BELQUA

2010 Annual Scientific Workshop

Brussels, 2 March 2010

Stevin Room, Academy Palace, Brussels

The Royal Academies for Science
and the Arts of Belgium

Programme

09.30 - 09.40 Introduction and opening: **M.F. Loutre**

09.40 - 10.00 **M. Streel, F. De Vleeschouwer, N. Fagel, P. Gerrienne, E. Javaux, C. Luthers, F. Damblon, M. Court-Picon, G. Le Roux, D. Mauquoy, N. Piotrowska, J. Sikorski, M. Allan, N. Mattielli, J. Brack, C. Wastiaux, M.-N. Hindrycks & L. Leclercq**
Spatio-temporal natural and anthropogenic environmental variability during the last 1500 yrs in an ombrotrophic bog (East Belgium)

10.00 - 10.20 **C. Derese & D. Vandenberghe**
Chronological research of Late Weichselian aeolian and fluvio-aeolian deposits in the NW European lowlands

10.20 - 10.40 **M. Thierens, H. Pirlet, C. Colin, K. Latruwe, F. Vanhaecke, J.-B. Stuut, J. Titschack, V.A.I. Huvenne, B. Dorschel, A.J. Wheeler & J.-P. Henriet**
Evidence for an ice-rafting British-Irish ice sheet since the Early Pleistocene (2.6 Ma)

Coffee break

11.10 - 11.30 **T. Verleye**
Mid-late Holocene changes in the El Niño Southern Oscillation and Hadley Cell intensity; their effect on sea-surface conditions in the mid-latitude southeast Pacific Ocean (41°S)

11.30 - 11.50 **T. Watanabe, T. Matsunaka, T. Nakamura, M. Nishimura, F. Watanabe Nara, Y. Izutsu, M. Minami, T. Kakegawa & L. Zhu**
Last glacial – Holocene chronology of sediment cores from a high-altitude Tibetan lake based on AMS ^{14}C dating of plant fossils

11.50 - 12.10 **F. Watanabe Nara, T. Watanabe, T. Kakegawa, H. Seyama, K. Horiuchi, T. Nakamura, A. Imai, N. Kawasaki & T. Kawai**
Climate control of sulfate flux into Lake Hovsgol, Mongolia, during the last glacial–postglacial transition: Constraints from sulfur geochemistry

Lunch break + BELQUA National Committee Meeting

13.45 - 14.40 **Key-note lecture**
A. Long
Sea-level changes: past and future

14.40 - 15.00 **D. Tys**
Archaeological and historical proxy data on sea-level rise in medieval coastal Flanders: their indicative meaning and interpretation

15.00 - 15.20 **M. Court-Picon, T. Polfliet, L. Serbruyns, M. Bats, J. De Reu, P. De Smedt, I. Werbrouck, A. Zwertvaegher, M. Antrop, J. Bourgeois, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers, & P. Crombé**
Pre- and protohistoric settlement and land-use systems in Sandy Flanders (NW Belgium): a diachronic and geoarchaeological approach

15.20 - 15.40 **S. Jusseret, D. Kaniewski, C. Baeteman & J. Driessen**
Holocene fluvial sedimentation and human activities in the coastal valley of Sissi, northern Crete

Coffee break

16.15 - 16.30 **M. Sintubin**
Archaeoseismology from a Mediterranean Perspective: Past, Present and Future

16.30 - 16.45 **B. Van Bocxlaer**
Documentation of evolutionary punctuations in the morphology of Bellamya gastropods from Lake Malawi utilising quantitative genetic models

Key-Note Presentation

Sea-level changes: past and future

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Over the Quaternary, multiple glacial-interglacial cycles have been associated with large scale transfers of water from the ice sheets to the oceans. The maximum amplitude of these global changes is of the order of 120 m of so, with periods of abrupt sea level rise associated with terminations but also occurring during interglacials themselves. In this paper I will start by reviewing the evidence for these global trends in long-term sea-level over Quaternary timescales, paying particular attention to the patterns observed during the previous, Eemian interglacial (Marine Oxygen Isotope Stage 5e). From here, I will focus on the patterns observed during the current interglacial, demonstrating the global variability observed in sites close to and far from the ice sheets. This will serve to demonstrate that "sea-level" is, in fact, far from level. The presentation will conclude by casting an eye to the future in order to consider the potential contribution of the polar ice masses to future sea-level change, and the challenges we face when trying to develop realistic regional to local sea level scenarios that are informed by our understanding of the past.

