelle, UMR7194, 1 rue René Panhard, 75013 Paris, France

Electron Spin Resonance (ESR) dating of quartz grains extracted from sediment is based on the detection of radiation-induced paramagnetic centers. Similarly to Optically Stimulated Luminescence (OSL) dating, the ESR signal measured in quartz may be reset by optical bleaching, allowing thus to date the moment when the sediment has been last exposed to sunlight. Actually, there is quite a wide range of ESR dating studies of optically bleached quartz grains from fluvial, eolian and littoral context, but so far the specific application to karstic environment has never been reported.

Taken into account that many prehistoric sites have been discovered in caves, their study provides an important source of evidence about the first human settlement in Europe and the establishment of an accurate chronological framework is highly needed. In that regard, ESR dating of quartz extracted from cave sediment might provide some useful chronological information, especially in the case of alicoid, not volcanic or too old deposits that preclude the use of other numerical methods such as luminescence or Ar/Ar.

The present study reports ESR dating results of quartz grains from the Gran Dolina site in Atapuerca (Spain). The sedimentary infilling of Gran Dolina represents one of the most complete Pleistocene sequences with a thickness of about 18m divided into 11 lithostratigraphic units including several archaeological levels. In particular, the upper part of the sequence (from TD6 to TD10 levels) has been extensively dated in the recent years by means of various techniques such as combined ESR/U-series, luminescence (TL, IRSL, TT-OSL), U-series and magnetostratigraphy. Consequently, the data set available is an excellent independent age control to evaluate the consistency of the ESR age estimates that have been obtained. This comparison will provide a good overview of the real potential of this application in cave environment.
Compound-specific radiocarbon dating of leaf waxes
Roland Zech

$n$-Alkanes and $n$-carboxylic acids are essential constituents of leaf waxes. They are well preserved in sediments and paleosols and can therefore be used as “biomarkers” for paleovegetation and -climate reconstructions (Eglinton and Eglinton, 2008). Thanks to recent technological developments it is now possible to perform “compound-specific” radiocarbon analyses on leaf waxes, i.e. to determine the $^{14}$C content of specific homologues ($n$-alkane and $n$-carboxylic acid chain lengths). In this contribution, the basic principles of compound-specific radiocarbon dating shall be outlined, followed by a presentation of first applications of this new technique.

The figure shows the radiocarbon ages for bulk organic material (treated with HCl to remove carbonates and fulvic acids), the even-chain $n$-carboxylic acids (FAMES), and specific $n$-alkane homologues for sample Cr 20, which is 29±3 ka (from Häggi et al., 2014). This corroborates the synsedimentary nature of long-chain leaf waxes, and illustrates the feasibility and potential of compound-specific radiocarbon dating in loess-paleosols.

References


Coupling 18O and 2H biomarker analyses in paleoclimate research: potential, conceptual model and a first application study from East Africa


We couple compound-specific δ2H results of leaf wax-derived n-alkanes with compound-specific δ18O results of hemicellulose-derived sugars extracted from the loess-paleosol-sequence Maundi on Mt. Kilimanjaro. This coupling allows the reconstruction of a ca. 100 ka record of isotopic composition of leaf water. This in turn allows (i) using deuterium-excess of leaf water as proxy for palaeohumidity and (ii) reconstructing the isotopic composition of precipitation.

Our results suggest and corroborate (Zech et al., 2013) that sedimentary δ2H leaf wax records should not be interpreted directly in terms of reflecting δ2Hprec because variable leaf water evaporative enrichment can strongly overprint δ2Hprec signals. Furthermore, our d-excess record as proxy for palaeohumidity does not support the interpretation of δ2Hprec in terms of an “amount-effect” in East African palaeoclimatic studies.

References

Luminescence dating of Quaternary sediments in Spain – problems and first results
Ludwig Zoeller (University of Bayreuth) and Dominik Faust (TU Dresden)

It is desirable to use specific luminescence emissions from pure mineral grains for dating. This is, however, not always possible or easy. The only ubiquitous mineral that can be purified from mineral mixtures by physical and chemical treatments is quartz. The OSL from quartz has, however, a low saturation dose in most cases liming the upper dating limit to ca. 100 ka or less. If the natural OSL signal is close to saturation age underestimates may occur. As stable quartz luminescence cannot be stimulated by IR the IRSL dating technique can be applied to feldspar-bearing sediments with up to 10-fold higher saturation dose. The upper dating limit of feldspar-derived IRSL is, however, often hampered by so-called anomalous fading, i.e. a long-term instability of the signal independent from its thermal stability. Uncorrected anomalous fading can also lead severe to age underestimates. In recent years, however, laboratory procedures (e.g., pIR-IRSL dating) have been developed to reduce anomalous fading to a tolerable minimum, thus enabling to produce reasonable ages of up to ca. 300 to 350 ka.

OSL quartz dating was applied to aeolian sediments in Spain ranging from a few decades (Doñana dunes) to ca. 100 ka (loess in the Upper Tajo Basin and desert margin loess from Lanzarote Island). Ages of ca. 170 ka were obtained using red TL emissions from quartz grains heated by lava flows on Lanzarote Island and confirmed by ESR dating of terrestrial shells whereas OSL dating failed for samples >ca. 100 ka old. Saharan dust atmospheric input to aeolianite-paleosol sequences of northern Fuerteventura Island yielded IRSL ages between ca. 4 and ca. 280 ka and now allow for a first chronostratigraphic frame of these sequences reflecting changes in paleo-moisture. Our results suggest a significantly older chronology for the eolianite-paleosol sequences than previous studies based on radiocarbon, amino acid and OSL ages. The studies in Fuerteventura and Central Spain are part of ongoing work.
The periglaciation of the Iberian Peninsula
M. Oliva; E. Serrano; A. Gómez-Ortiz; J.A. González Martín; A. Nieuwendam; D. Palacios; A. Pérez-Alberti; J. Ruiz-Fernández; M. Valcárcel & G. Vieira

Active periglacial processes are currently marginal in the Iberian Peninsula, spatially limited to the highest mountain ranges. However, a wide variety of periglacial deposits and landforms is distributed in low- and mid-altitude environments, which shows evidence of past periods with enhanced periglacial activity.

The purpose of the present research is to summarize the present knowledge on periglacial conditions in the Iberian Peninsula with a focus on the paleo-perspective. The chronological framework for periglacial activity has been based on four main stages: Last Glaciation, transition to the Holocene, the Holocene and present-day processes. This study focuses on the highest massifs (Pyrenees, Cantabrian Range, Galician mountains, Portuguese ranges, Central Iberian Range, Iberian Range, Sierra Nevada) as well as in other lower elevation environments, namely from the central Iberian Meseta.

Significant advances have been achieved over the last decades regarding the geochronology of periglacial activity in the past. Whilst periglacial studies until the 80’s and 90’s were mostly focus on the geomorphological mapping, description and relative dating of inactive landforms and deposits, during the last decade there has been a significant increase in the number of studies centred on the monitoring of present-day processes as well as in the age control of periglacial phenomena through absolute datings techniques.

During the Last Glaciation the periglacial belt extended to much lower altitudes than today, reaching sea level in the NW corner of the Iberian Peninsula. A wide range of geomorphological landforms and sedimentary records is indicative of very active periglacial processes, in some cases related to permafrost conditions. Most of the inactive landforms and deposits in low and mid elevations in Iberia are related to these phase. The massive deglaciation of Iberian massifs was accompanied by the gradual increase of temperatures. This phase was only interrupted by a short period with colder conditions (Late Glacial) that reactivated periglacial processes in the formerly glaciated cirques of the highest lands. During the Holocene periglacial processes have been active only in the highest ranges, shifting in altitude according to the regime of temperature and moisture conditions. The Little Ice Age saw the reactivation of periglacial activity in lower elevations than today. Currently, periglacial processes are only active in elevations exceeding 2500 m in the southern ranges and above 2000-2200 m in the northern massifs.
Quantifying post-sedimentary n-alkane contamination in loess using 14C and OSL dating
Michael Zech, Sebastian Kreutzer, Tomasz Goslar, Sascha Meszner, Roland Zech, Cameron McIntyre, Timothy Eglinton, Dominik Faust, Markus Fuchs

There is an ongoing discussion whether n-alkane biomarkers – and organic matter (OM) from loess in general – reflect a syn-sedimentary paleoenvironmental and paleoclimate signal or whether they are significantly post-sedimentary contaminated namely by root-derived OM. We present radiocarbon data for the bulk n-alkane fraction of lipid extracts and luminescence ages for the Middle to Late Weichselian loess-paleosol sequence of Gleina in Saxony, Germany. Three of four biomarker radiocarbon data are younger than the sedimentation ages as assessed by optically stimulated luminescence (OSL) dating, indicating a post-sedimentary rejuvenation of the bulk n-alkane fraction.

In order to estimate the post-sedimentary contamination more quantitatively, we apply a 14C mass balance calculation based on the measured pMC (percent modern carbon) values, the calculated syn-sedimentary pMC values and pMC values suspected to reflect likely time points of post-sedimentary contamination. Accordingly, no extensive modern, last decadal and/or 3 ka BP root/rhizomicrobial contamination can be asserted.
Al-bearing organic speleothems in granite caves or NW Iberia: characterization and chronology
Sanjurjo-Sánchez1,2, J., Arce Chamorro1,2, C., Vidal Romaní1,2, J.R., Vaqueiro2, M.
1Instituto Universitario de Geología “Isidro Parga Pondal”. Universidade da Coruña, A Coruña, Spain
2Clube Espeleolóxico “A Trapa” (CETRA), c/Manuel de Castro 8-3D. 36210 Vigo (España)

Water trickling through the discontinuities of granitic massifs causes rock weathering, resulting in mineral deposits within rock fissures and caves (speleothems). Granite caves are considered as pseudokarst. In such cavities few deposits can be found. The most common mineralogy of the deposits found are opal-A, secondary evansite and Al-bearing organic compounds (often called pigotite). They usually grow by accretion of concentric layers and the formation of some of them (as it has been reported at least for opal-A deposits) is caused by a significant biological activity of microorganisms. They also contain spores, pollen grains and diatoms, so it has been proposed their use as palaeoenvironmental records. However, there are still too many uncertainties about their chronology and formation process.

The Al-bearing organic compounds (or pigotite) have been described as a salt composed of alumina and organic acids forming incrustations on the walls of granitic fissures and caves. However both its mineral and chemical characteristics and formation process are unknown. It has been considered as an organic substance derived from the decay of moist moorlands above caves but their organic carbon content is around 5% and the information given by references is imprecise or still incomplete.

The biggest reported deposit was located in Trapa Cave, Galicia, NW Spain. A previous study on the composition and formation of such speleothems provided that pigotite is formed by a rhythmic accretion structure in concentric layers as it occurs in calcite speleothems. Such layers alternatively show light cream (Al-rich) and dark red colour (Fe-rich) that has been associated to seasonal changes (winter-summer deposition) similar to varves of lake deposits. Radiocarbon dating provided ages ranging from 1500 to 3000 years BP for such deposits. We have studied and characterized a Al-bearing organic deposit in Trapa Cave, other probably associated sediments (within upper levels of the same cave) and surface soils to characterise and understand the process that result in the formation of such Al-bearing organic compounds. We also have dated some samples by radiocarbon and luminescence dating to assess the age of formation of the deposits. Our results indicate that they are fine grain deposits saturated in water and rich in organic C (ranging 5-10%). The organic
matter is composed of soil compounds but also microorganisms. The mineral components are mainly oxides but also quartz, feldspars and heavy minerals are present, while clay minerals are almost absent. The age of the sediments corresponds to the Late Holocene, not older than 2 ka.
Luminescence dating of Iberian cave sequences – potential and drawbacks
Martin Kehl¹, Nicole Klasen¹, Christoph Burow¹, Helmut Brückner¹, Gerd-Christian Weniger²,³
¹ University of Cologne, Institute of Geography, Albertus-Magnus-Platz, 50923 Cologne, Germany
² Neanderthal Museum, Talstraße 300, 40822 Mettmann, Germany
³ Institute of Prehistoric Archaeology, University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany.

The transition from Neanderthals to early anatomically modern humans (AMH) in Iberia is documented in at least 28 caves or rockshelters, which contain both Mousterian and Early Upper Palaeolithic (EUP) layers. The timing of the transition and of Neanderthal demise is a matter of dispute. The radiocarbon method is afflicted by large uncertainties due to contamination of samples with young 14C and incomplete understanding of taphonomic processes within caves. Other geochronological dating methods attracted less attention, because appropriate samples such as stalagmitic crusts for U/Th dating or convenient sediments for luminescence age estimates are often not available. During the last years, the Cologne luminescence lab has been investigating several series of sediment samples from Middle to Upper Palaeolithic sites in Iberia, applying various dating protocols. At the sites Jarama VI and Cueva Antón, fluvial deposits intercalated by cultural layers were analysed and plausible postIR-IRSL290° ages were determined, which corresponded well with other luminescence dating protocols (e.g., OSL on quartz using single aliquots and single grains) as well as with new radiocarbon dates (Kehl et al. 2013, Burow et al., submitted).

At the site of Las Palomas de Teba, Middle Palaeolithic layers and covering slope deposits were sampled. Age estimates received by OSL and postIR-IRSL290° were partly younger than previous archaeological age estimates, probably related to reworking of archaeological materials. Luminescence properties of silty deposits at the site Finca Dona Martina were inappropriate for luminescence dating as indicated by the laboratory experiments (preheat plateau test and dose recovery test). This failure is most likely related to the sediment composition, which contained detrital silt from the shelter roof above the archaeological layers. Currently, samples from the sites La Boja, Quebrada, Cova Negra de Xàtiva and Cueva Arbreda are under study. Preheat plateau and dose recovery tests of the quartz samples failed for most samples or the quartz luminescence signal was found to be in saturation.

Overall, our experience from the seven different sites indicated that in most cases quartz was less suitable for luminescence dating and therefore,
further measurements will concentrate on feldspar dating. Moreover, those deposits showing clear features of fluvial deposition such as cross-bedding or fine lamination gave more reliable results than silty cultural layers mainly derived from disintegration of the cave wall.

References


Luminescence Dating on Middle to Late Pleistocene Eolianites from Eivissa, Western Mediterranean.
L. del Valle¹, J.J. Fornós¹, L. Gómez-Pujol¹,², F. Pomar¹, V. Anechitei-Deacu³,⁴ y A. Timar-Gabor³,⁴
1) Departament de Ciències de la Terra, Universitat de les Illes Balears. Ctra. de Valldemossa km 7,5 07122 Palma (Illes Balears).
2) SOCIB, Balearic Islands Coastal Observing and Forecasting System. ParcBit, Ctra. de Valldemossa, km 7,4 07122 Palma (Illes Balears)
3) Faculty of Environmental Sciences and Engineering, Babeş-Bolyai University, Cluj-Napoca, Romania. Interdisciplinary Research Institute on Bio-Nano-Science of Babeş-Bolyai University, Cluj-Napoca

This study deals with the sedimentary and stratigraphical description of Pleistocene deposits from six coastal areas of Eivissa (Balearic Islands). Twenty two sedimentary facies have been described involving the succession of eolian, colluvial and edaphic environments. Carbonate sandstones, breccias and silty deposits are the main component of these sequences. Despite the extensive eolian systems outcropping along the coast of Eivissa, there are very few studies performed to chronological framework of these deposits.