Oral Presentations

Spatio-temporal natural and anthropogenic environmental variability during the last 1500 yrs in an ombrotrophic bog (East Belgium)

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Peatlands cover ca. 3 % of the Earth's surface and provide crucial continental archives for deciphering past climatic changes and anthropogenic impacts on decadal to millennial timescales. Numerous studies have demonstrated that peat bogs are excellent archives to investigate past environmental and ecological changes during the Holocene. Studies focusing on intra-site variability at high-resolution are rare however, despite their potential to provide constraints on the reliability of the palaeoenvironmental reconstruction and the influence of micro-scale variability. Such variability must be taken into account in any peatland restoration process linked with recent environmental changes, particularly human-derived impact such as peat cutting, drainage and tree cultivation.

Four 1m-long Wardenaar monoliths were retrieved from the Misten bog (Hautes-Fagnes, East Belgium). The cores were investigated using chronological (radiocarbon AMS dating of plant macrofossils, ^{210}Pb age modelling), biological (macrofossils, pollen content, testate amoebae), organic (humification level) and geochemical proxies (major and trace geochemistry, Nd and Pb isotopes). The aims of this research were to: (1) to assess whether the bog vegetation and other environmental indicators have changed simultaneously in time and space, (2) identify the most sensitive palaeoenvironmental indicator(s) and (3) assess to what extent variation in peat accumulation rates affects the record of each proxy. Preliminary interpretations show great variability (up to 50 %) in peat development on a decimetre depth-scale as assessed by the variation in peat palynological and macrofossils zones from one core to another. In addition, our recent high-resolution records of environmental change have high-applied palaeoecological value since they can be used to inform conservation management (‘natural’ changes in the composition of the peat forming vegetation and the range of water table depth variability over a range of timescales).

Chronological research of Late Weichselian aeolian and fluvio-aeolian deposits in the NW European lowlands

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The transition from the Weichselian glacial to the Holocene was marked by rapid climatic shifts, resulting in environmental and ecological changes. In the NW European sand belt, these shifts are reflected in the varying intensities of aeolian activity and vegetation growth, and thus in the alternation of phases with widespread sand deposition and periods marked by soil formation. To study the landscape evolution in relation to climatic changes, it is essential to obtain accurate information about the timing of events. In this paper, optically stimulated luminescence (OSL) dating is applied to establish a reliable chronological framework for aeolian and fluvio-aeolian events in the NW European lowlands. Ages determined at Opgrimbie, Arendonk and Lommel (Belgium) and Lutterzand (The Netherlands) are compared with existing chronological information for the same and equivalent deposits. Although some spread in ages is observed, the dataset per site is generally internally consistent and the variation in age results is not (much) larger than expected from individual uncertainties. From the OSL datasets, it seems that sand deposition occurred during two important phases, separated by a deflation phase that caused the development of the Beuningen Gravel Bed, a widespread marker horizon within the coversand sequences. A first phase of sand-sheet deposition took place during the Late Pleniglacial (ages varying between ~17 and 25 ka); a second phase of quasi-continuous aeolian deposition took place during the Late Glacial (~12 to 15 ka). The Late Glacial soil horizons presumably developed during a relatively short time (a few hundreds of years) and OSL dating is not able to distinguish the different periods they represent. This illustrates (the limit on) the time resolution that can be achieved using state-of-art luminescence dating technology. At least at one locality (Opgrimbie), the age results do challenge the existing interpretation and significance of the sequence. This, in turn, demonstrates how chronological studies using luminescence dating techniques contribute to an improved understanding of how periglacial sandy deposits that are spread all over NW Europe should be correlated.

Evidence for an ice-rafting British-Irish ice sheet since the Early Pleistocene (2.6 Ma)

M. Thierens[1], H. Pirlet[2], C. Colin[3], K. Latruwe[4], F. Vanhaecke[4], J.-B. Stuut[5,6], J. Titschack[7], V.A.I. Huvenne[8], B. Dorschel[1], A.J. Wheeler[1] & J.-P. Henriet[2]

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The late Pliocene – early Pleistocene onset and intensification of Northern Hemisphere glaciation marks an important threshold in Earth's climate system. Evidence of early continental ice sheet expansion is preserved in the North Atlantic Ocean, where ice-rafted detritus (IRD) records attest to widespread discharges of debris-bearing icebergs into the ocean. So far, these surges have been related to the presence of high-latitudinal ice sheets (on Canada, Scandinavia and Iceland), without much evidence supporting significant ice build-up in more temperate mid-latitudinal regions (Ehlers & Gibbard, 2007).