Luminescence measurements were carried out using an automated Risø TL/OSL-DA-20 reader in the Luminescence Dating Laboratory of Babes-Bolyai University (Cluj-Napoca, Romania) under low intensity red light. For the deposits in north-western part of the Island (CalaXuclar) involved SAR-OSL dating on aliquots of fine (4-11 µm) and coarse (63/-90 -250 µm) quartz extracted from CalaBassa site (south-western Eivissa) the SAR-OSL protocol was applied on aliquots of fine (4-11 µm) and medium (63-90µm) quartz grains as well as on coarse quartz of different grain sizes (90-125 µm, 125-180 µm, 180-250 µm) (Anechitei-Deacu et al, 2014). Where in other sites (South: EsCodolar; South-western: CalaCompte, Cap Negret and South-eastern: S’estanyol) involved dating on aliquots of coarse (63-250 µm) grained quartz. OSL dating of nineteen eolian levels indicate that their deposition took place between the Middle and Upper Pleistocene, establishing a paleoclimatic evolution since 70 ka to 570 Ka. From the sedimentological and stratigraphic analysis, in conjunction with OSL data we can state that the eolian activity in the island of Eivissa took place during cold periods (MIS 14, 12, 10, 8, 6 and 4). Similar results have been obtained from many sites along the western Mediterranean Sea such as Mallorca (PomariCuerda, 1979; Nielsen et al, 2004), and the Italian coast (Andreucci et al, 2009; Pascucci et al, 2014).

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Doñana, a zonal and azonal pedogenesis archives for the Holocene (SW, Spain)
Díaz del Olmo, F.1, Recio Espejo, J. M.2, Borja Barrera, C.1:
1.Universidad de Sevilla (Spain)
2.Universidad de Córdoba (Spain)

The soil (paleosols or old soils, profiles or horizons), is one of the leading archives for the study of the Quaternary evolution regarding emerged landscapes, with applications into the geomorphological, sedimentological and environmental research.

This work shows an application of the use of the edaphic archive for the palaeoenvironmental evolution interpretation, from the Upper-Pleistocene to the present on the Aeolian Littoral Sand Sheet at El Abalario-Doñana (MELAD), in Doñana coast (Huelva, Spain). The zone has formed by a complex system composed principally by quartz sand (>80%). Five morphosedimentary units were recognized in MELAD: stabilized aeolian deposits in down position with ancient vegetation; stabilized aeolian deposits in upper position with ancient vegetation, humid character and small-lakes; stabilized aeolian deposits in upper position with ancient vegetation at dry character; semiactive dunes; and active dunes.

From the MELAD base, including into morphosedimentary unities and its geomorphological surface, three edafic-weathering sequences are identified:

1) A basal weathering compounded by sandy-clayey removed deposit where quartz predominating in sands and kaolinites in the clay minerals from Late Pleistocene.

2) A sequence with high zonal signification; this means wet Mediterranean climatic character, whose soils are evolutionated in dune complexes represented by Luvisol-soils (Upper and Middle Holocene), Arenosol-Luvisol-soils (Late Holocene and present) up to Haplic-Arenosol (present), with presence of illites, kaolinites and vermiculites.

3) Another azonal, therefore, with soils influenced by the effects of a acidophic geomorphological environment, with porose areas and other ones with obstructed drainage (dune / small-lakes systems) with quartz, high level smectite content and low level kaolinite proportion. Two are the main kinds of soils and weathering:

3.1. Vertisols (Middle Holocene) and degrading Vertisols by gleyecification processes (Vertic Stagnic Luvisol, Chromic Stagnic Luvisol) and protopodsolization (Stagnic Podsoluvisol) (Late Holocene and present).
3.2. In the semiactive and active dunes (Late Holocene to the present) with great presence of illmenite, has great participation in the currently different pedological processes (browning and podsolization).

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Measuring soil erosion by means of a low-cost photogrammetry
Fritz Haubold, Maximilian Klöcker & Dominik Faust
Technische Universität Dresden, Institute of Geography, Germany

Like the Mediterranean many climates are characterized by a more or less large seasonality of rainfall. Areas of such rainfall regimes are prone to soil erosion. Since ancient times soil erosion has stripped the Ethiopian landscapes and many attempts were made to control it. Although soil erosion is a natural process it mainly is driven by land use practice, namely deforestation. Climate change may accelerate the processes. In its extended form it even cuts a particular landscape into pieces. Our research makes an attempt to evaluate the effectiveness of the different soil and water conservation measures.

The study area is located near the town of Aje, about 35 km west of the city of Shashamene, East Shewa, Oromiya, Ethiopia. The main aim is to provide suggestions for improving soil conservation practices. In order to quantify soil erosion a low-cost and user-friendly most recent approach of close range photogrammetry was applied. Usually high-resolution topography survey and data collection is associated with major expenditures of equipment and logistics. Traditional photogrammetric methods require 3-D location and pose of the camera and thus are very inflexible to changing conditions during the study. In addition they often need particular knowledge of technique and technology.

Figure 1: Photo of a medium sized gully (left) and model derived from it (right). Made by Maximilian Klöcker

The type of the photogrammetric technique applied can be described as ‘structure-from-motion’. That means the camera pose and scene geometry are solved automatically that facilitates the use without detailed understanding in theoretical photogrammetry. Extensive photosets of multiple overlapping images were taken with a customer-grade digital camera. It is possible to generate from these photosets high-resolution digital models which provide an extraordinary overview of the gullies’ shape. Furthermore these models allow
high accuracy measurements. For example it is possible to measure the thickness of soil layers, distances and even volume calculations of how much soil has already been eroded. We implemented this technique to a remote tropical area to test its capacity, applicability, and usability in problems of soil erosion. First results suggest that it best fits to such environments.
Aeolian archives

Oral presentation chair: Pablo G. Silva Barroso


Christoph Zielhofer, William Fletcher, Steffen Mischke, Marc de Batist: Younger Dryas and Holocene hydroclimatic variability and aeolian history of the Middle Atlas (Morocco).

Susana Costas, FilipaNaughton and Hans Renssen: Major episodes of aeolian activity in the central coast of Portugal since the LGM.


Poster presentation chair: Christoph Zielhofer

H. Gil, A. Luzón, M.A. Soriano, A. Pérez and A. Pocovi: Early to Late Pleistocene aeolian deposits in the central Ebro Basin (NE Spain): new clues for deducing Pleistocene environmental variability in this area.


Pedro P. Cunha, Pedro Dinis, António A. Martins, Martin Stokes: Sedimentary characterization of a succession of aeolian sands in the Tejo River lower valley – a record of environmental changes of western Iberia during the Late Pleistocene to Holocene.

Christopher-B. Roettig; Daniel Wolf; Philipp Baumgart; Thomas Kolb; Dominik Faust: Aeolianite Sequences on Fuerteventura with different characteristics.
Leaf wax biomarkers in a Loess-Paleosol Sequence in El Paraíso, Spain

Imke Kathrin Schäfer*, Matthias Suhr**, Daniel Wolf ** and Roland Zech*

*University of Bern, Institute for Physical Geography, Hallerstrasse 12, 3012 Bern, Switzerland
**Technical University of Dresden, Department of Geography, Helmholtzstraße 10
01069 Dresden, Germany

Leaf wax biomarkers such as long chain n-alkanes and n-carboxylic acids are resistant against degradation and can be stable even under geological conditions, that’s why they are often used for the reconstruction of paleoenvironmental conditions (e.g. Hinrichs et al. 1998). Adequate archives are either marine sediments or, in the terrestrial environment, Loess-Paleosol Sequences (LPS).

Results from earlier biomarker studies of LPS showed that the homologue distribution pattern of the long chain n-alkanes can be used to distinguish between the inputs of different vegetation forms, e.g. forest vegetation vs. grasses (Zech et al. 2011) but changes of the pattern due to degradation in the upper soil need to be considered (Zech et al. 2013). Moreover, a compound specific stable hydrogen analysis of leaf wax remnants has gained more and more attention because the organic hydrogen originating from photosynthesizing organisms can be used as paleohydrological proxy (Sachse et al. 2012).

To assess the potential of the leaf wax biomarkers for paleoclimate and paleohydrological reconstruction we analysed 32 samples from a LPS in El Paraíso, Central Spain. For further proxy evaluation we will also analyse samples from the vegetation cover.

References


Younger Dryas and Holocene hydroclimatic variability and aeolian history of the Middle Atlas (Morocco)
Christoph Zielhofer, William Fletcher, Steffen Mischke, Marc de Batist

In this study we present a 20 m long lacustrine core record from the Middle Atlas in Morocco. The Lake Sidi Ali record features a continuous high-resolution archive from the Younger Dryas up to the Late Holocene. The core chronology is based on 210Pb sampling and 14C dated pollen concentrates. Hence, the Sidi Ali record provides, in addition to a detailed multi-proxy stratigraphical record, a robust chronological model allowing comparisons within the wider Western Mediterranean region. For the first time the hydroclimatic transition from the Younger Dryas to the Early Holocene is documented in a continuous matter from the North African mountainous environments.

The terrestrial input into the lake is dominated by aeolian silts. XRF provenance analyses from the core and a regional terrestrial transect point to alternating dust origins strongly coupled to sub-millennial scale North Atlantic climatic cyclicity. Here, enhanced Early and Mid-Holocene dust supplies from the south correspond with cold Bond events. However, the Holocene dust input includes a second superimposed provenance signal which corresponds chronologically to the end of the monsoonal-driven African Humid Period. Sidi Ali hydrological proxies from the lake clearly show a hydroclimatic see-saw with mountainous environments from Southeastern Spain. We postulate the impact of authigenic Western Mediterranean cyclones here.

In conclusion, the Lake Sidi Ali record from the North African mountainous desert margin is highly sensitive to Late Pleistocene to Holocene Rapid Climate Changes. The reconstructed sub-millennial to centennial scale hydroclimatic variability and aeolian history reveal evidence for changing impacts of North Atlantic, Saharan and Mediterranean air masses in the Western Mediterranean.
Major episodes of aeolian activity in the central coast of Portugal since the LGM
Susana Costas1, Filipa Naughton2 and Hans Renssen3
1CIMA, Universidade do Algarve, Portugal
2IPMA, Portugal
3Department of Earth Sciences, Faculty of Earth and Life Sciences, Vrije Universiteit Amsterdam, The Netherlands

The existence of vast and fixed transgressive dune fields along the European coasts suggests dramatic changes in the factors controlling the formation of these systems, namely windiness and sediment availability. In this regard, the analysis of dune fields not only provides significant insights about local conditions promoting the migration and formation of such systems, as it also has a great potential unraveling past atmospheric circulation regimes. The latter can be of great importance as atmospheric circulation uses to leave few direct traces in the geological record, making reconstructions of this crucial element of the climate system inherently difficult.

Here, we investigate the archive of aeolian activity preserved in Caparica, central coast of Portugal, using geophysical and dating techniques to determine major episodes of aeolian activity in the western coast of the Iberian Peninsula since the Last Glacial Maximum. The results are used to support the reconstruction of windfield regimes during the identified episodes. The analysis of the internal architecture obtained using Ground Penetrating Radar (GPR), the ages of the identified units from Optically Stimulating Luminescence (OSL), and the texture of the sediments support episodes of enhanced westerly winds during the last termination (20 to 11.5 ka) and the Holocene. Using clusters of ages within the entire dunefield we detected major episodes of aeolian activity centered at 0.35, 1.10, 5.60, and 17.5 ka. Remarkably, all identified episodes occurred during well-known climate events such as the Heinrich event 1 (18 to 15 ka), the Mid-Holocene (6.0-5.0 ka), the Terminal Classic Period (ca1.2-1.0 ka), and the Little Ice Age (0.71-0.13 ka), suggesting a significant climate influence. Additionally, we compared our results with present day analogs to identify favorable conditions for dune formation and encroachment, finding out that present conditions cannot explain the formation of explored dune fields and that required conditions include very strong westerly winds sustained by longer than today periods and the equatorward migration of the jet stream as a consequence of a relative (during the Holocene) and very strong (during the last termination) cooling over the northernmost Atlantic.
Loess-palaeosol-sequences in the Tajo basin - distribution and stratification
P. Baumgart*1, D. Wolf*1, R.C. Zapata2, J.S. Vizcaino2, D. Faust1
1 Institute of Geography, Dresden University of Technology, Germany
2 Departamento de Ingeniería Geológica y Minera, Universidad de Castilla La Mancha, Spain

Loess and loess-related sediments are sensitive recorders of palaeo-environmental conditions and may provide detailed information related to palaeo-climatic configuration. In the southern part of the Madrid Basin, we found up to 8 m thick deposits of aeolian origin including several palaeosol formations. The considered time span comprises at least the last glacial and thus, these loess sequences represent outstanding terrestrial archives, especially as environmental information is rare for this time period in central Spain.

A comprehensive study of seven representative loess-palaeosol sequences is presented based on several field campaigns and different analytical approaches. Loess deposits are mainly located on middle to late Pleistocene fluvial terraces along the Tajo river. Beside aeolian dynamics, likewise fluvial processes as well as slope processes are documented within the sections. To built up a consistent stratigraphy we used rock magnetic analyses that turned out to be a suitable tool for the correlation of different sediment profiles. According to field data as well as palaeo-environmental magnetic data we can actually define following three-fold division: a first phase of strong fluvial relocation of soil material and weathered marl sediments; a second phase of aeolian deposition with strong slope-depending relocation and intense palaeosol formation; and a third phase of "pure" aeolian loess accumulation with just weak differentiations within the upper parts of the investigated profiles.

Challenging issues are to (i) work out the just slight patterns of pedogenetic overprint within the uppermost profile sections, (ii) to provide a reliable chronological resolution, and (iii) to determine sediment proveniences.
Early to Late Pleistocene aeolian deposits in the central Ebro Basin (NE Spain): new clues for deducing Pleistocene environmental variability in this area

H. Gil, A. Luzón, M.A. Soriano, A. Pérez and A. Pocoví

Recent sedimentological and geomorphological studies carried out in the Quaternary deposits that form the terraces of the Ebro River have revealed significant accumulation of aeolian deposits throughout the Pleistocene in the central part of the Ebro Basin. These exceptional deposits provide new data on the characteristics of the palaeoenvironments developed permitting a better approximation to the palaeogeographical evolution in an area where, traditionally, only alluvial systems had been interpreted.

This finding plays an outstanding role. Indeed, although the presence of aeolian dunes Late Pleistocene to Holocene age is relatively common in the coastline of the Spanish territory and diverse aeolian landforms Late Pleistocene to Holocene age have been described in different areas of the Duero Basin and in the La Mancha region, this had not be the case of the Ebro Basin where only recent scarce aeolian landforms had been reported till the moment. Besides, when described, they were more related with erosive processes (yardangs) than with wind-related deposition activity (some loess accumulations in valley bottoms or in leeward slopes, and decimetric-high dunes).