In this study, a unique record of early Pleistocene (2.6 – 1.7 Ma; Karo et al., 2007) ice-rafting is presented from the Irish NE Atlantic continental margin (east Porcupine Seabight). There, the Challenger Mound was successfully drilled during IODP Exp. 307, providing the first complete sequence through a coral carbonate mound (a bio-geological seafloor feature built through successive stages of cold-water coral-mediated sediment accumulation), from its early Pleistocene initiation till its late Pleistocene – Holocene growth decline.

A rigorous detection and ground-truthing procedure (siliciclastic particle-size end-member modelling (Weltje, 1997), quartz grain-surface microtextures) allowed the identification of multiple IRD intervals throughout the Challenger Mound sequence; the oldest deposited around 2.6 Ma. Multiproxy provenance analyses, including Nd-Sr isotopic fingerprinting, clearly indicate a dominant sediment input from the adjacent British-Irish Isles, even for the early Pleistocene IRD deposits. Consequently, this study evidences, for the first time, the presence of a considerable, early Pleistocene ice sheet on the British-Irish Isles, which repeatedly expanded into the marine domain. Even in the early stages of Northern Hemisphere glacial expansion significant ice accumulation in mid-latitudinal regions, such as the island of Britain and Ireland, should therefore be accounted for.

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Mid-late Holocene changes in the El Niño Southern Oscillation and Hadley Cell intensity; their effect on sea-surface conditions in the mid-latitude southeast Pacific Ocean (41°S)

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The study focuses on the observed effects of changes in the El Niño Southern Oscillation (ENSO) and Hadley Cell intensity on sea-surface water conditions in the SE Pacific (41°S; Site ODP1233) during the last 8.000 years. Recent studies suggest that periods characterised by a negative Southern Oscillation Index (SOI; El Niño) cause positive precipitation anomalies during austral winter (and annually) in Mid-South Chile, while austral summer periods are rather drier. This because El Niño weakens the southeast (SE) Pacific anticyclone, causing a northward shift of the westerly wind belt resulting in higher annual rainfall at 41°S. Positive rainfall anomalies result in a increasing runoff, which causes a decrease in sea-surface salinity (SSS) in near-shore areas. At first sight, this is supported by the process length of *Operculodinium centrocarpum* (a dinoflagellate cyst), which constitutes a proxy for a changing SSS/SST (sea-surface temperature)-ratio. A decreasing SSS and constant SST result in a shortening of the process lengths. However, when comparing the Fe-record of GeoB3313-1 with the intensity and frequency of the El Niño events during the studied period, a negative SOI seems not to be necessarily associated with positive annual rainfall anomalies in Mid-South Chile. Three major peaks in the frequency and intensity of El Niño events correspond with drier conditions at 41°S. Those three periods occur simultaneous with an increasing Hadley Cell activity, which in turn strengthens the SE Pacific anticyclone. This causes a southward shift of the westerlies, leading to dryer conditions at 41°S, in turn causing less runoff and an increase rather than a decrease in SSS. Thereby, negative SST anomalies occur offshore Mid-South Chile during the intensification of the SE Pacific anticyclone. Both the lower SST and higher SSS should result in longer process lengths while an obvious shortening is observed. Therefore, we suggest that the shortening of the process results from a further northward penetration of the less saline Chilean Fjord Waters. This is most likely caused by favourable southerly winds associated with a more poleward position of the SE Pacific anticyclone, due to an increase in intensity of the Hadley Cell. Those results indicate a domination of the Hadley Cell effects over the effects of ENSO in the mid-latitude SE Pacific Ocean.