Lithological features of the deposits integrating the terraces are very heterogeneous (mainly gravels, sands and rare mud). Gravel features indicate they were mainly deposited in braided fluvial systems in which longitudinal gravel bars and channels prevailed. Fluvial activity dominated in periods of high availability of water. Laterally to the braided system, alluvial fans coming from Neogene materials of neighbouring reliefs inside the Ebro Basin, sporadically interacted with the main channel net.

But, as pointed previously, the most relevant conclusion is that encased in gravel well-sorted sands in until 4m-thick bodies appear. Grain size distributions, sedimentary structures, geometry of deposits and paleocurrents, permit to interpret most part of the sandy bodies as aeolian deposits. Transverse dunes are the dominant forms but sand complex dunes, sand sheets, and loess have been also identified; moreover faceted clasts and interdune deposits are quite common. OSL dating and palaeomagnetism studies show that aeolian accumulations existed, at least, since the Early Pleistocene. In a climate context characterised by glacial and interglacial periods the genesis of aeolian deposits was favoured by stage of low water discharge where alluvial plains acted as a sand source for wind action.
It is noteworthy the preservation of thick non-cemented sandy deposits in a setting dominated by fluvial sedimentation and gravel deposition. The study of a great number of artificial slopes, mainly on quarries, shows that karstification played an important role in sand preservation, since most of sands levels appear in synsedimentary subsiding areas.
Granulometrical, Mineralogical and Geochemical Characterization from a Loess Palaeosols Sequence in the Tagus Basin

F.R. Calvo* (1), J. Sánchez (1), A. Acosta (2), D. Faust (3), D. Wolf (3) P. Baumgart (3)

Dpto. de Ingeniería Civil y de la Edificación, E.T.S.I. Caminos, Canales y Puertos, Universidad de Castilla La Mancha. Ciudad Real, Spain.
Dpto. de Química Física, Facultad de CC. Químicas, Universidad de Castilla La Mancha.
Ciudad Real, Spain.

This paper presents the results of the investigation of a loess-paleosol sequence of Middle Valley of the Tagus river, called Paraíso Profile. Information of granulometry, mineralogy and geochemistry are given. This profile (depth 8m) has been selected because it is the most complete from seven sections studied. The sampling for analysis was performed according to stratigraphic and sedimentological criteria, by taking samples in each discrete level of the sequence. Detailed and well recorded grain size, mineralogical and geochemical variations have been observed.

Within the sequence can be differentiated four parts from the bottom to the top, each one of them with different granulometric characteristics. The main mode of this section is marked in the coarse silt fraction (between 40 and 60 μm.), while the secondary modes, when present, are observed in the clay size (about 1 μm.) and fine sand (between 127 -140μm.). From a mineralogical point of view, the sequence presents a greater abundance of carbonate minerals (Calcite [≈40%] and Dolomite [≈20%]) than of silicate minerals (Quartz [≈30%], Feldspars [≈ <10%], mainly potassic feldspars and of clay minerals (unmeasured). The lowermost part of the sequence is characterized by its content of Gypsum [≈1%]. Its interesting to highlight the widespread increase in carbonates in the finer fractions and silicates in the coarser fractions. For geochemical analysis see the table below.

<table>
<thead>
<tr>
<th>Elements</th>
<th>SiO2</th>
<th>Fe2O3</th>
<th>MgO</th>
<th>Al2O3</th>
<th>CaO</th>
<th>Na2O</th>
<th>K2O</th>
<th>TiO2</th>
<th>SO3</th>
<th>Sr</th>
<th>Other Elements</th>
<th>LOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>30.04</td>
<td>2.1</td>
<td>3.03</td>
<td>8.2</td>
<td>25.68</td>
<td>0.26</td>
<td>1.71</td>
<td>0.47</td>
<td>2.17</td>
<td>0.16</td>
<td>0.24</td>
<td>25.94</td>
</tr>
</tbody>
</table>

Together with all these previous analyses have been carried out SEM studies that have allowed to show the general morphology of the samples, and
particularly single grains. With this technique, we have noted the presence of two types of carbonates, primary (grains of different morphologies) and secondary (coating over other mineral grains). Also, in general terms, it has been found a high degree of angularity in the grains, typical of eolian deposits, being predominant in the quartz grains, in which their characteristic conchoidal fracture is observed.

All these different studies have allowed a new comprehensive approach about a loess profile in Spain, providing a high-resolution record of loess-paleosol sequence from a granulometric, mineralogical and geochemical point of view. This paper is the beginning of a series of investigations that will be providing about loess deposits in the middle valley of the Tagus river.
Sedimentary characterization of a succession of aeolian sands in the Tejo River lower valley – a record of environmental changes of western Iberia during the Late Plistocene to Holocene

Pedro P. Cunha1, Pedro Dinis1, António A. Martins2& Martin Stokes 3
1 - MARE – Marine and Environmental Sciences Centre, Universidade de Coimbra, Dep. Ciências da Terra, Portugal.
2 - Centro de Geofísica, Universidade de Évora, Dep. Geociências, Portugal; aam@uevora.pt
3 - School of Geography, Earth and Environmental Sciences, University of Plymouth, UK.

Aeolian sands have been recognized along the Tejo River valley in Portugal. Some of these sediments occur intercalated with fluvial deposits of the youngest terrace of the Lower Tejo (the Terrace T6 of a suit of six) but they constitute almost always a cover unit. This unit, named Carregueira Sands, is up to 15 m thick and covers the terrace staircase along the SE river valley margin at altitudes ranging from 30 m to 150 m. The Carregueira Sands were dated by Quartz OSL as 31 Ka (base) to 4 ka (top). The best exposures are located at sand pits near Carregueira village and were used for the sedimentological characterization here presented.

The unit is interpreted as recording climbing dunes, organized into a stacked succession of <3.5 m thick cross-bedded sub-units, corresponding to dune foresets, intercalated with palaeosoils. Palaeocurrents indicate sand transport towards SE, suggesting sand sourcing from the exposed alluvial plain. Eleven facies were recognized, including dominant aeolian deposits, intercalated with thin paleosoils, mud lenses (wet interdune) and minor fluvial deposits. Large scale tabular, tangential or slightly trough cross-bedded sets (0.5–3.5 m thick) consisting of medium-grained sands are the most expressive aeolian dune deposits. Aeolian deposits are also represented by decimetre to meter thick massive, low angle or horizontally stratified fine to medium grained sands (4 facies).

Fluvial facies are represented by small sized (up to 1 m thick, width/height ratios of 0.5-5) channel-shaped beds formed by well-rounded gravel in a moderately sorted sandy matrix (2 facies), horizontally laminated sand-mud beds (1 facies) and tabular laterally persistent faint laminated or massive fine to medium sands with floating rounded pebbles (2 facies). The wet interdune/paleosoil facies are sub-horizontal decimetre thick sand beds with significant silt-clay fraction (up to 30 %). The grain-size distributions of aeolian and sandy fluvial sediments are similar, being dominated by medium sand particles (modal sizes of 0.25-0.5 mm). However, aeolian sediments are always
unimodal whilst sandy fluvial sediments usually integrate subsidiary populations of coarse silt and, occasionally, pebble. Thickness of the Aeolian sets tends to decrease upwards. The presence of micaceous lamina, moderate amounts of mud (up to 5 %), relatively coarsegrain-size, poor sorting and the dominant weak roundness of the quartz grains indicate short aeolian transport. The aeolian sands should be mainly derived from the Tejo alluvial plain during cold and dry periods, when the river undergone incision and the vegetation diminished. The dunes climbed the slopes of the left margin of the valley, forced by strong NW Atlantic winds. The aeolian sub-units record long periods of wind controlled sand accretion, punctuated by episodes of dune stabilization and vegetation development (interstadials).
Aeolianite Sequences on Fuerteventura with different characteristics
Christopher-B. Roettig1; Daniel Wolf1; Philipp Baumgart1; Thomas Kolb2; Dominik Faust1
[1] Dresden University of Technology; [2] University of Bayreuth

Volcanism as well as fluvial and aeolic processes shaped the landscape of Fuerteventura, one of the easternmost Canary Islands. The local archives support information about the different tracks of the sediments: i. High carbonatic dune sediments, consisting of shells and molluscs from the local shelf, ii. Loess-like sediments, characterized by finesand and silt originated from the local shelf and even silt and long-range-transport-dust from the african continent and iii. Different tephra accumulations, most probably from eruptions on the island itself.

The main tasks are to divide the different accumulation-, soil forming- and erosion-phases, to set up a stratigraphy and to correlate soils and sediments (stratigraphical units) over longer distances and to come up with a scenario of landscape evolution. Based on that we want to infer to the different climatic conditions of the last glacial.

The first sites of northern Fuerteventura give an overview of the different appearances at the same stratigraphical position. Obviously it is a consequence of small-scale changeovers. As first result we present a standard profile of the studied sites so far. Furthermore we want to give insight into the causes of the multi-faced soils and sediments and present the reliable characteristics of them.
Alluvial archives

Oral presentation chair: Pierre Antoine

Rafael Baena-Escudero; José J. Fernández-Caro; Inmaculada Guerrero-Amador; María Patrocínio Espigares; Sergio Ros-Montoya; José Carlos Posada-Siméon: Evidence of huge Hippopotamus in the Pleistocene from T12 terrace deposits located on the River Guadalquivir (La Rinconada, Seville, Spain): stratigraphic meaning and palaeoenvironmental value.


L. Schulte, R. Julià, A. Hilgers, F. Carvalho, F. Burjachs: River response to environmental changes during the Late Pleistocene to Holocene transition inferred from fluvial archives, tufa and slope deposits in the southeastern Iberian Peninsula.

António A. Martins, Pedro P. Cunha, André Paiva, João Cabral, & Martin Stokes: Geomorphological cartography on the River Tejo lower valley – implications for interpretation of landscape and environmental changes of western Iberia in the last 2 Ma.


Poster presentation chair: Christoph Zielhofer

Melanie Bartz, Gilles Rixhon, Dominik Brill, Josef Eiwanger, Gerd-Christian Weniger, Abdeslam Mikdad, Helmut Brückner: Quaternary fluvial environments in the eastern Rif (Morocco) – the case study of Wadi Selloum in the vicinity of the prehistoric site Ifrin’Ammar.

Dominik Faust, Daniel Wolf: Tectonic Signals in Fluvial Archives – Jarama River in Central Spain

Daura, J., Sanz, M., Ramos, J., Julià, R., Riera, S., Miras, Y., Alluè, E., Picornell, Ll., Domènech, R., Fornós, J.J., López-Reyes, D: Palaeoenvironmental reconstruction of the Llobregat River between VI to IV millennia cal. BP from the Cal Maurici sediment archives (Barcelona, NE Iberian Peninsula).

J. Sanjurjo-Sanchez, C. Arce Chamorro, W. Viveen, A. Goy-Diz: Palaeoenvironmental data from fluvial deposits associated to ancient fishing weirs in the Miño River, NW Iberia.


Evidence of huge Hippopotamus in the Pleistocene from T12 terrace deposits located on the River Guadalquivir (La Rinconada, Seville, Spain): stratigraphic meaning and palaeoenvironmental value.

Rafael Baena-Escudero; José J. Fernández-Caro; Inmaculada Guerrero-Amador; María Patrocinio Espigares; Sergio Ros-Montoya; José Carlos Posada-Simeón.

A new assemblage of remains of larger mammal of the Pleistocene with Elephas antiquus, Bos primigenius e Hippopotamus amphibius, amongst others, has been found in the fluvial deposits of the Guadalquivir River in La Rinconada (Seville, Spain) associated to acheulean lithic industry. In Spain, the presence of Hippopotamus in the fluvial records is scarce limited, in the case of those of greater size (H. antiquus), to the Jucar terraces of +60 meters (Fuensanta del Júcar), Guadiana (Valverde 1), and tributaries of the Jarama River in Cabecera (Pontón de la Oliva), while in the paleoenvironment lacustrine system they are located in the basins of Guadix-Baza (VentaMicena, Barranco León, Fuente Nueva III, Huéscar I) and Banyoles (Incarcal) dating between 800 and 1600 ka. As for the H. Amphibius, species still present in Africa, the same are registered in the terraces of the Tagus River (Pinedo a +25-30 m; Toledo, Salchicha Inferior, Buena Vista Inferior a +40-45 m), as in the Jarama River (Arganda I +30-32 m) as well as in the last lacustrine sediments of Guadix-Baza (Solana de Zamborino) in the Middle Pleistocene (ca. 280 to 400 ka). In this last case its presence is always associated to lithic industry as well to taxa like Elephas (paleoxodon) antiquus, Bos, Equus, Cervus elaphus ..., that indicate humid and mild conditions of the Middle Pleistocene during the MIS 11, MIS 10/9; MIS 9; MIS 8/9 and MIS 7 isotopic stages (Santonja & Pérez-González, 2010; Mazza & Bertini, 2012; Hugues et al., 2014).

The deposits of the T12 terrace of the Guadalquivir River in La Rinconada at +26-32 m, show a complex stratigraphic presence with a overlaying of alluvial deposits clearly dating from before 150 ky and of probable initiation in the full Middle Pleistocene (ca.450-490 ka, Baena et al. 2014). Amongst the hippopotamus new dental remains now located, those from the base of the sediments of this terrace (left and right inferior canines), indicate the existence of, at least, two adult individuals with dimensions of the teeth unknown in Spain and only comparable in Occidental Europe to those H. antiquus fossils found in Upper Valdano and Collecurti Italy of more than 1 Ma, or those H. amphibius of Barrington (U.K.) of more recent age (MIS 5e). Additionally that means that the presence extralarge specimens along with men during the Middle Pleistocene, a interesting and controversial paleoenvironment marked by the
existence of humid and mild macrofauna in the Valley of the Guadalquivir River in a cold isotopic stage (MIS 12).

References


**Time-integrated 3D late Quaternary sediment-depocentre migration in the Tagus depositional system: from river valley to abyssal plain**

Geert-Jan Vis¹, Cornelis Kasse, Dick Kroon, Jef Vandenberghhe, Simon Jung, Susana M. Lebreiro, Teresa Rodrigues

¹: presenting author, TNO Geological Survey of the Netherlands, PO Box 80015, 3508TA Utrecht, Netherlands

Quantification of sediment volumes in continental to deep ocean basins is key to understanding processes of sediment distribution in source-to-sink depositional systems.

We present the first quantification of sediment-volume changes in basins along the course of a major southwest European river during the deglaciation. The salient points of this quantitative record in the Tagus and equivalent North Atlantic basins show crucial roles for sea level, climate and land-use in the distribution of sediments. Bypassing of sediments starved the Tagus basins, and subsequently sedimentation mainly occurred on the Tagus Abyssal Plain during the sea-level low stand of the Last Glacial Maximum. The main sediment depocentre rapidly shifted via the continental shelf to the Lower Tagus Valley during sea-level rise in the deglaciation period.

![Summary figure of Tagus depocentres since ~18 ka with respect to relative sea level (RSL).](image)
Finally, the main sediment depocentre shifted further landwards into the Lower Tagus Valley during sea-level high stand in the Holocene (last 7 ky).

During the high stand phase, sediment flux increased up to 2.5 times, due to climate and land-use changes. The average catchment denudation rate (0.01 mm/y) is in agreement with those of other European catchments. However, the denudation rate increased from ~0.05 mm/y (12-0 ka) to ~0.13 mm/y (7-0 ka), corroborating the intensified sediment flux during the last 7 ky.

This study clearly demonstrates the added value of detailed knowledge of 3D depocentre distribution, size and chronology. This allowed us to identify an increased sediment flux during the last 7 ky, which was not identified using local observations from boreholes alone.
River response to environmental changes during the Late Pleistocene to Holocene transition inferred from fluvial archives, tufa and slope deposits in the southeastern Iberian Peninsula

L. Schulte¹, R. Julià², A. Hilgers³, F. Carvalho¹, F. Burjachs⁴

¹ Department of Physical Geography and ICREA Academia, University of Barcelona, Spain
² Institute of Earth Science “Jaume Almera”, CSIC, Spain
³ Institute of Geography, University of Cologne, Germany
⁴ ICREA at the Catalan Institute of Human Palaeoecology and Social Evolution (IPHES), Spain

Fluvial archives, tufa and slope deposits in the River Aguas basin provide paleoenvironmental proxies sensitive to climate changes during the last 170 kyr. From the chronostratigraphic data sets we establish a model of Late Pleistocene and Holocene river dynamics that focuses on erosion and aggradation pulses in the southern Iberian Peninsula.

U/Th and OSL dating define the major periods of freshwater tufa formation of the Alfaix tufa platform located at 12 km from the Mediterranean. The tufa aggradation ranges from 169 to 26 kyr interrupted by at least four incision events: 167-148 kyr, 148-110 kyr, around 95 kyr and at 71 kyr. Aggradation of the River Aguas ceased after 26 kyr and incision occurred during OIS 2.

Downstream, at 7 km from the coastline, a 5 m-thick sedimentary record shows fluvial, alluvial and colluvial aggradation periods from 49 kyr on as indicated by isothermal luminescence dating. Each of the 8 sedimentary pulses ends with a weak or moderate soil formation (higher TOC at the top and CaCO₃ at the base). Major tendencies of geochemical data series such as Fe and magnetic susceptibility correlate closely with the variability of the δ¹⁸O record of core MD95-2040 from the Atlantic Iberian margin. The timing of these pulses may be triggered by climate deterioration. Major unconformities (erosion) coincide with lower δ¹⁸O values (cooler climate pulse) and periods of soil formation (stability) correlate with higher δ¹⁸O values (warmer climate pulses).

Subsequently to the river incision in the Alfaix tufa surface the terraces T4a and T4b were deposited in the Aguas river system. OSL dating of the T4a channel deposit in the Rambla de Hornos, tributary of the River Aguas, provides maximum ages of 28, 20 and 18 kyr. Furthermore, short climatic events, such as the Younger Dryas, produced two more river incision episodes during OIS 2. During the Holocene incision stopped and terraces are composed of point bar deposits accumulated by meandering rivers with less sediment discharge. ¹⁴C- and ²¹⁰Pb-ages and pottery fragments, date the deposition to the Atlantic period, early Middle Ages, Little Ice Age (LIA) and the 20th century.
Nonetheless, for river systems influenced by tectonics, climate and sea-level changes it is difficult to assess the weight of each controlling factor. Regarding the three mechanisms of Pleistocene river dynamics in middle-size catchment areas of the littoral region of southeast Spain, our results support the hypothesis that large scale tectonics triggered the general down-cutting trend, whereas the main aggradation and incision phases occurred during periods of major sea-level changes. Over short-time scales the influence of climate variability, as documented by pollen records, plays a decisive role. The incision events of the River Aguas around 72, 25 and 11 kyr occurred simultaneously with the decrease of the arboreal vegetation indicated by the pollen records of the Padul basin (Pons and Reille, 1988) and the Alfaix tufa platform. Thus, the river responses to the three cyclic mechanisms operate at different time scales although synergetic processes should be considered with respect to the magnitude of abrupt incision/aggradation events.
Geomorphological cartography on the River Tejo lower valley –implications for interpretation of landscape and environmental changes of western Iberia in the last 2 Ma

António A. Martins¹, Pedro P. Cunha², André Paiva³, João Cabral⁴ & Martin Stokes⁵

¹ - Centro de Geofísica, Universidade de Évora, Dep. Geociências, Portugal.
² - MARE – Marine and Environmental Sciences Centre, Universidade de Coimbra, Dep. Ciências da Terra, Portugal.
³ - Univ. Coimbra, Departamento de Ciências da Terra, Portugal.
⁴ - IDL, Lisbon University, Faculty of Sciences, Portugal.
⁵ - School of Geography, Earth and Environmental Sciences, University of Plymouth, UK.

Since the second half of the 90s of the last century, geomorphological cartography in some reaches of the Lower River Tejo (Portugal) was undertaken (Martins, 1999; Cunha, et al., 2008; Martins, et al., 2009, 2010a). Up to six terraces were identified in reach I (Ródão), reach III (Abrantes) and reach IV (V.N.Barquinha–V.F.Xira). A resistant Paleozoic basement proved to be favorable to the development of a narrow valley with almost no terraces. On the contrary, reaches located upstream of resistant local base levels or with a substratum of Cenozoic sediments promoted the valley enlargement and alluvial aggradation. A long-term trend of incision driven by regional uplift, punctuated by episodes of valley enlargement and aggradation promoted by high sea-level periods was considered in the formation of the terrace staircase (Martins et al., 2010b).

This contribution focuses on the unpublished terrace sequence of reach IV, located just upstream of the modern estuary. Geomorphological mapping at a 25,000 scale reveals an asymmetrical development of the terraces in reach IV. The asymmetric development of the terraces indicates differential uplift. In the Chamusca area up to ca. 30 m of differential uplift is estimated to have occurred after the formation of terrace T3 (minimum age of 340 ka). Since the beginning of down-cutting in the Piacenzian-Gelasian culminating surface (the Tejo River alluvial plain before the incision stage), the geometry of the valley evolved from broadly aggradation surfaces in the older terraces (T1 to T4) to a more narrow and incised valley coeval of the lower and younger terraces (T5 and T6). This feature is widespread in the Tejo upstream reaches, up to 200 km from the river mouth. This change in time of the valley geometry is insufficiently understood, but the terrace elevations and the available ages (postIR-IRSL for the younger terraces, T6, T5 and T4, Cunha et al., 2012; ESR for the T4 to T1, Rosina et al., 2014) suggests longer periods of valley enlargement and aggradation for the older terraces, compared with the younger terraces possibly due to the acceleration of uplift. The cartography also evidences the Holocene alluvial plain, and a late Pleistocene aeolian sand unit only represented in the eastern margin of the valley.
References


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The terraces staircases of Douro River at the Pocinho and Barca D’Alva sectors (NE Portugal) – records for the interpretation of the evolution of W Iberia during Quaternary

A. Gomes1, P. P. Cunha 2, F. Lopes 3, A. A. Martins 4, D. I. Pereira 5 & J. Cabral 6

1 CEGOT, Dep. of Geography, University of Porto, Portugal.
2 MARE – Marine and Environmental Sciences Centre, University of Coimbra, Dep. of Earth Sciences, Portugal.
3 Centro de Geofísica, Dep. of Geosciences, University of Évora, Portugal.
4 Centro de Geofísica, University of Coimbra, Dep. of Earth Sciences, Portugal.
5 Geology Centre, University of Porto; Earth Sciences Department, University of Minho.
6 IDL, Lisbon University, Faculty of Sciences, Portugal.

In the Iberia Peninsula, the process leading to the drainage of the Douro basin towards the Atlantic at the latest Cenozoic remains a major geomorphological challenge (Pereira et al., 2000; Anton et al., 2012), particularly understanding the connection between the geomorphological evolution of the trunk river and its tributaries in the Portuguese sector, that captured the drainage of the previously endorheic Douro Cenozoic basin (in Spain). However, geomorphological and sedimentological data are available to interpret the ongoing incision stage punctuated by episodes of valley enlargement and aggradation leading to the formation of fill and rocky terraces (Cunha et al., 2010). These terraces are well individualized at confined areas of the Douro and Sabor valleys, as well as on other tributaries rivers of the Portuguese part of the basin.

This contribution is focused on the Douro River terrace staircases in two reaches, Pocinho and Barca D’Alva.Geomorphological mapping and luminescence dating, of the lower terraces (with sedimentary deposits), are also presented and discussed. Furthermore, the control of river evolution by climate, tectonics and eustasy is also interpreted.

The fluvial staircases on both reaches are similar for the lower fill terrace, located just above the actual alluvial plain (T1=±10/15m). It comprises mainly fine sands that give quartz-OSL of 24 to 14 ka. For the upper terraces, significant differences between the fluvial staircases were identified: a) more levels of fill terraces exist at the Barca D’Alvareach (4-5 levels at Quinta da Canameira site and 2-3 at Barca D’Alva site) than for Pocinho reach (2); b) also differences in sedimentary architecture and lithology can be identified: the second fluvial terrace above actual alluvial plain (T2), tends to be coarser and was explored, at Barca D’Alva, by the Romans for gold. For the T2 terrace, the quartz-OSL dates obtained are minimum ages (>122 ka). However, using the pIR-IRSL method (K-feldspar), ages up to >360ka (+47.5m; terrace T3) were obtained. The differences between the studied fluvial staircases, despite of local geological/geomorphological conditions, seem to reflect regional tectonic
conditioning, since these fill terraces are well preserved in small NNE-SSW elongated depressions. The faults that bound these depressions are also responsible for the preservation of Paleogene-Pliocene sediments along these small sinistral strike-slip basins, which support the hypothesis of a reactivation of Variscan strike-slip faults that are well impressed on the relief of the area, particularly for the Pocinho staircase where one of the lower terraces (the T2) are thrust by the basement (granite).

References


This work is part of the activities of the project PTDC/GEO-GEO/2860/2012, approved by the Fundação para a Ciência e a Tecnologia and co-founded by the FEDER.
Flood periods are wet periods? - A critical examination of Atlantic River Basins in Spain.

Wolf, D., Faust, D.
Institute of Geography, Technical University of Dresden, Helmholtzstr. 10, 01062 Dresden.

In the Mediterranean realm, environmental changes and related effects on landscape dynamics during the Holocene attracted the interest of research for a long time now. Especially in view of the high fragility of numerous Mediterranean landscape units, the interrelation between certain climate changes and triggering of geomorphological systems gains particular importance. However, the reaction of river systems on climatic variations is still a subject of controversy. In this context, periods of observed high flood activity on the Iberian Peninsula are frequently correlated with more humid climate conditions.

A basic assumption for our contribution to this issue is that floodplain dynamics of appropriate river systems may be suitable to indicate landscape dynamics on catchment scale. Therefore, we investigated fluvial sediment successions of different river systems in Spain (Jarama, Guadalete & Guadalquivir) in order to work out periods of floodplain/landscape activity and floodplain/landscape stability. Activity periods are characterized by the occurrence of high floods as well as overbank sedimentation of cohesive flood loams, which in turn, provides information on the intensity of catchment erosion. The correlation with numerous comparative studies on terrestrial archives of regional significance revealed that periods of floodplain sedimentation may be linked to phases of climatic aridification. As arid periods are generally accompanied by increased rainfall variability, runoff may be generated by extreme precipitation events on the one hand and by diminishing of vegetation leading to reduced infiltration and increased slope erosion on the other hand.

The spatio-temporal distribution of fluvial dynamic phases over SW and Central Spain as well as a comparison with marine coring along the Iberian Margin strengthen this assumption of a climate-driven occurrence of high-flood events.

Thus, we expect that high-flood events that are recorded in floodplain records can be attributed to heavy precipitation events, but not in a sense of humid periods; instead high rainfall variability under more arid climatic conditions may be crucial.
Quaternary fluvial environments in the eastern Rif (Morocco) – the case study of Wadi Selloum in the vicinity of the prehistoric site Ifri n’Ammar
Melanie Bartz1*, Gilles Rixhon1, Dominik Brill1, Josef Eiwanger2, Gerd-Christian Weniger3, Abdeslam Mikdad4& Helmut Brückner1

1 Institute of Geography, University of Cologne, Albertus-Magnus-Platz, 50923 Köln (Cologne)/Germany
2 Commission for Archaeology of Non-European Cultures (KAAK), Dürenstr. 35-37, 53173 Bonn/Germany
3 Neanderthal Museum, Talstraße 300, 40822 Mettmann/Germany
4 Institut National des Sciences de l’Archéologie et du Patrimoine (INSAP), 1, rue Ghandi, Rabat/Morocco

The impact of environmental changes on the emergence and dispersal of anatomically modern humans (AMH) is particularly important in North Africa, since the Straits of Gibraltar might have served as western migration route for the AMH from Africa to Europe. The prehistoric rock shelter of Ifri n’Ammar in NE Morocco reveals discontinuous Middle and Late Palaeolithic occupation phases since ~170 ka.

Our study focusses on fluvial deposits of Wadi Selloum in the direct vicinity of Ifri n’Ammar, to reconstruct local palaeoenvironmental features in the eastern Rif Mts. The major tools are the application of geochronological techniques (e.g. dating with OSL) as well as sedimentological and geochemical studies. While analyses of grain-size and X-ray fluorescence of major and trace elements were carried out in order to document phases of morphodynamic activity, palaeosols were studied as indicators of morphodynamic stability. Oxygen and carbon stable isotope ratios of the Wadi Selloum gastropods (Otala cf. lactea) provide a further proxy for reconstructing climatic changes during the time of human occupation in the Ifri n’Ammar rock shelter.

Wadi Selloum deposits yield ages ranging from 1.3 ± 0.2 ka (quartz, fine sand fraction) to at least 94.0 ± 7.7 ka (potassium feldspar, postIRIR290, fine sand fraction). Our study reveals phases of overbank aggradation around 60 ka and 90 ka, intercalated with periods of even higher morphodynamic activity.
The Upper Pleistocene (with lithic industries) and Holocene sequence in the Guadalquivir’s floodplain (Seville, Spain): from a fluvial system to an aggradation and shallowing-upward alluvial processes

F. Borja¹; F. Díaz del Olmo²; J.A. Caro³; J.M. Recio³; C. Borja²; J.A. Valiente⁴.
¹Univ. de Huelva; ²Univ. de Sevilla; ³Univ. de Córdoba; ⁴9 arqueología constructiva S.L.

The Guadalquivir River’s alluvial floodplain around Seville city (SW of Spain), about 25 km from the mouth’s estuary into the Atlantic Ocean, current Guadalquivir’s marsh (closed estuary by littoral spit and dunes systems), shows alluvial sedimentary fillings, of heterogonous thickness of approximately 20 m from Upper Pleistocene to recent historical periods (19th and 20th century).