Last glacial – Holocene chronology of sediment cores from a high-altitude Tibetan lake based on AMS ^{14}C dating of plant fossils

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We obtained ~4 m-long piston cores from a high-altitude lake (Lake Pumoyum Co; altitude, ~5020 m asl; lake surface area, 280 km^2; maximum water depth, ~65 m) on the southeastern Tibetan plateau for reconstruction of environmental changes during the last glacial – Holocene transition. In this study, we established the chronology for sediment cores from Lake Pumoyum Co, ca. 18.5 cal ka BP at the bottom, by ^{14}C analyses of terrestrial plant residue concentrates (PRC, >125 μm) and aquatic plant residues. The calibrated ages of the PRC fraction in the surface sediment were nearly modern (0.1 ± 0.1 cal ka BP), and the $\delta^{13}C$ values (–22 ‰ to –24 ‰) were agreed well with those of modern terrestrial C3 plants. In addition, we estimated ^{14}C reservoir ages of macrophyte remains from changes in their $\delta^{13}C$ values. The major climate boundary layers in the cores (transitions to Bølling-Allerød, 14.5 ± 0.5 cal ka BP; Younger Dryas, 12.8 ± 0.1 cal ka BP; and Preboreal, ~11.6 cal ka BP) were confirmed by our ^{14}C chronology. The transition to the Bølling-Allerød warm phase from the last glacial (14.5 ± 0.5 cal ka BP) coincided with an obvious lithologic boundary (a rapid decrease in the abundance of the macrophyte remains) in the Lake Pumoyum Co sediment cores.

Climate control of sulfate flux into Lake Hovsgol, Mongolia, during the last glacial–postglacial transition: Constraints from sulfur geochemistry

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Lake Hovsgol, Mongolia, in the interior of the Eurasian continent formed through the development of the Baikal rift zone. Its age is constrained between 2.5 and 4 Ma. Sediment samples from Lake Hovsgol have attracted researchers as paleoclimatic archives of the last 4 Ma. Several global paleoclimatic and paleoenvironmental studies have revealed drastic environmental changes at Lake Hovsgol. For example, the last glacial–postglacial (LGPG) transition have been clearly linked to an increase in primary productivity, a rise in lake level (Prokopenko et al., 2005), and a salinity change in the lake water.

Two sediment cores (cores X104 and X106) that record paleoenvironments since ca. 25 cal ka BP, were recovered from Lake Hovsgol in Mongolia. Total sulfur (TS) concentrations are very high (up to 0.4 wt%) in both cores during the last glacial–postglacial transition (LGPG) (from 22 to 11 cal ka BP) in Lake Hovsgol. TS and total organic carbon (TOC) are strongly correlated in both core samples during the LGPG transition (correlation coefficients are 0.85 for core X104 and 0.80 for core X106). The high concentration (up to 0.4 wt %) of TS is found in pyrite-rich layers that correspond to the LP-GP transition in both cores. These results suggest that the activity of sulfate-reducing bacteria was dependent on the availability of organic matter, yielding high concentrations of TS during this period. The slope of the regression of TS against TOC (C/S ratio) during the LGPG transition (0.20 for cores X104 and X106) implies that the sulfate concentration of Lake Hovsgol increased at that time to a level comparable to normal marine waters. The high $\delta^{34}S$ values (up to +32.3 ‰) in the high-TS layers suggest that the sulfate supplied to Lake Hovsgol during the LGPG transition was derived not only from the rainfall entering Lake Hovsgol and increased weathering of soils but also from glacial meltwater carrying sulfate from Cambrian evaporites in the region. These results imply that rapid climate change from dry to wet associated with global warming caused the change of water salinity in Lake Hovsgol.

Archaeological and historical proxy data on sea-level rise in medieval coastal Flanders: their indicative meaning and interpretation

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A wide range of several archaeological and historical data on settlement, dike building, storms and environmental management in coastal Flanders has been brought to the attention since the last ten years. Several doctoral studies and projects have indeed revealed many data and have provided new approaches to the use and interpretation of these data, showing both their analytical and interpretative value for studying sea-level changes in the historical period in coastal Flanders. New archaeological research has shown that certain zones of the salt marsh environment of Flanders were already inhabited from the 8th century onwards. Especially silted up tidal channels were favourable for these earlier settlements. Also artificial dwelling mounds were raised in order to construct collective settlements in the coastal plain in the early medieval period. Landscape historical research has provided information on how and when the first embankments of the coastal plain took place. Specifically, these embankments can be brought in relation to social, economic and political processes and can be seen as contextual landscape transformations in which the exercise of socio-economic and political power played a decisive role. At the same time, these embankments had important consequences for the relation between men and their environment. Many sources describe the unforseen inundation problems that started after the embankment of coastal Flanders. Some interesting charters on peat extraction on the beach near Ostend show how the medieval beach and dune system in this area was eroded heavily by 1200. The disappearance of coastal villages during the 14th century provide also information on this process of coastal erosion, while specific new dike types behind the dune belts show how people tried to react against heavy sand drifts between the 13th and 16th centuries. These and similar data have to be studied by paying attention to their chronological and spatial context in order to get a good understanding of their meaning and how they can help us to understand sea-level rise in medieval coastal Flanders in an interdisciplinary perspective.

Pre- and protohistoric settlement and land-use systems in Sandy Flanders (NW Belgium): a diachronic and geoarchaeological approach

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The area of Sandy Flanders, situated between the North Sea coast and the lower course of the Scheldt River in NW Belgium, is a relatively flat and low-lying area situated at the southern limit of the lowland cover sand region of the NW European plain. During the Late Pleniglacial and the Late Glacial, numerous, generally small but elongated sand dunes, shallow lakes and wet depressions were formed.

During the last three decades intense archaeological prospection has taken place in this region, which is now one of the most intensively surveyed areas of NW Europe. This has led to the production of archaeological distribution maps, which show a distinct pattern regarding the temporal and spatial distribution of these archaeological sites. Some areas with a presumed high ecological value, such as the large but shallow Late Glacial fossil lake of the Moevaart Depressie (ca. 15km long and 2,5km wide), seem to have been attractive settlement locations in Prehistory, given the high amount of close-lying sites along its borders and on the cover sand ridge on its northern border. Habitation however seems to have 'moved' in time, and is completely absent in Protohistory and even the Roman Period.

During the Late Glacial and Holocene the landscape in the Belgian area of Sandy Flanders was subjected to major changes due to climatic fluctuations, and besides human factors, environmental conditions such as topography, soil, vegetation, but also hydrology and climate, may have influenced settlement conditions throughout time and played a role in this change in site location and the occupational history of the region.

In this light an inter-disciplinary project *'Prehistoric settlement and land-use systems in Sandy Flanders (NW Belgium): a diachronic and geoarchaeological approach'* (GOA project, UGent), involving archaeology, geography, palaeoecology, sedimentology and geophysical survey, has been undertaken. The study of both "empty" and densely inhabited areas is ongoing and aims at analyzing the settlement dynamics of the area of Sandy Flanders in terms of environmental potentials (theory of "wandering farmsteads") and the human impact ("enculturation") on the landscape. Likewise, we seek to investigate the reasons why other areas, which were inhabited in previous periods (e.g. the Moervaart area) were apparently not attractive anymore from the Metal Ages onwards. Indeed, to determine the suitability of a certain land type for a certain activity, it is necessary to understand the different types of land use (hunting-gathering, farming,...), the soil characteristics and the environment at different time intervals.

During a large field campaign, a 70m long trench was dug through the deepest part of the former Moervaart lake, revealing alternating layers of (organic) lake marl and peat(y clay) indicating warmer/colder and drier/wetter phases. In addition, 15 mechanical corings have been made at four different locations within the depression, in large palaeochannels that cross the palaeolake, and on its borders. Both trench and corings were extensively sampled for palaeoenvironmental and sedimentological analyses and for OSL and ^{14}C-dating.

We present here the problematic, objectives and research strategies of the project, as well as the different methodologies involved, which are expected to provide new insights in the

palaeolandscape evolution of this area during the Late Glacial and the early Holocene, in order to evaluate in detail how and to which degree this evolution determined the pre- and protohistoric occupation and exploitation within Sandy Flanders.

Holocene fluvial sedimentation and human activities in the coastal valley of Sissi, northern Crete

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The Kephali hill at Sissi (northern Crete) is of major cultural interest since it carries a Minoan settlement (3000-1190 BC), close to the Minoan "palatial" site of Malia. Geoarchaeological investigations were carried out in the valley west of the hill on the basis of hand-operated auger cores. The geoarchaeological researches at Sissi bring important information for the understanding of Bronze Age occupations of coastal valleys in Crete, and their relations with river responses to seasonal and longer-term climatic fluctuations. Data from Sissi also suggest the existence of a buried Final Neolithic/Early Bronze Age to Late Bronze Age horizon of open-air settlements and occupation areas in the coastal valleys of Crete.

Four facies units (Units 1 to 4 from top to bottom), all deposited in a fluvial environment, were identified in the western valley. Unit 2 may correspond to hybrid deposits accumulated by Bronze Age anthropogenic activities and fluvial sedimentation. Units 3 and 4 appear consistent with a wetter Early-to-Middle Holocene climate. In the western valley, the discovery of Final Neolithic/Early Bronze Age to Late Bronze Age pottery sherds in Unit 2 suggests that the first agricultural activities occurred on or in the direct vicinity of abandoned channel fills. This wet area may have provided early farmers with easily accessible groundwater for the irrigation of drier parcels, and encouraged the cultivation of cereals during spring time. It may also have offered a permanent source of drinking water.