The thickest stratigraphic sequences are located in the eastern sector of the city, whence comes from which we present in this paper (JMC sequence), in order to show a alluvial model of the transit from the Middle Upper Pleistocene (< 62 ky BP) to the Middle Holocene in the moment of the fulfillment of the Rise of Sea Level (RSL) transgression (ca. 6,5 ky BP), a phase in which it is configured the big inlet of the Guadalquivir’s marshes (open estuary) (Zazo et al., 2008).

The JMC sequence, developed onto the Upper Miocene marls (Blue Marls Fm), shows a thick alluvial stratigraphy of 20 m, with 4 sedimentary assemblages:

-First ensemble (-11,80/-2,00 m): Deposit of alluvial bars with lateral migration in alluvial sinuous system. System of bars with big pebbles (centile 290 mm), gravels and fine-gravels (centile 143 mm) superimposed, with plentiful silt-sand matrix (with visible planar structure) (Gp) (Miall, 1977). Lithologically, the pebbles are in quartzite (34%), quartz (26%), various metamorphic stones (11%), sandstone (8%) and other lithologies (21%), with roundness shapes which index of roundness (Ir) is for quartzite 0,44 (Mode) and for quartz 0,5 (Mode), and tendency to spherical shape (Mode of flatness Index -If- of quartzite 1,75; and of quartz 1,50). From the upper stratigraphic section they are recovered 8 pieces of well-rounded lithic industry (R3) in quartzite (maximum length: 245 mm); and 2 in flint, one of these well-rounded (R3) and the other one slightly rounded (R1) (maximum length: 50 mm).To the top (-2,18 m.) a loam-sandy level has provided a chronology of 62 ky BP (OSL on quartz silts matrix).

-Second ensemble (-2,00/-1,08 m.): Deposit of alluvial over-flooding with the upper level alternately emerged and presence of alluvial peat. It is constituted by silt-clayey sediments with fine-gravels floating on the matrix and some fine-gravels (centile <1 cm.), bars of dominant quartzite and quartz. To the top it is located one chopper without rounding (R0) of metamorphic nature (Length: 137 mm) inserted in a loam-clayey facies with abundant rests of O.M.,
bioturbation and ponds vegetation. For correlation with the western sequences of the Guadalquivir’s alluvial floodplain (Borja et al., 2011), the chronology of this assemblage is late Upper Pleistocene/Lateglacial (27 ky BP $^{14}$C-AMS).

-Third ensemble (-1,08/+0,72 m.): Deposit of alluvial over-flooding with marginal facies of laminated sediments (crevasse-splay). They are formed from massive sandy-clayey sediments, with abundant O.M and roots fragments; those, at bottom, present a thick lamination from an accumulation of fine-gravels and sands; to the top they become mainly loamy with an abundance of bioturbation, roots and gastropods. This assemblage provides chronologies between 8 ky BP (peat level in laminated deposits, $^{14}$C AMS) and 6 ky BP (charcoal) (Borja et al., 2008).

-Fourth ensemble (+0,72/4,40 m.): Deposit of alluvial floodplain with edaphic features. These are loam-sandy sediments with scattered gravels and fine-gravels levels and thick clayey levels, with edaphic episodes, gastropods and bioturbation. Chronologically they correspond to many historical episodes, from the Roman period and The Middle Ages to the contemporary clayey episodes (19th and 20th century).

Therefore, the JMC sequence shows for the transit to the Upper Pleistocene to the Holocene a double sedimentary system:

Firstly, a thick detrital series of alluvial gravels of the Upper Pleistocene (correlative to MIS 4), with well-rounded lithic industries whose chronology and stratigraphy link to the Guadalquivir’s terraces from the Upper Pleistocene (T12, T13 the PSG, Pleistocene Sequence of the Guadalquivir river valley) (Caro et al., 2011). The industries are correlated to The Middle Palaeolithic (Mode 3) displaced within an alluvial sinuous environment from the habitual workshops of knapping. The transit from alluvial gravels of the Upper Pleistocene to the sequences of Lateglacial/Holocene happens through a strong erosive unconformity (contact between assemblages 1 and 2), from which it is settled the second sedimentary system. It is about an alluvial vertical model, ensembles of facies of sedimentary aggradation in floodplain, dominating deposits of over-flooding and to the top, episodes of emergences (ensemble 3 and afterwards 4). The without rounded industry located in this system gives evidence of presence of human activity in the floodplain. The correlation between this second system (ensemble 3) and the phase of fulfilment of the Rise of Sea Level (RSL) Holocene transgression (ca. 6,5 ky BP) in the Guadalquivir’s marshes, which are constituted as an open estuary (Zazo et al., 2008), shows an alluvial shallowing-upward sequence with two levels of emerged floodplains temporary, one of these in the base (ensemble 2) and the other to the top (ensemble 3). For Reineck & Singh (1980) this kind of sequence constitutes a model of sedimentation with high influence of terrigenous tidal environment.
Acknowledgements

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References


River dynamics are controlled by climate, tectonics, human impact and intrinsic factors related to the physiographic constellation of the catchment. To identify the importance of each factor controlling river behavior is a complicated task. During our research on the fluvial history of the Rio Jarama, we could observe halokinetic features leading to special system response in terms of non expective sedimentation and erosion features over a longer time span. The halokinetic uplift seems to be a rapid movement resulting in different features compared to those of slow tectonic uplift movements.

According to our findings the River Jarama reacts with strong erosion in the uplift area that washed out all sediments over the entire floodplain of about 1.5km width. After a longer time span of erosion (according to dating it lasted ca. 10 ka), sedimentation started at about 5 ka with very coarse gravels that were deposited by a braided river over the entire floodplain. The sedimentation
of coarse gravels lasted about 2 ka leaving a gravel body of more than 2 m. The system calms down at about 3 ka starting with sandy deposits and the tendency to meander. Halokinetic disturbance features were then completely smoothed. Even today the floodplain longitudinal gradient is still steeper in this part of the river section.
Coastal ecosystems, in particular large deltas and wetlands, are areas of high productivity of food resources, as has been demonstrated by the archaeological and palaeoenvironmental record. During prehistoric and protohistoric times the evidence of littoral exploitation becomes an important factor in human resources. Moreover, behavioural and social implications are derived from this littoral procurement, as the mobility or prehistoric exchange based on marine elements found away from the seacoast.

The littoral plain of Barcelona is a depression crossed by the Llobregat river between Collserola and Garraf mountain range where several Neolithic to Bronze Age sites yielded a number of malacological and fish bone signalling marine and shore resource use and a strength interaction between earlier farmer communities and marine ecosystems. Away from the coast, several sites yielded ornaments made of diversified marine materials that are indicative that shells were transported inland as a result of humans groups and coastal shore interaction.

However, our knowledge of past littoral ecosystems from a multi-approx data is poorly recorded in this area and it is essential to evaluate the ecological conditions for human procurement. Our archaeological investigation is focused on several test pits developed in Cal Maurici site and provides an opportunity to examine the environmental conditions during the Late Prehistory and can be used to assess foraging areas for human groups. Stratigraphical and ecofactual analyses are carried out in Cal Maurici site (6171 to 3712 cal BP), depicting a complex palaeoenvironmental evolution in the area of Llobregat delta over 3000 years.
Palaeoenvironmental data from fluvial deposits associated to ancient fishing weirs in the Miño River, NW Iberia.

J. Sanjurjo-Sanchez1, C. Arce Chamorro2, W. Viveen1,2*, A. Goy-Diz3

1Instituto Universitario de Geología, Edificio de Servicios Centrales de Investigación, Campus de Elviña, University of A Coruña, 15071, A Coruña, Spain
2Soil Geography and Landscape Group, Wageningen University, P.O. Box 47, NL-6700 AA, Wageningen, the Netherlands
3Facultad de Humanidades, University of Santiago de Compostela, Spain

Fluvial sediments provide palaeoenvironmental records of the Quaternary. In some cases, fluvial deposits are caused by anthropogenic process that changes the water regime of rivers in some river stretches.

This is the case of present dams. It has been reported that some dams, or at least partial dams existed from some thousands of years ago for fishing purposes or water use in canals. This is the case of some fishing weirs. In a recently published work it has been demonstrated that some thick deposits can be related with this kind of structures that partially dam the river water. Optically stimulated luminescence (OSL) has recently provided the burial age of fluvial deposit caused by a fishing weir in historic times in NW Iberia. OSL was used due to the absence of either datable organic or carbonaceous compounds, showing a 1300 year old reconstructed fluvial record that does not match with known climate fluctuations in the area. At least three sedimentation phases have been identified in the sediment record. In this work the sedimentary features of such deposit are explored to get palaenvironmental data that could be linked to either natural climatic/environmental changes (middle age warm period of the little ice age) or anthropogenic process that affected to the landscape.

The deposit is made of fine to medium size sand, indicating no significant changes in the water flux and sedimentation conditions during most of the sedimentation record. Grain analyses indicate a high homogeneity in the mineral components of the deposit layers. The mineralogy fit the composition of the granitic rocks of the surroundings (and some km upstream), indicating no significant changes in the source of materials and transport and a major contribution of materials of the nearby landscapes of the weirs. Moreover, significant changes in the roundness and sphericity of the grains are not observed. However, the analyses of organic carbon, N, S and isotopic analyses of C and N on organic matter have indicated the major contribution of phytoplankton to the organic matter deposited in the uppermost 4 m of the deposit while for the lowermost layers results indicate the main contribution of terrestrial plants to the organic matter due to anthropogenic activity in the surrounding landscapes. The strong differences in the sedimentation rates...
observed in the three sedimentation phases can be linked to anthropogenic activities in the surroundings of the weirs. Such data have also been compared with historical data. The interpretation of results shows a strong anthropogenic effect on the deposition in the river stretch.
Dating fluvial terraces of the River Mero Basin (NW Iberian Peninsula) by luminescence
Arce Chamorro, C., Sanjurjo-Sánchez, J., Vidal-Romaní, J.R.
Instituto Universitario de Geología “Isidro Parga Pondal”. Universidade da Coruña, A Coruña, Spain

The Mero River basin (A Coruña, Spain) drains an area of ≈345 km² and flows into the Ria of A Coruña (NW of the Iberian Peninsula). The basin is developed on two lithologies: schists (≈70% of the area) and granodiorite (≈30% of the area), with a clearly asymmetrical distribution of river courses in the schistose area (Rivers Mero, Barcés, Brexa, Govia) over the granodiorite area (River Valiña). The main peculiarity of the Galician river network is the poorly developed terrace deposits, except in river courses that flow through areas of suitable lithology (e.g. quartzite, quartz).

In the Mero Basin, despite the unfavourable lithology river terraces are well developed although they are essentially found on the schistose areas. They are quartz and quartzite gravel deposits embedded in a clay-silt rich matrix. The older relative chronology of such deposits has been established on the fact that the location of the headwaters of the river network (Barcés River) starts in the Basin of Meirama, of Neogene age. This provides a minimum age for the river network and also for the Ria of A Coruña.

In this work we have applied optically stimulated luminescence (OSL) dating to establish the chronology of different terrace deposits of the Mero Basin. OSL dating provides the burial age of Quaternary deposits. It has been applied to some basins in the NW of the Iberian Peninsula with limited results due to the predominant lithology of this area, dominated by granitic rocks with high content on radioactive isotopes (U, Th and K). Such content results in high radiation dose-rates that hinder the use of OSL dating to get ages older than ≈20-40 ka, due to the saturation of the OSL signals of quartz. Even the use of infrared stimulated luminescence (IRSL) on feldspars (that typically saturates at higher doses allowing dating deposits up to 0.5 Ma) provided ages not beyond 100 ka.

However, the studied terraces of the Mero Basin correspond to materials of low radioactive isotope content due in the schist lithology. Thus, the application of OSL for dating the terraces has led to better older ages for the development of the inland river network of the Mero Basin. Now it is assigned to the Upper Quaternary, fitting the chronology obtained by cosmogenic isotopes and OSL for terraces of the final extent of the River Miño. Considering that the Galician estuaries (Rias) and river systems that flow into the mare much
older, this contradiction, at least for the Mero, can be attributed to are cycling of the materials forming the river several times during the Quaternary and may be the UpperTertiary.
Valley incision trends and subsequent chronosequences of fluvial terraces for Atlantic large rivers in the Iberian Peninsula and Northern Europe.

P.G. Silva (1), E. Roquero (2), M. López-Recio (3), P. Huerta (1), A. Martínez-Graña (1)

3 Dpto. Prehistoria y Arqueología, Universidad Autónoma de Madrid. Spain.

This work analyze the age-height terrace relationships for different Atlantic river valleys in western Europe in order to compare trends of valley incision throughout the Quaternary Period in response to climatic (global sea-level changes), tectonic (differential uplift) and typical intrinsic factors controlling fluvial behaviors (mainly catchment area and distance to the main river outlets into the Atlantic Ocean, in this case). As showed by preliminary approaches developed by the authors for Atlantic rivers in Spain (Silva et al., 2013; Roquero et al., 2014), general curves illustrating valley incision result from 3rd Order Polynomial regression equations between numerical ages and relative heights of fluvial terraces above the respective river thalwegs. In this work we use about one hundred published geochronological data (OSL, TL, Th/U, AAR) and paleomagnetic relative ages for valleys of central Spain and Portugal (Tagus and Duero river basins), Northwest France (Somme, Seine, Loire, Creuse) and southern England (Thames and Solent). In all the cases the obtained curves illustrating valley incision have correlation ratios ($R^2$) above 0.9 and display similar sigmoidal geometries featuring significant changes in incision rates in response relevant sea-level changes in the Atlantic from the end of the so called Middle Pleistocene transition (MPT) from 0.7 Ma BP.

![Fig.1. 3rd Order Polynomic regression lines illustrating valley incision trends for the Atlantic catchments of Central Spain, Portugal, France and England. In the north Euro-pean cases most of the data come from valley zones located less than 300 km away from their respective outlets into the Atlantic and terrace height distribution is mainly controlled their distance to the outlets.](image-url)
Only the data for Central Spain, behave in a different way with a nearly constant incision trend from the end of the Gelasian (c. 1.8 Myr). This can be explained by the important role of differential uplift, and westward tilting, of the entire Iberian Peninsula as a consequence of the asymmetric erosional unloading triggered from the Messinian Salinity Crisis in the Mediterranean catchment; An isostatic process, still relevant during the Early Pleistocene, that shaped the fluvial basins in the Iberian Peninsula and sustained high incision rates throughout the Quaternary in Northern Europe the presence of the Alps constituted a important geomorphic threshold concealing the propagation of a similar process to the North, where valley incision was mainly controlled by climatically driven sea-level changes.

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Chronologies of long-term Quaternary fluvial terrace archives in the Eastern Betic Cordillera, SE Spain

Stokes, M., Mather, A.E., Geach, M.R., Ilott, S., Meikle, Whitfield, E.

School of Geography, Earth and Environmental Sciences, Plymouth University, UK
Institute of Petroleum Engineering, Heriot Watt University, Edinburgh, UK
Golder Associates, Sydney, Australia
School of Natural Sciences and Psychology, Liverpool John Moores University, UK

The Betic Cordillera comprises a series of intra-montane Neogene sedimentary basins that have developed as part of the ongoing collision between Africa and Europe.

During the Quaternary basins in the Eastern Betic Cordillera have become inverted, characterised by 1) a switch from marine to continental conditions within the final stages of sedimentary basin infilling and 2) erosion of the sedimentary basins by drainage network incision, characterised by headward erosion, drainage network expansion and basin-scale re-organisations through capture. The erosional stage is recorded by an inset sequence of soil capped fluvial and fan terraces comprising 1-15m sediment aggradations of overlying an erosional surface cut into underlying bedrock. These landforms have aspatial and temporal distribution linked to Quaternary climate and base-level change histories, with base level influenced by interplay between uplift, sea-level changes and river captures.

The stratigraphic framework of the terrace archives have traditionally been based upon relative dating methods using combinations of landform height, degree of soil development (calcretes, redness) and lithostratigraphic characteristics.

These methods have revealed a regional pattern of up to 5 landform levels. In the Sorbas and Tabernas basins the terraces are inset into a top basin fill surface. Cosmogenic dating of this surface in the Sorbas basin indicates a 1-1.2Ma (Early Quaternary) age. The higher and older terraces of Levels 1 and 2 span the Middle Quaternary based primarily on cosmogenic dating from the Sorbas and Carboneras basins. The lower and younger terraces of Levels 3-5 span the Late Quaternary (143-2Ka) based upon OSL dating. These OSL dated younger terraces show some relationship of climate changes to terrace formation and abandonment, characterised by cold stage aggradation and complex incision patterns during climate transitions. The cosmogenic dated older terraces show less clear climate relationships. However, the burial and exposure ages do highlight the potential for providing age constraint insights into Early-Middle Quaternary landscape development during a hitherto little
quantified time period for SE Spain and the Eastern Betic Cordillera. To explore the regional landform stratigraphic framework and its drivers of environmental change we compare the cosmogenic and OSL dated terrace sequences from the Carboneras-Sorbas-Tabernas-Vera Basins to other dated terrestrial (lake, landslide, travertine, speleothem) and marine archives within the Eastern Betic Cordillera region. The comparison of these dated time series archives allow for an updated model of Quaternary landscape development in the Eastern Betic Cordillera to be proposed.
Human occupation archives and climate change

*Oral presentation chair: Vincent Ollivier*

**V. Lopes**, M.C. Freitas, C. Andrade, S. Moreira, A. Bento, M.C. Cabral, A. Cearreta, M. Cachão, M. F. Araújo: *Environmental evolution of the Pederneira lowland (W Portugal) during the Holocene – a multi proxy study.*


**Lisa M. Fontes**: *The Initial Magdalenian at Urtiaga Cave (Deba, Gipuzkoa, Spain): A Preliminary Presentation.*

**L. Luís**, R. Danielsen, Bas van Geel, P.M. Mendes, M. Sim-sim, V. Lopes & C. Andrade, M. C. Freitas: *Holocene environmental changes along the Portuguese SW coast; a contribution based on pollen and non-pollen palynomorphs to disentangle the impact of climate and human driven changes.*

**William Fletcher**, Jennifer Campbell, Sebastien Joannin, Steffen Mischke, Christoph Zielhofer: *Perspectives on early Holocene environmental and climatic changes in the western Mediterranean and NW Africa: a view from the Middle Atlas, Morocco.*

**J. van ´t Hoff, T. Schröder**, M. Melles, K. Reicheter: *Palaeoclimatological research of the Early Quaternary from the Laguna de Medina, Cádiz, Spain.*

**Felicitas Schmitt**: *A Window within the Holocene: The Chalcolithic in the Micro-Region of Azután (Toledo, Spain).*
Poster presentation chair: Christoph Zielhofer

**Heike Schneider:** Roman land use patterns on the Iberian Peninsula – a result of natural conditions and economic strategies.

**H. Reddad, M. El Ghachi, Y. El Khalki, A. Roujjati, M. Taeib, F. Thevenon, B. Damnati:** Moroccan lacustrine records suggest a variable positive state of the North Atlantic Oscillation during the early to mid-Holocene.

**Jesús F. Jordá Pardo, J. Emili Aura Tortosa, Esteban Álvarez Fernández, Bárbara Avezuela Aristu, Ernestina Badal García, Adolfo Maestro González, Juan V. Morales Pérez, Manuel Pérez Ripoll, Mª. Paz Villalba Currás:** The archaeological record of the Cave of Nerja (Malaga, Andalusia, Spain) and its contribution to the study of the palaeoenvironment during the Late Upper Pleistocene and the Early Holocene of southern Iberia.

**Torsten Klein, Wiebke Bebermeier, Jan Krause, Brigitta Schütt:** The Palaeogeographical Situation of a Possible Phoenician Anchorage in the Hinterland of the Phoenician Settlement in Modern Ayamonte (Province of Huelva/ Lower Andalusia).

**Tabea Schroeder, Jasmijn Van’t Hoff, Helmut Brueckner, Martin Melles, Klaus Reicherter:** Quaternary palaeoclimatological results of the Laguna de Medina, Cadiz, Spain.

**J. B. Ries, F. M. Thomas, M. Trunk, A. Birster, M. Czechowski, C. Eichberg, B. Kausch, R. Hansen, M. Schumacher, M. Seeger:** Los Bañales, reservoir sediments as indicators for land-use changes and geomorphodynamic processes – geomorphological and palynological investigations on sediments of a roman reservoir.
The Pederneira lowland, located south of Nazaré (western central Portugal), is at present an alluvial plain with a surface of 22km² and a maximum height of 10m (a.s.l). The paleosurface that accommodated water and sediments throughout the Holocene has an estimated volume of about 2x10⁸ m³. In order to understand the evolution of the basin during the last 10 ka, a multiproxy study (sedimentological - texture, composition; paleontological - foraminifera, ostracods, nannoplankton; geochemical and geochronological) of a long core (29.30m-NZS2) has been undertaken under the project PTDC/CTE-GEX/65789/2006.

Results allowed the definition of four major lithostratigraphic units which correspond to distinct sedimentary environments reflecting changes in sedimentation constrains.

The basal Unit I (-25.05 to -17.14ma.s.l) consists of coarse sandy sediments, aozoic, deposited until c.9600 cal BP in a high-energy fluvial environment contemporaneous of a lower sea-level.

Subunit IIA from c.9600 to c. 5012 cal BP (-17.14 to - 5.35m a.s.l) is characterized by muddy sediments deposited in a low energy, confined environment (lagoonal/estuarine). The earliest signature of marine influence is registered at the base, corresponding to the first pulse of a rising sea level attempting to drown the Pleistocene valley. A few valves of brackish and littoral marine ostracods species, frequent in outer estuaries, occur. Information given by nannoplankton and foraminifera indicate that marine influence began at c. 9246 cal BP (-16.01m a.s.l) with a variable expression but increasing to the top of the Subunit. The maximum marine influence occurred during this time interval, evidenced by the highest values of paleosalinity geochemical proxies and CaCO₃ content. Euryhaline species of
foraminifera are present in high abundance and diversity as well as nannoplankton typical of marine conditions, the latter decreasing towards the top of Subunit IIB indicating the establishment of more confined conditions; abundant forms of both marine and brackish ostracods also occur, the latter being the only present at the top of the Subunit, above -3.88m.

Unit III (-2.14 to 0.41m a.s.l/c.3641 to c.988 cal BP) consists of peat and muddy azoic sediments deposited in a marginal low-energy environment and corresponding to a decrease in the intensity of the marine signal and an increasing terrestrialization of this paralic system.

The top Unit IV (0.41 to 4.25m a.s.l), deposited after the 12th century, correspond to coarser sandy, azoic material in a more energetic environment, resulting from the progradation of the Alcôa River alluvial fan and plain sediments over the former lagoon, which contributed to the complete infilling of the lowland.
Millennial aridity cycles as a driver of human occupation in central Spain: a reinterpretation.
Juan I. Santisteban\textsuperscript{1}, Rosa Mediavilla\textsuperscript{2}, Alberto Celis\textsuperscript{3}, Silvino Castaño\textsuperscript{2}, Almudena de la Losa
\textsuperscript{1}Dpt. Stratigraphy, Fac. Geological Sciences, Univ. Complutense de Madrid.
\textsuperscript{2}Instituto Geológico y Minero de España, Madrid, España.
\textsuperscript{3}Museo Comarcal de Daimiel, Daimiel, España.

Two main periods of pre-Muslim human occupancy at the surroundings of Las Tablas de Daimiel National Park are documented by archaeological sites and classical sources: the Motillas culture (Bronze Age) and the Ibero-Roman period.

Classical interpretations, based on the presence of hydraulic structures (wells and dams), assumed that the settlement took place during arid periods. However, the sedimentological and geochemical records of Las Tablas de Daimiel National Park point to human occupancy during wet periods and cessation of this occupation at arid periods.

These aridity periods result from a combination of out-of-phase changes in water supply and temperature that took place ca. 1.5 ka BP, ca. 3 ka BP and, the oldest one, ending around 5 ka BP, and they could be correlated to Bond events number 1, 2 and 4. As in other locations, Bond event 3 (around 4.2 ka BP) is not present and, for this period, wet conditions due to enhanced water supply during a colder period are invoked.

These results led to the hypothesis that those hydraulic structures were built to obtain clean water (wells during the Bronze Age) and to sanitize waters and to increase their energy (dams during the Ibero-Roman Period).
Acknowledgements: This research is supported by the Spanish Ministry of Science and Innovation Research Grant CGL2011-30302-C02-01 – “Reconstrucción paleoclimática y paleohidrológica del Alto Guadiana (Tablas de Daimiel)” and by the IGCP Project 618 – “Palaeoclimate information obtained from past-recharged groundwater”. Thanks to the staff of the Las Tablas de Daimiel National Park and to the Museo Comarcal de Daimiel for their help and support.
Lower Sado basin sediments: a source of information for the late Mesolithic behaviour

Ana M. Costa¹,²,³, M. Conceição Freitas³, Pablo Arias², Mariana Diniz⁴, Ana Cristina Araújo¹, César Andrade³, Aurora Rodrigues⁵, João Duarte⁵, Mário Cachão³, Manel Leira³

¹ – LARC/DGPC and EnvArch / CIBIO / InBIO, Rua da Bica do Marquês 2, 1300-087 Lisboa
² – IIIPC, Universidade de Cantábria, Avda de los Castros S/N, 39005 Santander
⁴ – UNIARQ, Universidade de Lisboa, Alameda da Universidade, 1600-214 Lisboa
⁵ – Instituto Hidrográfico, Rua das Trinas 49, 1296-093 Lisboa

Around 8000 years BP, the lower Sado valley was densely occupied by late Mesolithic communities and are latively high consumption of marine resources was identified. Eleven sites, usually describe as shellmiddens have been identified ca. 30km upstream the present day estuary and ca. 45km of the present coastline.

Despite the unknown extension of the marine influence, it is fairly evident that the Early Holocene sea level rise produced the flooding of the pre-incised Sado valley. Did marine water reach the area of the Sado valley occupied by the Mesolithic groups, influencing the local biodiversity? Did they exploit the shellfish in the vicinity of their settlements, or did they collect them elsewhere closer to the Sado mouth?

To characterize the environmental conditions of the Lower Sado valley experienced by Mesolithic people 8000 years ago, a 690 cm sediment core was collected in the alluvial plain near the Arapouco shellmidden, in the Sado left margin. The cored sediment was measured for magnetic susceptibility, macroscopically described and sub-sampled. Sub-samples have been studied for sedimentology (texture, organic and calcium carbonate contents), geochemistry (organic carbon, nitrogen, δ¹³C and δ¹⁵N) and microfossil (calcareous nannoplankton and foraminifera) proxies. A ¹⁴C date of 3300 cal BP was obtained from organic sediment collected at 355cm core depth (radiocarbon dating of the base of the core is still in progress).

The core is composed by mud with the exception of 40cm at the very base and two lenses occurring between 627-630cm and 633-635cm that consist of sand. Whole shells of Scrobicularia plana were found at ~515cm and ~573cm depth, but calcareous nannoplankton and foraminifera are absent. A marine influence index (Fi) was determined using the higher (marine) and lower (terrestrial) measured δ¹³C values.
All the analysed proxies show a major difference in the depositional environment at ~350 cm depth (~1.2m below mean sea level - msl) ca. 3300 cal BP. Between the core base (ca.-4m msl) and - 1.2 msl (3300 cal BP) the Arapouco section was influenced by marine/brackish water and sedimentation is compatible with a marginal intertidal flat. The marine influence decreases up-core and above ca. -1.2m msl the fluvial/terrestrial influence dominates the sedimentation pattern. The top 200 cm correspond to the aggradation of an alluvial plain.

Sea level curves established for Portugal indicate that 8000 years ago relative mean sea level stood at around 8m below present day level attaining ca.-4m around 7500 cal BP. However, there is a range of uncertainty associated to these figures. The lack of objective dating of the base of the core prevents assessing whether this section of the Sado valley was under marine influence during the Mesolithic occupation, but the analysis made on the sediment core collected at Arapouco are providing data to build the middle/late Holocene history for this section of the valley.
The Initial Magdalenian at Urtiaga Cave (Deba, Gipuzkoa, Spain): A Preliminary Presentation
Lisa M. Fontes¹,²

¹Department of Anthropology and ²Latin American and Iberian Institute, University of New Mexico MSC01-1040, 1 University of New Mexico, Albuquerque, NM 87131

Urtiaga cave (Deba, Gipuzkoa) is an extraordinarily rich, multi-component Magdalenian site whose materials have remained largely unstudied since their excavation in 1928-1936.

Level F, which dates to 17,050 +/-140 BP, has long been considered the remnant of Lower Magdalenian occupations at Urtiaga. However, recent systematic analyses of the lithic industry revealed an assemblage with mixed Solutrean and Lower Magdalenian elements, which together with previous analyses of faunal and osseous industry indicate that Urtiaga Level F pertains to the Initial Magdalenian period, making it the first site in Gipuzkoa that can testify to important technological changes associated with the gradually warming, yet fluctuating climate immediately following the Last Glacial Maximum.

This preliminary presentation discusses the Initial Magdalenian lithic industry recovered from Urtiaga, including: (1) from where the flints were procured and what this indicates about Initial Magdalenian territory sizes; (2) how materials were manufactured at the site and what kinds of tools were made; and (3) how this assemblage relates to other Initial Magdalenian sites in the Vasco-Cantabrian region.