Archaeoseismology from a Mediterranean Perspective: Past, Present and Future

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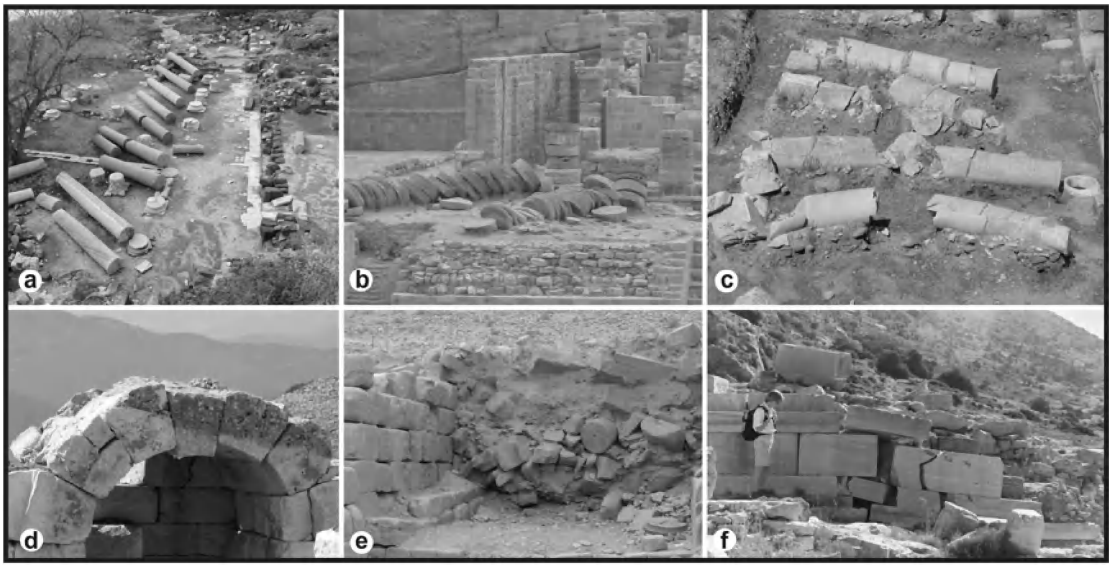
The combination of high seismicity and a high density of archaeological sites, spanning some millennia of world history, makes from the Mediterranean region one of the most exquisite testing grounds for **archaeoseismology** – the study of ancient earthquakes through traces left into the archaeological record. It is thus no surprise that the Mediterranean is the 'cradle' of this burgeoning scientific discipline. The Mediterranean is indeed not only home of some of the most ancient civilizations in the world, it is also part of one of the seismically most active regions in the world. Seismic activity in much of this Alpine-Himalayan seismic belt is distributed across an often diffuse network of active fault line, individual segments of which rupture every few centuries or millennia. A better understanding of the activity of these faults, ultimately improving the assessment of the potential hazard from large earthquakes, has an ever increasing societal benefit taking into account the growing megacities in the Mediterranean region (e.g. Istanbul, Tehran).

The bulk of archaeoseismological research in the Mediterranean has drawn from the rich architectural heritage. In this respect archaeology may provide crucial information in three ways. First, archaeological constructions displaced across fault lines can be used not only to locate active faults but also to determine the type and amount of coseismic and cumulative slip, and derive time-averaged slip rates. Second, ancient buildings can be studied for structural evidence of ancient seismic shaking. The forensic examination of the distorted architecture, such as overturned columns, sunken arches and collapsed masonry, may reveal how ancient monuments fail under seismic shaking and indicate levels of shaking that can be expected in a region, crucial information which can be used in designing local building codes. Third, cultural relics and artifacts (e.g. distinctive pottery types, coin hoards) included in destruction layers can be used to discriminate the history of successive ancient earthquakes.