These first results demonstrate in situ regional human behavioral adaptations during the Solutrean-Magdalenian transition, a time when the Vasco-Cantabrian environmental patchwork was shifting and human groups were beginning to expand their territories outside of southern refugia, initiating the Magdalenian networks that would later traverse the European continent.
Holocene environmental changes along the Portuguese SW coast; a contribution based on pollen and non-pollen palynomorphs to disentangle the impact of climate and human driven changes
L. Luís(1,2,3), R. Danielsen(4), Bas van Geel(3), P.M. Mendes(4), M. Sim-sim1(5), V. Lopes(2) & C. Andrade (2), M. C. Freitas(2),
(1) Universidade de Lisboa, Faculdade de Ciências de Lisboa, DBV, Centro de Biologia Ambiental, C2, Campo Grande, 1749016 Lisboa, Portugal. (2) Universidade de Lisboa, Faculdade de Ciências de Lisboa, Departamento de Geologia, Centro de Geologia, C6, 3º Piso, Campo Grande, 1749-016 Lisboa, Portugal. (3) Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Science Park 904, P.O. Box 94248, 1090 GE Amsterdam, Netherlands (4) Laboratório de Arqueociências, LARC/CIBIO-InBIO, Rua da Bica do Marquês 2, 1300-087 Lisboa, Portugal. (5) Museu Nacional de História Natural e da Ciência, Jardim Botânico/CBA, Rua da Escola Politécnica, nº 58, 1250-102 Lisboa, Portugal.

Depositional systems such as lagoons and estuaries are natural archives of information about coastal and environmental changes that occurred in the past. In the particular case of the Portuguese coastal fringe an evolutionary model based on sedimentological, palaeoecological and geochronological data has been proposed.

To improve the resolution of that model, pollen-based environmental reconstructions were made from a 4.96m-long core (LSA4) collected in the permanently flooded domain of the Santo André lagoon. The sedimentological analysis and 14C dating of the core allowed the identification of four major lithostratigraphical units, accumulated after 6300 cal BP.

Vegetation in the region reflects a Mediterranean climate, indicated by the dominance of pollen from a local Quercus forest and Mediterranean shrubs. From c. 5000 cal BP, the decrease/replacement of an existing Pinus forest by evergreen forest suggests a regional drying trend that was also observed elsewhere in southern Iberia.

Anthropogenic influence on the vegetation (deforestation and evidence for grazing and agriculture) is detected from around 5000 cal BP. From around 2500-1500 cal BP, human impact on the vegetation is distinct and continuous. Following the reforestation 200–300 years ago human impact becomes predominant in the pollen diagram.

The study represents a high resolution and well-dated pollen record of the southwestern Portuguese coast obtained from the sediments that were deposited in the Santo André lagoon during the Holocene. It gives a relevant contribution and improvement of the Santo André evolutionary model concerning palaeoclimatological and human-induced influences.
Perspectives on early Holocene environmental and climatic changes in the western Mediterranean and NW Africa: a view from the Middle Atlas, Morocco

William FLETCHER¹, Jennifer CAMPBELL¹, Sebastien JOANNIN², Steffen MISCHKE³, Christoph ZIELHOFER⁴

¹Geography, School of Environment, Education and Development, The University of Manchester, United Kingdom
²Centre de Bio-Archeologie et d’Ecologie UMR 5059, Montpellier, France
³Faculty of Earth Sciences, University of Iceland, Reykjavik, Iceland
⁴University of Leipzig, Institute for Geography, Leipzig, Germany

The understanding of environmental and climatic change in the Iberian Peninsula should be situated in the wider regional context of the Western Mediterranean and Atlantic margins. Here we present results of centennial-scale palynological and charcoal analyses as part of a multiproxy palaeoecological and palaeolimnological study of sediment cores from Lake Sidi Ali in the Middle Atlas, Morocco (33° 03 N, 05° 00 W; 2,080 m a.s.l.).

Absolute dating via AMS ¹⁴C dates on pollen concentrates indicate that the new record includes the onset of the Holocene and early Holocene – both poorly known in the regional context. Pollen assemblages are dominated by steppichers, evergreen Quercus and Cedrusatlantica, and reveal the progressive development of montane forest from the onset of the Holocene onwards. The local establishment of Cedrusatlantica is marked, however, by abrupt setbacks during the early Holocene at ca. 10.3 ka and 8.4 ka. The population collapses of Cedrusatlantica occur along side increases in evergreen Quercus and steppic taxa. Background regional fire regime is furthermore enhanced following these events. The combined indications from vegetation composition and regional fire levels suggest shifts towards drier, high fire-regime, and possibly warmer conditions at these times. The record provides the first indications of centennial-scale instabilities in the terrestrial ecosystems of the Middle Atlas during the early Holocene. The findings support a regional signature of North Atlantic early Holocene cooling events, as previously detected in the Iberian Peninsula and Alboran basin. The long recovery time of Cedrusatlantica populations between these events (ca. 1500 years) has implications for the resilience of Cedrusatlantica in the face of current climate change.
Palaeoclimatological research of the Early Quaternary from the Laguna de Medina, Cádiz, Spain.

J. van ´t Hoff a, T. Schröder b, M. Melles a, K. Reicheter b

a Institute of Geology and Mineralogy, University of Cologne, Germany
b Institute of Neotectonics and Natural Hazards, RWTH Aachen, Germany

Our work (C3 project) is a contribution to the CRC 806 “Our way to Europe”, dealing with the climatic and environmental changes in the Upper Pleistocene –Middle Holocene of the Iberian Peninsula (IP) and its connection to human migration. The connection between archeological and geological archives is one of the aims of this research. The question of the Late Quaternary climate in the Western Mediterranean and its influence on human migration is still not, or more over contradictory answered. This is probably due to scarce investigable archives on the Southern Iberian Peninsula.

The climate had strong influence on the migration of early humans (Finlayson et al. 2006). (Bard 2013) stated, that transformations resulting out of increasing demographic pressure due to climate lead to the rise of civilizations like the Egyptian and the Mediterranean climate is one of the most sensitive to changes (Beklioglu et al. 2007). Short term climate changes like the Heinrich-events (HE), which lead to arid and cold conditions on the southern IP (Bout-Roumazeilles et al. 2007) (Bard et al. 2000), could have affected human populations even more because of the shorter time of adaption. Lakes constitute excellent climate archives (Cohen 2003) and in Southern Spain they are often endorheic, which makes them even more sensitive to changes of the climate (Corella et al. 2011). Lacustrine deposits of Holocene age on the IP were investigated, but most of these archives lack a sub millennial resolution (Corella et al. 2011).

In this study, the lacustrine deposit of the Laguna de Medina, the second largest inland salt lake of Andalusia (De Vicente et al. 2012), is investigated. In September 2014 two sediment cores with a total length of 21,34 m were drilled with the use of a platform (N36°37´04,380 /W06°03´12,720; water depth 1,7 m). The cores were scanned by the MSCL every centimetre for magnetic susceptibility and by the XRF-scanner for elements (every 0.2 cm) and radiographic photos (every 0.02 cm). Samples of 2 cm were taken every 6 cm for grain size analyses, TIC/TOC, CNS, ostracods, diatoms and plant remains and every 24 cm for pollen analyses.

The Laguna de Medina contains a more or less continuous record of past conditions. After (Reed et al. 2001), these lake sediments demonstrate high variations of water depth and salinity, at least of the last 8700 years. Moreover,
the lake shows a trend of perennial conditions in earlier times to ephemeral conditions, closely linked to climate. Our preliminary results show a high resolution signal of probably the last 20,000 years, which will lead to a much better understanding of the relation between climate and human migration on the IP because of our multi-proxy approach and a close interfingering with archaeologists working in the nearest archaeological sites.

References

A Window within the Holocene: The Chalcolithic in the Micro-Region of Azután (Toledo, Spain)

Felicitas Schmitt M.A
PhD student in the Collaborative Research Center 1070 Resource Cultures of the Eberhard Karls-Universität Tübingen (Germany), Gartenstr. 29, 72074 Tübingen

During the age of the Holocene rapid changes took place, at least if we regard it from the archaeological perspective. Not only did the *Homo sapiens* in many regions adapt a mainly sedentary lifestyle, the society also transformed step by step from a hunter-gatherer society to one based on agriculture and animal husbandry. Another significant event in prehistoric archaeology was the first use of metal ores. In the Iberian Peninsula the first metal used was copper and first evidence can be found during the 4th millennium BC. The period of interest in this case study is the one referring to the Iberian Copper Age (or Chalcolithic), from the end of the 4th to the beginning of the 2nd millennium BC. In relation to the Quaternary, we investigate in a very brief window but within this time frame important socio-cultural and environmental transformations took place.

This study belongs to an interdisciplinary framework of scientific research within the Collaborative Research Center 1070 Resource Cultures, subproject A02 “Many ores and cultural little change in connection with the use of resources in the later prehistory of the Iberian. Case study 2, in Azután (Toledo, Spain), focuses on the Chalcolithic and its objective is to track the so-far poorly known settlement patterns as well as local resources and how the use of said resources formed the prehistoric environment.

The center of the Iberian Peninsula showed a lack of investigation till the end of the 1980s. For the past 25 years the knowledge regarding the prehistory of the Mesetas has increased, although compared to the South of the Iberian Peninsula the broader context of settlement hierarchies and the society structure is still mostly unidentified.

In an area formerly only known for megalithic burials, detailed surveys were undertaken in the spring of 2014 in collaboration between the universities of Tübingen and Alcalá de Henares. The collected material leaves no doubt, that there is a settlement at the southern bank of the river Tajo which refers to the dolmen that is only little more than 1km away. The preliminary results show clear settlement continuity at least from the end of the Neolithic period through the whole sequence of the Copper Age (end of 4th till end of 3rd millennium BC). Further investigations of satellite images (SPOT 5 PNT) also revealed at least two enclosures which are already typical for other areas of the Peninsula.
during the Copper Age. In October 2014 geomagnetic surveys were carried out in order to visualize possible archaeological structures. With the help of pedology and palynology we aim to reconstruct the society, its use of the environment (all kinds of resources) and the ways of communication during a time 5000 years ago.
Roman land use patterns on the Iberian Peninsula – a result of natural conditions and economic strategies
Heike Schneider
Friedrich-Schiller-University Jena, Institute of Geography, Löbdergraben 32, D-07734 Jena, Germany

Sedimentological and palynological investigations of roman sediments on the Iberian Peninsula bears some problems) because of the semiarid climate and the special roman agricultural innovations, which influenced the soil erosion as well as the changes in sediment transport in the fluvial systems. It is known that the romans followed special agricultural strategies for land use and landscape managing, but information about concrete changes in the landscape during the roman time in high resolution is rare until now. An investigation of different geo-bio archives like floodplaines, estuaries, archeological excavations and roman reservoirs gives an idea about the different use of several landscapes.

The results show in all sites a preroman land use with extensive agrarian mixed economy. A decrease of intensityis visibleat 2250 cal. BP, but animal husbandry was still important. At the beginning of the roman period appears a change in the composition of grassland types, which shows a richer and more distinctive spectrum of species. The intensification continues throughout the following centuries and culminates in the time period between 1800 and 1500 cal. BP. At the same time a strong cultivation of land is recognizable. The adoption of roman settlement structures by the Visigoths around 1500 cal. BP leads also to continuation of the roman land use patterns, but also to a slight decrease of use intensity. This trend is resumed especially between 1400 and 1200 cal. BP. The land use increases drastically at the beginning of the Islamic occupation and even more distinctive in second Islamic occupation period around 1000 cal. BP. The comparison between charcoal values and pollen combination allowed conclusions according climate development.

According to the results, it is to resume that the regular purpose of roman reservoirs is reflected in their size. Smaller water storages, which were built for the safety of sources or to store a winter’s rain, carried water only seasonally. Unfortunately, their sediments cannot be evaluated palynologically.

Overall the reservoirs are excellent archives, even though not all of them are suitable for multidisciplinary analysis. The comparison of very different archives arises the opportunity for reconstruction of land use during Roman Time in several types of landscapes and in this way the use structures in adaption to landscape and climate conditions.
Moroccan lacustrine records suggest a variable positive state of the North Atlantic Oscillation during the early to mid-Holocene.

H. Reddam (1), M. El Ghachi (1), Y. El Khalki (1), A. Roujjati (2), M. Taeib (3), F. Thevenon (4) and B. Damnati (5)

(1) Sultan Moulay Slimane University, FLSHBM, Department of Physical Geography, Beni Mellal, Morocco
(2) Cadi Ayyad University, FSTM, Department of Earth Sciences, Marrakech, Morocco
(3) CEREGE, Aix-en Provence, France
(4) Institute F.-A. Forel, University of Geneva, Versoix, Switzerland
(5) Abdel Malek Essaâdi University, FSTT, Department of Earth Sciences, Tangier, Morocco

We present a multiproxy analysis using mineralogy, geochemistry, palynology and microcharcoal data from a 200 cm lacustrine record (Lake Ifrah (33.33°N, 04.56°W, 1610 m), Middle Atlas, Morocco) providing a reconstruction of fire activity during the Holocene.

Results show a significant increase in microcharcoal abundance, between 10,800 and 4,500 cal yr BP, which likely reflects regional emissions from forest fires, which in turn were associated to prolonged periods of drought, as inferred by synchronous abrupt decreases in surface runoff input records (e.g. organic matter, trace elements and magnetic susceptibility) and increases in carbonate content, calcite and Mg-calcite concentrations. Furthermore, results suggest important climate implications concerning the evolution of the North Atlantic Oscillation (NAO).

A comparison of the multiproxy data from Lake Ifrah with other NAO related proxy records confirms that the early to mid-Holocene was dominated by positive NAO conditions. Changes in fire activity in the southwestern Mediterranean region during this period suggest a regional millennial-scale climatic control fire activity through the amount of fuel pyrophile. According to Davis and Stevenson (2007), marked increase in fire frequency occurred between 8800 and 8000 yr BP both in southern and northeastern Spain, with an expansion of fire-tolerant evergreen oak and a decline in lake level; this increase fire activity was largely attributed to the northward shift of the subtropical high pressure in the Mediterranean Basin, which has not only increased summer aridity, but also caused a conflicting regional warming to cooling characterizing the 8200 years BP event in the northern part of the Mediterranean Basin and Northern Europe (Davis et al., 2007). This regional anti-phase is probably related to the variability of the North Atlantic Oscillation and the persistence of the positive anomaly during this period. A similar pattern of the NAO has been suggested to explain the vegetation changes on the Iberian Peninsula (Davis et al., 2007; Vannière et al., 2010). An atmospheric configuration close to one of
the major situations positive NAO could have prevailed during this period of aridity, involving high pressure stability in the Southwest Mediterranean Basin and favoring the movement of the westerlies to the north. Such pattern has certainly decreased precipitation and increased flammability of vegetation. This situation is also supported by the reconstruction of the NAO pattern during the Holocene from the mass balance of glaciers in Norway (Nesje et al., 2001).
The archaeological record of the Cave of Nerja (Malaga, Andalusia, Spain) and its contribution to the study of the palaeoenvironment during the Late Upper Pleistocene and the Early Holocene of southern Iberia

Jesús F. Jordá Pardo1, J. Emili Aura Tortosa2, Esteban Álvarez Fernández3, Bárbara Avezuela Aristu1, Ernestina Badal García3, Adolfo Maestro González4, Juan V. Morales Pérez5, Manuel Pérez Ripoll3 and Mª. Paz Villalba Currás5

4 Departamento de Investigación y Prospectiva Geocientífica. Instituto Geológico y Minero de España. Calle Calera, 1. E-28760 Tres Cantos (Madrid)

We present the palaeogeographic, palaeoclimatic and palaeoenvironmental changes occurred during the Upper Pleistocene and the Early Holocene in the southern Mediterranean coast of the Iberian Peninsula in the eastern sector of the province of Malaga, at south of the Sierra de Almijara.

The study of these changes has been made from the analysis of bathymetric and geomorphological mapping of the coastal submarine in the studied area, the record of the sea surface temperature of the Alboran Sea from the MD95-2043 core and the radiometric, archaeological and palaeobiological data provided by the stratigraphic record of the external chambers of the ancient entrance of the Nerja Cave (Nerja, Malaga, Andalusia, Spain).

This sedimentary record was placed in the cavity between the final stages of the Late Pleistocene and the Holocene, covering the end of OIS3, the OIS2 and the first half of OIS1 with a chronological span between 29600 and 3940 years cal BP, according to the information provided by radiocarbon dating. To be more precise: this sedimentation began in the interstadial complex GI4 immediately after Heinrich event 3 and ended in the chronozone Subatlantic with twelve stages of development of erosion and sedimentation that have six occupational episodes well-defined (Gravettian, Solutrean, Magdalenian, Epipaleolithic, Neolithic and Chalcolithic) and a worse delimited period (Mesolithic) separated by hiatuses of varying duration.
During the Upper Pleistocene and Early Holocene the position of the sea surface was located at different levels below their current position, which conditioned the emergence of a coastal strip of varying amplitude overtime, in which, human populations living in the Nerja Cave developed their activities. Throughout that period we also observed a marked variation in the surface temperature of sea water and a series of changes in the position of the bioclimatic belts in the Sierra de Almijara and in the composition of vegetation and vertebrate and invertebrate fauna that were consumed by the prehistoric inhabitants of the Cave of Nerja.

In this context it should be noted the abundant presence in the record of the cavity of marine fauna (echinoids, crustaceans, molluscs, fish, birds, mammals), among which, several species of northern latitudes and colder waters are included, currently outside the Mediterranean.
The Palaeogeographical Situation of a Possible Phoenician Anchorage in the Hinterland of the Phoenician Settlement in Modern Ayamonte (Province of Huelva/ Lower Andalusia)
Torsten Klein¹, Wiebke Bebermeier¹, Jan Krause¹ und Brigitta Schütt¹
¹ Institute of Geographical Science, FreieUniversität Berlin, Germany

As bays, lagoons and estuaries ensure protection from wind, during early Iron Age Phoenician settlers chose these characteristic locations all over the Mediterranean for their seaports, to build outposts from which they established trade with the indigenous population. Today many former Phoenician anchorages, harbours and settlements at the Mediterranean and Atlantic coasts of SW-Iberia are located several kilometres inland, due to sedimentation processes.

![Location map of the study area](image)

Fig. 1: Location map of the study area

Since June 2013 the joint project of the Physical Geography unit (FU Berlin) and the German Archaeological Institute (DAI/Madrid) studies Phoenician settlement activity and their environmental implications by combining archaeological and geographical investigations of the former coastal site of Ayamonte (Andalusia/Spain) immediately at the Guadiana estuary, where previous excavations have revealed Phoenician remains. Geomorphological, sedimentological and geophysical methods are applied to study landscape changes and human – environment interactions in the hinterland of Ayamonte and within the wetlands of the estuary.
This specific study aims to investigate whether the scenario, in which the nowadays silted-up bay-like environment of the Estero de la Nao - a tidal channel and small tributary within the lower Guadiana estuary - could have served as a natural prehistoric harbor location for the seafaring Phoenician population, is true or not.

The focus is set on a systematic analysis of sedimentological data provided by vibracoring. The lithostratigraphy of three sediment cores, arranged in one E-W striking transect and dated by AMS radiocarbon dating, shows that at least since 7000 years BP open water conditions within a marine embayment characterised by sedimentation under estuarine conditions prevailed for several millennia. However, despite these favorable maritime conditions a small top layer of stiff, organic rich mud indicating tidal-flat and salt-marsh deposits indicates recent silting-up processes of the former open sea areas. Additionally, several distinct shelly units give evidence on apparently instantaneous environmental changes like energy wave events (EWE).
Quaternary palaeoclimatological results of the Laguna de Medina, Cadiz, Spain

Tabea Schroeder[1]; Jasmijn Vant Hoff[2]; Helmut Brueckner[3]; Martin Melles[2]; Klaus Reicherter[1]

1Inst. of Neotectonics and Natural Hazards, RWTH Aachen University, Germany;
2Institute of Geology and Mineralogy, University of Cologne, Germany;
3Institute of Geography, University of Cologne, Germany

The lacustrine deposits of the Laguna de Medina in southern Spain, the second largest inland salt lake of Andalusia situated in Triassic gypsum karst, have been investigated.

Two sediment cores with a total length of 21.34 m were drilled from a platform. The cores were scanned by MSCL in centimeter distance for magnetic susceptibility and by the XRF-scanner for different elements (every 0.2 cm) and radiographic photos. Samples of 2 cm thick intervals were taken every 6 cm for grain size analyses, TIC/TOC, CNS, ostracods, diatoms and plant remains and every 24 cm for pollen analyses.

Preliminary results of the Laguna de Medina record cover a more or less continuous record of sediments and, hence, a tool to unravel past conditions. The lake sediments demonstrate high variations of water depth and salinity, at least of the last c. 8700 years. Moreover, the lake shows a trend of perennial conditions in earlier times to ephemeral conditions, closely linked to climate and associated changes. Our preliminary results show a high resolution signal of probably the last 20 000 years, which will lead to a much better understanding of the relation between climate and human migration on the Iberian Peninsula because of our multi-proxy approach and a close interfingering with archaeologists working in the nearest archaeological sites (within the frame of the German research project C3 of the www.SFB806.de).
Los Bañales, reservoir sediments as indicators for land-use changes and geomorphodynamic processes—geomorphological and palynological investigations on sediments of a Roman reservoir

The geoarchaeological and palaeogeographical research of the Roman settlement of Los Bañales in the northeast of the Ebro Basin is still at its beginning. First field research at the Presa de Cubalmena dam, probably built for water supply of the settlement, suggests that its sediments represent a continuous archive between the pre-Roman settlement time up to the middle of the 3rd century AC. There could be found several indicators for a landscape evolution, vegetation and the effect of grazing, clearing, agricultural use, colonisation of the catchment as well as on soil erosion processes.

The results of geomorphological, palynological and sedimentological analysis indicate the occurrence of phases with higher vegetation density corresponding to a lower geomorphodynamic activity, as well as phases with intensified land-use with grazing and agriculture. Sediment cores down to a depth of 2.5 m, show a $^{14}$C maximum age 4420 +/- 30 BP (early Bronze Age) as well as several other ages corresponding to pre-Roman Iron Age and Roman times. The dating results within the Roman phase are partially inverse, indicating erosion processes transporting older material into the reservoir and its sedimentation on younger material. This is supported by high concentration of HPC-spores (a taxon related to dung) and Pinus pollen, which indicate high grazing intensity, forest-clearance and the following land-use change. But a clear evidence for these findings has still to be found. Therefore, additional field and lab work is planned: digging a profile for a comprehensive characterisation of the sediments and the analysis of undisturbed core material with computer tomography. The latter method, which is still in an experimental phase, shall help to identify sediment layers which cannot be discerned visually.
CONTENTS

LIST OF PARTICIPANTS .................................................................................................................. 3
PREFACE .......................................................................................................................................... 5
GUEST LECTURER .......................................................................................................................... 7
TOPIC INDEX .................................................................................................................................. 9

Coastal and karstic archives ................................. 11

Links between Holocene environmental change and paleolimnological development in wet dune slacks (SW Portugal) ..... 14

Giant catastrophic cascade events induced by the Zanclean flooding of the Mediterranean in the Gibraltar Arc (South Spain) ..... 15

Geological records of Holocene extreme wave events (EWE) in SW Iberia: Tsunami and storm surge deposits ............................... 17

Holocene environmental reconstruction along the southern Portuguese coastal region (Algarve) .......................................................... 19

From fabric microstratigraphy of stalagmites to environmental changes affecting the process of calcite precipitation. A case study from two caves in N Spain ................................................................. 20

Usefulness of the study of palaeokarst affecting Quaternary deposits in the Central Ebro Basin .......................................................... 22

The evolution of the Guadalfeo submarine delta (northern Alboran Sea) during the last ca. 200 years ............................................. 24

Speleothem growth rate and stable isotope record during the last interglacial from a Campanet cave stalagmite (Mallorca, Western Mediterranean): evidences for significant hydro-climate changes ...... 27

Estuarine coastal barriers as archive of high-energy events during the mid-late Holocene (Gulf of Cádiz, SW Spain): Human implications. .................................................................................................................... 29

Reading the sequences: A two-step look on Mediterranean Holocene fluvial tufa deposits evolution inferred by climatic and anthropogenic parameters ................................................................. 32

FROM ARCHIVE TO PROCESS
Inventory of large blanket tufa deposits in the Iberian Peninsula. Geomorphological response to paleoclimatic and tectonic changes during the Pleistocene ................................................................. 34

Methods applied to archives and open topics ...... 36

Micromorphological features of in-situ or reworked shelter sediments of the Iberian Peninsula ................................................................. 38

On the potential of ESR dating of optically bleached quartz grains from karstic environment ................................................................. 39

Compound-specific radiocarbon dating of leaf waxes .............. 40

Coupling 18O and 2H biomarker analyses in paleoclimate research: potential, conceptual model and a first application study from East Africa ................................................................. 41

Luminescence dating of Quaternary sediments in Spain – problems and first results ................................................................................. 42

The periglaciation of the Iberian Peninsula ........................................... 43

Quantifying post-sedimentary n-alkane contamination in loess using 14C and OSL dating ................................................................. 44

Al-bearing organic speleothems in granite caves or NW Iberia: characterization and chronology ................................................................. 45

Luminescence dating of Iberian cave sequences – potential and drawbacks ......................................................................................... 47

Luminescence Dating on Middle to Late Pleistocene Eolianites from Eivissa, Western Mediterranean ............................................................. 49

Doñana, a zonal and azonal pedogenesis archives for the Holocene (SW, Spain) ......................................................................................... 50

Measuring soil erosion by means of a low-cost photogrammetry 52

Aeolian archives ................................................................................. 54

Leaf wax biomarkers in a Loess-Paleosol Sequence in El Paraíso, Spain ................................................................................................. 55

Younger Dryas and Holocene hydroclimatic variability and aeolian history of the Middle Atlas (Morocco) .................................................. 57

Major episodes of aeolian activity in the central coast of Portugal since the LGM ....................................................................................... 58
Loess-palaeosol-sequences in the Tajo basin - distribution and stratification ........................................................................................................... 59

Early to Late Pleistocene aeolian deposits in the central Ebro Basin (NE Spain): new clues for deducing Pleistoceneenvironmental variability in this area ................................................................. 60

Granulometrical, Mineralogical and Geochemical Characterization from a Loess Palaeosols Sequence in the Tagus Basin .................. 62

Sedimentary characterization of a succession of aeolian sands in the Tejo River lower valley – a record of environmental changes of western Iberia during the Late Plistocene to Holocene ....................... 64

Aeolianite Sequences on Fuerteventura with different characteristics ........................................................................................................ 66

**Alluvial archives** ...................................................................................... 67

Evidence of huge Hippopotamus in the Pleistocene from T12 terrace deposits located on the River Guadalquivir (La Rinconada, Seville, Spain): stratigraphic meaning and palaeoenvironmental value. 69

Time-integrated 3D late Quaternary sediment-depocentre migration in the Tagus depositional system: from river valley to abyssal plain ........................................................................................................ 71

River response to environmental changes during the Late Pleistocene to Holocene transition inferred from fluvial archives, tufa and slope deposits in the southeastern Iberian Peninsula ............... 73

Geomorphological cartography on the River Tejo lower valley – implications for interpretation of landscape and environmental changes of western Iberia in the last 2 Ma ...................................................... 75

The terraces staircases of Douro River at the Pocinho and Barca D’Alva sectors (NE Portugal) – records for the interpretation of the evolution of W Iberia during Quaternary .................................................. 77

Flood periods are wet periods? - A critical examination of Atlantic River Basins in Spain. ............................................................................ 79

Quaternary fluvial environments in the eastern Rif (Morocco) – the case study of Wadi Selloum in the vicinity of the prehistoric site Ifri n’Ammar ........................................................................................................... 80

The Upper Pleistocene (with lithic industries) and Holocene sequence in the Guadalquivir’s floodplain (Seville, Spain): from a fluvial system to an aggradation and shallowing-upward alluvial processes .......................................................... 81
Tectonic Signals in Fluvial Archives – Jarama River in Central Spain

Palaeoenvironmental reconstruction of the Llobregat River between VI to IV millennia cal. BP from the Cal Maurici sediment archives (Barcelona, NE Iberian Peninsula)

Palaeoenvironmental data from fluvial deposits associated to ancient fishing weirs in the Miño River, NW Iberia.

Dating fluvial terraces of the River Mero Basin (NW Iberian Peninsula) by luminescence.

Valley incision trends and subsequent chronosequences of fluvial terraces for Atlantic large rivers in the Iberian Peninsula and Northern Europe.

Chronologies of long-term Quaternary fluvial terrace archives in the Eastern Betic Cordillera, SE Spain.

**Human occupation archives and climate change 95**

Environmental evolution of the Pederneira lowland (W Portugal) during the Holocene – a multi proxy study

Millennial aridity cycles as a driver of human occupation in central Spain: a reinterpretation.

Lower Sado basin sediments: a source of information for the late Mesolithic behaviour.

The Initial Magdalenian at Urtiaga Cave (Deba, Gipuzkoa, Spain): A Preliminary Presentation.

Holocene environmental changes along the Portuguese SW coast; a contribution based on pollen and non-pollen palynomorphs to disentangle the impact of climate and human driven changes.

Perspectives on early Holocene environmental and climatic changes in the western Mediterranean and NW Africa: a view from the Middle Atlas, Morocco.

Palaeoclimatological research of the Early Quaternary from the Laguna de Medina, Cádiz, Spain.

A Window within the Holocene: The Chalcolithic in the Micro-Region of Azután (Toledo, Spain).

Roman land use patterns on the Iberian Peninsula – a result of natural conditions and economic strategies.
Moroccan lacustrine records suggest a variable positive state of the North Atlantic Oscillation during the early to mid-Holocene. .......... 111

The archaeological record of the Cave of Nerja (Malaga, Andalusia, Spain) and its contribution to the study of the palaeoenvironment during the Late Upper Pleistocene and the Early Holocene of southern Iberia ......................................................... 113

The Palaeogeographical Situation of a Possible Phoenician Anchorage in the Hinterland of the Phoenician Settlement in Modern Ayamonte (Province of Huelva/ Lower Andalusia) ......................... 115

Quaternary palaeoclimatological results of the Laguna de Medina, Cadiz, Spain................................................................. 117

Los Bañales, reservoir sediments as indicators for land-use changes and geomorphodynamic processes –geomorphological and palynological investigations on sediments of a roman reservoir........ 118