Reflecting on archaeoseismology from a Mediterranean perspective, a clear evolution can be discerned. Pioneering archaeologists, such as Heinrich Schliemann at Troy, Sir Arthur Evans at Knossos and Claude Schaeffer at Ugarit, introduced earthquakes into archaeology. Earthquakes simply added drama and conjecture to their site's history. But the imprecise age control inevitably lead to discrete multiple seismic events being amalgamated, thereby giving rise to apocalyptic seismic catastrophes. While critics portray this view as neocatastrophism, advocates see the earthquake hypothesis as the simplest solution. The question should, however, be asked if calling upon earthquakes isn't an easy trap in the earthquake-prone Mediterranean. What started as an 'extravaganza' in a good story (*archaeological perspective*), turned into a multidisciplinary effort to get a maximum amount of information on the parameters of ancient earthquakes from archaeological evidence. From this *seismological perspective*, archaeoseismology bridged the gap between instrumental and historical seismology on one side and palaeoseismology and earthquake geology on the other. The archaeological record of ancient earthquakes would seem ideal to augment the grossly incomplete historical record of past seismicity. But once again some pitfalls added to the skepticism maintained by many earthquake scientists. The danger indeed exists that the anomalous earthquakes, supposedly proven by archaeologists, are used by seismologists as real events in a seismic-hazard assessment. By correlating archaeological evidence, often with a rather poor temporal resolution, with documented earthquakes in historical catalogues the risk of circular reasoning is imminent. The question needs to be asked if archaeological evidence can actually provide the information seismic-hazard practitioners really need.

However, archaeological sites may have a potentially unique value in earthquake science. Rather than simply augmenting earthquake catalogues with, potentially highly conjectural,

ancient earthquakes, archaeological sites can be used strategically to examine specific earthquake scenarios (*archaeoseismological perspective*). In this context, archaeological sites become *'seismoscopes'*, a testing ground for predicted site effects of ancient earthquake models (quantitative archaeoseismology).



Classical examples of earthquake-characteristic structural damage: (a) series of aligned overturned columns (Susita, Golan Heights); (b) overturned columns (Petra, Jordan); (c) series of aligned overturned columns on top of destruction layer (Knidos, Turkey); (d) subsided keystone in an arch (Sagalassos, Turkey); (e) destruction layer (Petra, Jordan); (f) faulted temple wall (Knidos, Turkey).

But maybe the scope and goals of archaeoseismological research should still be broadened, benefiting from more intimate collaboration between earthquake scientists and archaeologists in deciphering the precise role of earthquakes in the cultural history of a site. By highlighting how ancient cultures dealt with and responded to damaging earthquakes, archaeoseismology could play a key role in fostering better earthquake preparedness in modern local communities that are equally threatened, and establishing the essential earthquake culture in a region (*sociological perspective*). The International Geoscience Programme IGCP567 *Earthquake Archaeology* provides the forum to pursue these goals (http://ees.kuleuven.be/igcp567/).

Documentation of evolutionary punctuations in the morphology of Bellamya gastropods from Lake Malawi utilising quantitative genetic models

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Punctuated equilibrium evolution claims that phenotypic evolution is concentrated in punctuations separated by long-lasting morphological stasis. Punctuations are hard to study because they occur faster than is observable in the fossil record, but generally too slow for study on biological timescales. Here we study an evolutionary punctuation in four endemic *Bellamya* gastropod species, recently derived from a common ancestor preserved in early to middle Holocene, radiocarbon-dated lacustrine deposits in the Malawi Basin to study geological punctuations with a combined neontological-palaeontological approach. Morphometric comparison of extant and fossil morphs with semi-landmark analysis and traditional measurements results in a 3.1-5.5 times morphospace expansion since the middle Holocene. If the associated cladogenetic events were gradual on biological timescales, Lynch Delta rates of morphological evolution cannot be separated from the neutral expectancy of genetic drift. If they represent punctuations even on a biological timescales, modelling according to displaced optima indicates that adaptive shifts towards new optima and hence the morphospace expansion likely completed within 25 to 500 years for each cladogenetic event. Associated Lynch Delta rates of morphological evolution fall within or above the neutral expectancy of genetic drift, but are slower or equal to rates commonly observed in selection experiments, suggesting that punctuated speciation such as that of *Bellamya* in Lake Malawi can entirely be explained by natural selection on generational timescales. Molecular work on the extant species indicates that at least on a geological timescale, the observed phenotypic change and speciation co-occurred. Morphological conservatism in African *Bellamya* species, geographically isolated in rivers of separated drainage basins, lead to the construction of pseudo-stationary lineages, whereas disparity increased by morphological adaptation to lacustrine environments.